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Final Report

Benefits of reuse
Case Study: Office Furniture

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Front cover photography: Recycled Products - Office Furniture (ID: 4368)

Executive Summary

In 2009, WRAP published *Meeting the UK Climate Challenge: The Contribution of Resource Efficiency*. This showed that one of the best resource efficiency strategies for reducing greenhouse gas emissions was reuse[1].

WRAP has developed a specific methodology for quantifying the benefits of reusing products. This can be applied to a range of products using an accompanying excel-based tool to provide a consistent means of assessing the impacts of different activities. The tool allows the calculation of three environmental indicators (i) greenhouse gas emissions, (ii) energy demand and (iii) resource depletion, and two economic indicators (i) number of jobs and (ii) financial impacts, as well as where these occur in the supply chain. This methodology is outlined in www.wrap.org.uk/benefitsofreuse.

The methodology and tool has been tested for specific clothing, furniture and electrical products. This case study describes the results for office furniture products.

The products chosen were an office desk and chair.

Office Desks

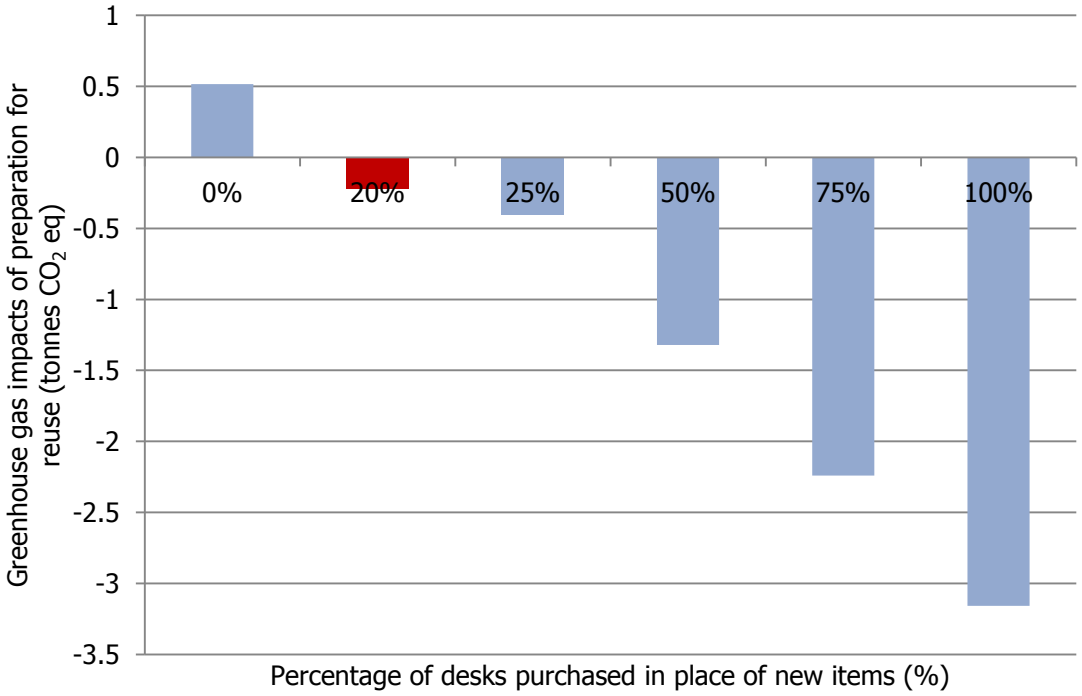
Approximately 200,000 desks (ca 5000 tonnes) are reused in some way in the UK every year. This is approximately 14% of desks reaching the end of their life each year. The remainder go to landfill, energy recovery and recycling.

The key environmental, financial and employment benefits associated with this reuse activity are:

- Current levels of reuse of desks avoids 3,600 tonnes CO_2-eq per year.
- Providing 1 tonne of desks for direct reuse e.g. second hand shop or eBay can result in a net GHG savings of 0.4 tonnes CO_2-eq when compared to landfill.
- Providing 1 tonne of desks to a preparation for reuse network can result in a net GHG saving of 0.2 tonnes CO2-eq compared to landfill.
- Each desk reused can yield over £80 net revenue to reuse organisations / government in combination (discounting wider costs or losses to householders, offices or businesses)
- Businesses are estimated to spend £9 million per annum disposing of desks to landfill.
- Businesses benefit by £8.2million per year as a result of purchasing reused desks in place of new desks. However, they also spend £13.9 million per year on reused desks which do not displace new products, giving a net cost to purchasing businesses of £5.7 million.
- The net employment benefit of dealing with all desks that reach the end of their life today (business-as-usual) is 200 jobs. There are approximately 150 jobs in reuse organisations.
- The most important parameter for all indicators is the extent of avoiding the purchase of new desks as a result of reuse – the so-called displacement effect. Figure i below shows how greenhouse savings vary with different displacement effects for preparation for reuse, with the current, business-as-usual situation highlighted in red. If all desks reused through this pathway were bought in place of new items, the greenhouse gas savings could increase to almost 2.5 tonnes CO_2-eq per tonne desks. This highlights that the impact of reuse is determined by whether or not the person purchasing a reused desk does so in place of a new item or not.

[1] *"Reuse" covers reuse, repair and refurbish*

Figure i Change in environmental impact of preparation for reuse of office desks with substitution rate, compared to landfill (tonnes CO_2 eq per tonne desks).



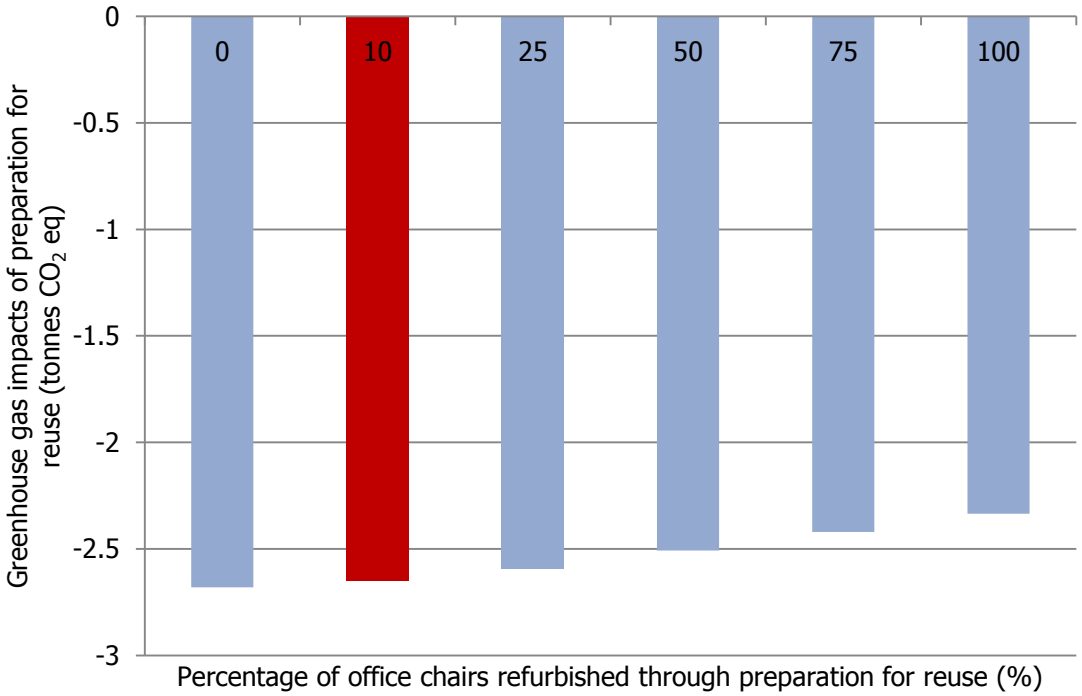
Office Chairs

Approximately 295,000 office chairs (3,500 tonnes) are reused in some form in the UK every year. This represents 14% of all office chairs reaching the end of their life each year. The remaining 86% are sent to recycling, energy recovery or landfill.

The key environmental, financial and employment benefits associated with this reuse activity are:

- Current levels of reuse of office chairs avoids 12,000 tonnes CO_2-eq per year.
- Providing 1 tonne of office chairs for direct reuse e.g. second-hand shop or eBay can result in a net GHG saving of 3 tonnes CO_2-eq. This is just over 35kg CO_2-eq per chair.
- Providing 1 tonne of office chairs to a preparation for reuse network can result in a net GHG saving of 2.6 tonnes CO_2-eq net. This is approximately 30kg CO_2-eq per chair.
- The proportion of chair requiring refurbishment does not significantly alter the environmental benefits of preparation for reuse. This is illustrated in figure ii below. The reason for this is the relatively low impact of refurbishment compared to the higher impact of avoided production.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each chair reused can yield over £6 net revenue to reuse organisations (discounting wider costs or losses to householders, offices or businesses)
- Business users and households benefit by over £6m per year as a result of sale of items through reuse exchange and avoiding purchase of (more expensive) new items.
- The *net* employment benefit of dealing with all office chairs that reach the end of their life today (business-as-usual) is 20 jobs.

Figure ii Change in environmental impact at different levels of refurbishment of office chairs through preparation for reuse (tonnes CO_2 eq per tonne of chairs)



Office Furniture

We estimate that office desks and chairs for about 21% and 13% respectively of all office furniture that reaches the end of its life in any particular year. The net benefits of reusing all office furniture are obviously even higher than for the individual categories above. The results above can be extrapolated for all office furniture, especially for the financial benefits. For the employment opportunities and environmental benefits, we recommend more caution as the results are strongly dependent on the question of whether or not reused items are more or less likely to substitute for imported or domestically produced goods and the material composition of the product.

The environmental impact of reuse is also influenced by the material composition of the reused item, and the item it displaces. Office chairs typically comprise several materials including materials with high carbon intensities. Desks generally comprise wood and small quantities of metal and plastic. As wood has a relatively low environmental impact under the indicators selected, the burden avoided by reuse is relatively small.

Next steps

This project to understand the benefits of reuse has clearly indicated the need to improve the quality of the primary data used in the tool and make the conclusions more robust. WRAP would like to work with stakeholders to improve the quality of this data on office furniture contained in the tool. In particular, we encourage research for or sourcing of better quality data on:

- the quantity of reused items displacing new items;
- the manufacturing burdens associated with new desks and office chairs;
- the propensity of reused items to displace imported or domestically produced items;
- the employment needs and costs for checking and preparing reused items.

Contents

Glossary

Preparation for reuse	*Means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing .* (Waste Framework Directive 2008)
Private costs	*Costs that are incurred to an individual or firm when they are carrying out the activities of consumption or production. They include costs of labour, rent, taxes and transfers, and with the costs of capital reflecting market rates.*
Reuse	*Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived (i.e. dealing with waste prevention); (Waste Framework Directive 2008)*
Social costs	*The total costs of an activity to society. As such, the social cost excludes taxes and transfers which move money from one part of the economy to another, but do not add to or remove from the overall balance.*

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1.0 Office Furniture: Office Desks

This chapter discusses office desk reuse in the UK and provides an estimate of the net environmental and economic, both financial and social, benefits of the current levels of office desk reuse and the potential impact of increases in reuse.

An 'average' desk is assumed to be the item replaced by reusing a desk. This is modelled as being made of MFC board (80%), low alloyed steel (19%), ABS plastic and lacquer (1%).

This chapter outlines:

- An overview of desk reuse in the UK, including material flows from the end of their first life through the various reuse and disposals routes.
- The methodology and data quality issues relating to this analysis of the benefits
- The current business-as-usual situation today for desks with some scenario analysis for:
    - environmental benefits
    - financial costs
    - employment opportunities
- The key conclusions

1.1 Office desk reuse in the UK

Furniture reuse in the UK is a well-established practice, facilitated principally through members of the Furniture Re-use Network (FRN), a national co-ordinating body for appliance reuse and recycling organisations. Another important reuse pathway is via commercial second-hand shops. Some office furniture is also likely to pass via free and paid exchanges, such as Ebay or Freecycle, although numbers of items are more difficult to quantify.

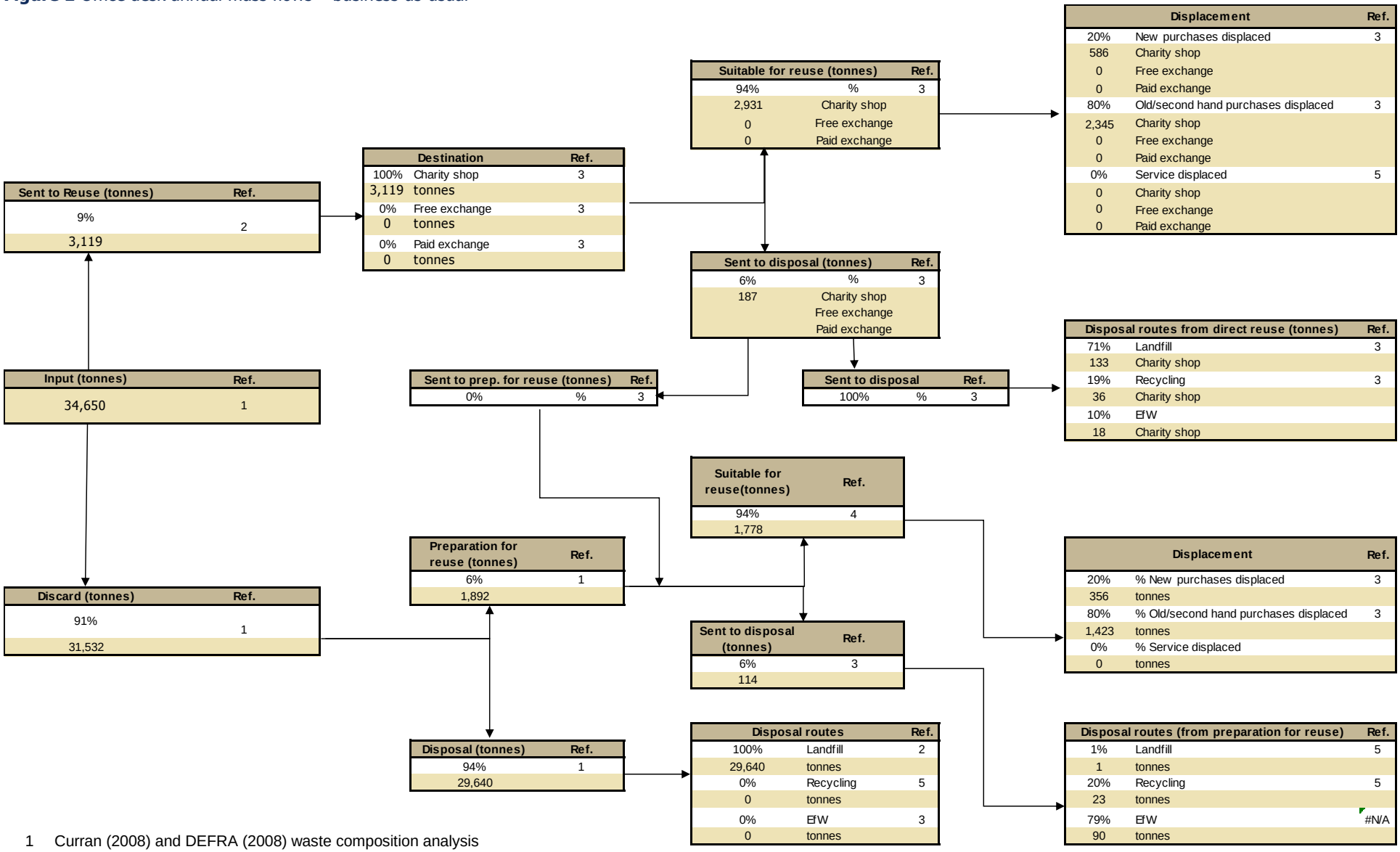
Bartlett (2009) estimates that 165,000-200,000 tonnes of office furniture are sold in the UK every year. Data from ONS (2011a) on net sales suggests that 96,800 tonnes of office and shop furniture was consumed in the UK in 2010. However, there are inconsistencies within the net figure may in some cases underestimate consumption. For example, the trade data shows that although the UK made no metal office desks, we imported 962 tonnes of metal office desks, we exported 1,431 tonnes, with a net balance of -468 tonnes. In addition, ONS data also shows 123,500 tonnes of office and shop furniture were imported, more than net supply, with some implicit re-exports. To allow for these potential differences, Bartlett's estimate has been used as an estimate of UK consumption and disposal. 21% of office furniture is assumed to be desks, based on UEA (2003) and ONS (2011a) ONS (2011b) suggests 19,000 were employed in 940 enterprises in the office and shop furniture industry in 2009, a reduction from 22,000 in 1,075 enterprises in 2008.

WRAP has developed estimates of annual office desk waste arisings and subsequent fates, as outlined in Figure 1. This sets out the 'business-as-usual' profile modelled in this assessment, with 'direct reuse' characterised by local reuse through second-hand shops and 'preparation for reuse' characterised by a national, or regional, furniture reuse organisations.

The Figure can be used to trace the fate of office desks - approximately 35,000 tonne/year – passing through the various pathways. Key estimates are made of the percentage of new office desk purchases that are avoided as a result of the reuse action. This is called the displacement effect.

Figure 2 shows the final destination of office desks which pass through the different pathways identified in Figure 1. Only 14% of office desks that reach the end of their life are reused.

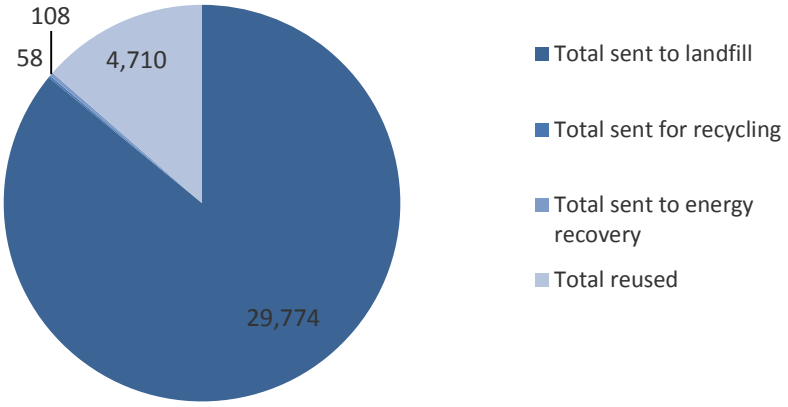
Figure 1 Office desk annual mass flows – business-as-usual



References

1 Curran (2008) and DEFRA (2008) waste composition analysis
2 75% bulky waste collections, 6% of voluntary collections and 9% HWRC to landfill
3 Curran (2008) and Charity Retail Assocation (2010) data
4 FRN
5 Green-Works

Figure 2 Final Destination of Office Desks– 'business-as-usual' (tonnes)



1.1.1 What does 'direct reuse' look like for office desks in this assessment?

The general definition of 'direct reuse' for office furniture are those routes where which the original owner makes a conscious choice, or takes direct action, to enable reuse. For office furniture, the principal pathway for this is thought to be via **second-hand shops** (as opposed to charity shops, which do not handle significant tonnages of office furniture).

Whilst there is no evidence of office furniture passing through charity shops, the burdens and costs associated with operating a **charity shop and a second-hand shop are assumed to be similar**, and so second-hand shops are represented as charity shops. This is with the exception of employment implications, where charity shops have a relatively high allocation of volunteer labour. Second-hand shops were assumed not to take on volunteers.

As modelled for charity shops, furniture passing via the second-hand shop pathway is assumed to come **free of collection burdens**. It is assumed that this is a local collection network that is not centrally organised and so transportation is likely to be a relatively small burden, and one that is difficult to characterise. Instead, the financial, employment and environmental costs of direct reuse are incurred solely through sorting, refurbishment and resale overheads, and management of any residual items that are not considered suitable for reuse.

As well as generating income for second-hand shops, the benefits of direct reuse come through the displaced need to produce equivalent items elsewhere in the economy (the '**avoided cost of production**'). As discussed for other products, the amount of new product displacement that occurs is a key consideration – and one that is difficult to quantify with any certainty.

'Functional' items, such as furniture, are likely to be replacement purchases, as opposed to additional purchases (a different situation to that with clothing, for example). They are also 'workhorse' items, which, appropriately looked after, can last a long time. Therefore, it is reasonable to assume that a reused item has enough remaining 'wear' for a second use and that only one reused item is needed to replace a new item (as opposed to other products which for technical or quality reasons may not last as long in a second life). This is supported by market research undertaken by WRAP that compared the lifetimes of furniture items provided to reuse schemes with the anticipated lifetime reported by recipients and found them to be the equivalent.

Whilst potentially having the technical capability to replace a new item, the low cost and potentially lower perceived quality/functionality of reused furniture is such that, in many instances, the purchase of a reused item may not replace the purchase of a new item (and so avoid its production). In this assessment, we have assumed the following as a default, based upon feedback from industry experts. The sensitivity of these assumptions in reporting results is considered in section 1.3.1. The reuse tool that supports this study allows users to alter these assumptions and to analyse the resulting implications.

- **20% of reuse is displacement of a new item**. In the case of office desks, 'displacement of new' assumes that the reused item will directly **avoid the production of a typical office desk** of equivalent weight. The environmental burdens associated with the production of a typical office desk were sourced from a study by the Centre for Remanufacturing and Reuse (CRR), Chapman (2010). This study presents the results of a full life cycle carbon footprint of a standard 1.6m x 0.8m desk consisting of a metal frame, laminated chipboard top and plastic fittings. The study also provides a breakdown of the materials required, and the associated embodied emissions, for a full refurbishment operation involving the replacement of the desk top. A further CRR study (Bartlett, 2009) reports that, of the 9000 tonnes of office furniture collections by FRN members in 2008, less than 1000 tonnes were remanufactured. From this, it has been assumed that, by default and across all office furniture reuse pathways, on average **10% of re-sold items undergo refurbishment**.

- **80% of reuse is displacement of an old item**. This route assumes that a reused item will replace another reused item (e.g. another purchase from a second-hand shop), rather than a new item. In this case, no avoided production is allocated, to avoid the double-counting of such benefits.

A full list of data and assumptions used to characterise the direct reuse pathway is set out in Tables A1, A2 and A3 in Appendix A

1.1.2 What does 'preparation for reuse' look like for office desks in this assessment?

The preparation for reuse pathway for office desks, as well as other furniture, models the collection, refurbishment and sale of desks recovered by centralised networks, such as FRN-affiliated organisations. For office furniture, the major reuse organisation in the UK is Green-Works, a social enterprise scheme that diverts redundant office and school furniture from landfill and provides reused and remanufactured furniture to small businesses, schools and community groups. Green-Works are estimated to process 50%-66% of office furniture reused through reuse networks in the UK.

Preparation for reuse includes the financial, employment and environmental burdens of:

- **collection** – e.g. via commercial waste collection, bring sites or direct delivery from businesses;
- **sorting and refurbishment** operations at handling facilities;
- **delivery of items suitable for reuse** for sale, or gifted;
- **recycling, recovery or landfill of items unsuitable for reuse**; and
- **avoided impacts or benefits** due to the displacement of new items – using the same profile as for direct reuse.

A full list of data and assumptions used to characterise the preparation for reuse pathway is set out in Tables A1, A2 and A3 in Appendix A.

1.1.3 What does 'disposal' look like for office desks in this assessment?

As discarded furniture does not typically end up in the mixed residual waste stream, no office desks are sent to incineration in the model through direct disposal. Consequently, disposal in this study is characterised into just two routes, as follows.

- **Landfill** (the primary direct disposal route) – including collection and subsequent disposal in landfill. Emissions associated with materials degrading in a landfill over an infinite time period are accounted for wherever relevant (no credits are given for carbon storage in landfill).

- **Recycling** (rejects from direct reuse and preparation for reuse activities) – as noted elsewhere, recycling is not typically considered as a disposal route, but is assumed to be so in this study to enable differentiation between reuse at the top of the waste hierarchy, and management routes lower down the hierarchy. Furniture recycling is not well characterised in the existing literature, and so it was assumed that all items are dismantled by hand into their constituent materials and that separated materials are recycled for low-grade applications as applicable (e.g. recycling of low quality recovered wood for use in particle board manufacture, recycling of mixed low grade plastics into plastic lumber, shredding of low quality recovered textiles to produce rags or filling materials).

A full list of data and assumptions used to characterise the disposal pathway is set out in Tables A1, A2 and A3 in Appendix A.

1.2 Quantifying the Benefits of Reusing Office Desks

The section describes the methodology used and data quality issues in the estimation of the environmental and economic benefits of reusing office desks.

1.2.1 Approach to the assessment

For an overview of the approach adopted for this case study please refer to WRAP (2011) *A methodology for quantifying the environmental and economic impacts of reuse.*

1.2.2 Data quality

Tables A1, A2 and A3 in Appendix A set out all of the data sources and assumptions used in the assessment of environmental and financial costs and employment criteria, along with a consideration of their quality and applicability for the study.

The most up-to-date information available has been sourced. However, we note that some considerable uncertainties remain, in particular for:

- Current arisings data is very uncertain on an individual-item basis. The mass flow data for office desks gathered by WRAP suggest that around 10% of office desks currently in circulation enter the waste or reuse stream annually, based on approximately 10 million office workers in the UK (Flexibility, undated).
- Of particular significance for the findings is the proportion of displacement of new items that is assumed. Currently there is no empirical data to support these assumptions, and displacement is based on the view of reuse organisations.
- A general assumption was made that 10% of office desks undergo full refurbishment (replacement of desk top). The significance of this for results is noted in Section 1.3. Alternative assumptions could increase or decrease the environmental impacts associated with reuse significantly and collection of more specific evidence regarding the refurbishment rate for office desks is recommended.
- With regard to environmental impacts, data relating to the displacement value that can be attributed both to reuse (displacing new) and to recycling are of significance. The data used for reused items are from a good source and are considered to be a reasonable representation, but reused items will vary by mass and material composition. Data for furniture recycling are lacking and further research is recommended if specific comparisons are to be made.
- Cost and employment data were provided to WRAP by the steering group partners for the assessment. The best currently available sources have been gathered, but the significant uncertainty and high potential variability of the values used is noted.

1.3 Results and Discussion

1.3.1 Environmental impacts

Environmental impacts: Business-as-usual

This section describes the environmental benefits of office desks for the business-as-usual case, as set out in Figure 1. The indicators are greenhouse gas emissions, resource depletion and global energy demand. The background to these is set out in more detail in methodology document (WRAP 2011).

Table 1 presents the **environmental impacts and benefits associated with the current management, including direct reuse, preparation of reuse and disposal, of all end-of-life office desks estimated to arise in the UK each year**. This includes the impacts associated with waste management activities occurring in the UK, and the benefits of avoided production of materials through reuse and recycling (occurring in the UK or abroad). Due to the uncertainty associated with estimates of yearly waste arisings, net impacts/benefits are also presented for a single desk and a tonne of desks in Table 2.

Table 1 Business-as-usual management: Environmental impacts – UK yearly office desk arisings

Activity	Total UK Office Desks – GHG Emissions (tonnes CO_2-eq)	Total UK Office Desks – Resource Depletion (tonnes Sb-eq)	Total UK Office Desks – Global Energy Demand (MJ-eq)
Reuse pathway	3,480	10	15,700,000
- of which collection	0	0	0
- of which site operation (inc. refurbishment)	949	14	24,000,000
*- of which disposal of residuals**	2,530	-4	-8,300,000
Preparation for reuse pathway	2,530	4	7,410,000
- of which collection	279	2	4,020,000
- of which site operation (inc. refurbishment)	783	5	8,620,000
*- of which disposal of residuals**	1,460	-3	-5,230,000
Disposal pathway	24,300	-41	-81,300,000
- of which landfill	24,300	-41	-81,300,000
- of which incineration	0	0	0
- of which recycling	0	0	0
Reuse displacement effects	-3,660	-21	-34,900,000
	0	0	0
TOTAL	26,700	-49	-93,100,000

Note: negative figures denote a net saving, through displacement of other products/materials and their avoided production
* this includes the recycling of items unsuitable for reuse, or of parts removed following refurbishment. It also includes the ultimate disposal of reused items at the end of their second life (assumed to be landfilled).

Table 2 Business-as-usual management: Environmental impacts

Scale	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
For total UK office desk arisings	26,700	-49	-93,100,000
Per tonne of office desks	0.77	-0.0014	-2690
Per office desk	0.02	-0.00004	-69.9

Note: negative figures denote a net saving, through displacement of materials/energy, and their avoided production

These show that current UK management of office desks results in annual net GHG emissions of approximately 27,000 tonnes CO_2-eq, equivalent to 21kg CO_2-eq per desk handled. This reflects the high proportion of desks that are estimated to be disposed to landfill, discussed further below.

The results for business-as-usual management of office desks are **overwhelmingly influenced by impacts associated with disposal to landfill**. This reflects the very low proportion of reuse or recycling that is thought currently to be the case for office furniture.

Table 1 and Table 2 also show a different profile of impacts and savings for the different indicators: GHG Emissions, Resource Depletion and Energy Demand. **GHG emissions are positive (net impact) because of the degradation of the wooden components of the desk in landfill**. This material degrades to yield methane, a powerful greenhouse gas. Some of the methane emitted from landfill will be captured and combusted to generate electricity that can be exported to the national grid – displacing predominantly fossil-fuel based electricity. Hence we see negative impacts for Resource Depletion and Energy Demand: net savings from the avoided burdens of electricity displacement. There are also GHG savings from electricity displacement, but these are outweighed by the impacts associated with methane that escapes to the atmosphere.[1]

This highlights the fact that wider environmental impacts are sometimes decoupled from GHG emissions so that trade-offs are often required to determine the most 'environmentally friendly' solution. These trade-offs will usually have to be made based on value judgements over which impact is seen as the most important by stakeholders.

As previously noted, there are considerable uncertainties around the 'business-as-usual' flows assessed, and so the values presented should be treated with caution in their absolute sense. The best available data have been used in this respect, but are difficult to determine on an item-by-item basis.

Environmental impacts: Scenario analysis

Table 3 shows the net environmental impacts associated with a range of hypothetical scenarios for office desk management, on a 'per item' basis.

Table 3 Scenario analysis: Environmental impacts per tonne of office desks

Scenario	GHG Emissions (kg CO_2-eq)	Resource Depletion (kg Sb-eq)	Energy Demand (MJ-eq)
Business as usual	0.77	-0.0014	-2690
100% direct reuse	0.39	-0.00115	-1900
100% preparation for reuse	0.60	-0.00201	-3100
100% recycling	-0.07	0.000000908	36.5
100% landfill	0.82	-0.0014	-2740
Current rates of disposal*	0.82	-0.0014	-2740

Note: negative figures denote a net saving, through displacement of materials/energy, and their avoided production

* 100% disposal at current residual management rates (assumed 100% landfill)

Table 3 shows the net **environmental impacts associated with recycling and both reuse pathways** to be **considerably lower than those associated with other management routes** (recycling or landfill).

Because of the high GHG emissions associated with landfilling wooden components, these findings in their comparative sense are not sensitive to the modelling assumptions made. There is always an **environmental benefit associated with diverting office desks from landfill.**

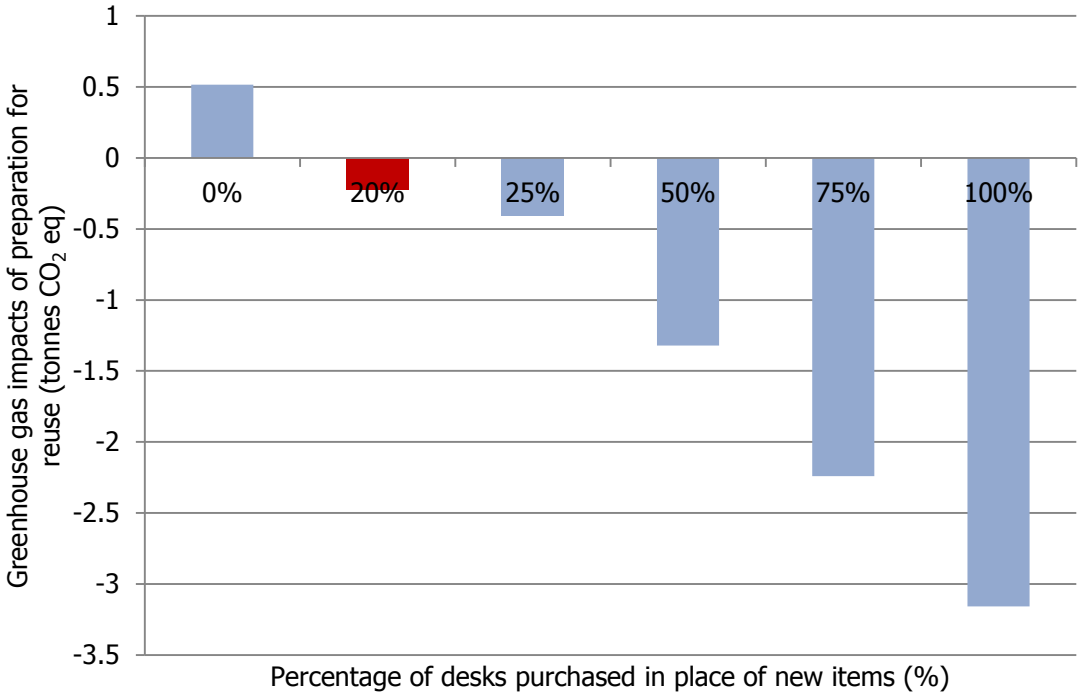
([1]) Note – there are different approaches to accounting GHG emissions over time. This assessment does not include any carbon storage benefits for slowly degrading materials in landfill. There are methodologies that consider the benefits of delaying greenhouse gas emissions and manage uncertainties with regard to oxidation rates for gas escaping at some time in the future. The data used in this assessment are consistent with current best estimates (Defra reporting factors, 2010 and the Environment Agency WRATE tool), but this uncertainty is noted.

However, the absolute values presented, in particular for the reuse and recycling pathways, are sensitive to the following variables in particular.

- **In the 'direct reuse' scenario, if the quantity of 'displace new items' is increased from 20% to 50%, net GHG benefits (instead of impacts) are seen.**
- **In the 'preparation for reuse' scenario, if the quantity of 'displace new items' is increased from 20% to 50%, net GHG benefits (instead of impacts) are seen.**

The most important parameter for all indicators is the extent of avoiding the purchase of new desks as a result of reuse – the so-called displacement effect. Figure 3 below shows how greenhouse savings vary with different displacement effects for preparation for reuse, with the current, business-as-usual situation highlighted in red. If all desks reused through this pathway were bought in place of new items, the greenhouse gas savings could increase to 2.5 tonnes CO2-eq per tonne desks.

Figure 3 Change in environmental impact of preparation for reuse of office desks with substitution rate, compared to landfill (tonnes CO_2 eq per tonne desks).



- The difference in performance between the direct reuse and preparation for reuse scenarios is subject to the data uncertainties with regard to collection and site operations (see Table A1 in Appendix A).
- Because of the low displacement effect assumed for reused desks**, recycling has a greater GHG benefit than reuse**. This is because only 20% of reused desks are assumed to displace a new product, and 100% of wood from desks is assumed to displace new wood
- It was assumed that 10% of items passing through preparation for reuse pathways require substantial refurbishment or remanufacturing (from Bartlett, 2010). This was represented in the assessment by a full replacement of the desk surface, modelled according to a scenario presented in the CRR report (Chapman, 2010). The remainder of items are assumed to require only labour, and no further material input. Should either greater or lesser refurbishment be required, results for the reuse pathways will be affected accordingly. Importantly, **if all desks require remanufacture before subsequent reuse, increases in net GHG impacts (instead of savings) are seen.**

1.3.2 Financial costs

Financial cost: Business-as-usual

This section describes the financial benefits of office tables for the business-as-usual case, as set out in Figure 1. The background to this analysis is set out in more detail in methodology document (WRAP 2011). However, it is important to note there are two approaches, private metric accounting, which includes landfill tax, and social metric accounting, which does not.

Analysing the business-as-usual case, as set out in *Figure 1*, Table 4 presents costs for each reuse pathway and core activity, split according to the party to whom costs and benefits accrue. These are estimates for the current overall UK annual situation.

Due to the uncertainty surrounding total UK arisings, net costs and benefits on a unit item or unit mass basis are presented in Table 5.

Key points from the results are as follows.

- Financial costs, as with environmental impacts, are dominated by costs associated with disposal and because of this the majority of the financial burden associated with the business-as-usual scenario falls to local authorities.
- A significant proportion (>50%) of waste management costs are associated with collection – predominantly through bulky waste collections. The uncertainty associated with collection costs, and their importance for the financial cost model, has been noted for other products and is significant for the assessment of office desks.
- The reuse organisations and householders/offices are the main financial beneficiaries of reuse activities, as may be expected. For the reuse organisations, a net income of about £5m per year is seen, as estimated sales exceed operating costs. For householders/ offices, a net saving through avoided purchases is seen.
- Both reuse organisations sales estimates and avoided purchases can be considered, at best, a high-level estimate. Data sources and quality considerations are presented in Table A2 in Appendix A.
- Savings to business are achievable however there will be an equal cost to retailers/industry through lost sales. Some of this lost revenue will occur outside the UK, but is recorded for completeness.
- The uncertainty associated with the quantification of financial savings from onward employment from reuse organisations, such as Social Fund Community Care Grants is noted but not quantified in this study.

There are uncertainties around 'business-as-usual' flows, and so these values should be treated with some caution in their absolute sense. As discussed for the environmental criteria, the overall findings are sensitive to the assumptions regarding current arisings and flows to different pathways, as well as to the amount of displacement that occurs.

Table 4 Business-as-usual: **Total UK** net cost/benefit (private metric)

Activity	Total UK Net Cost/Benefit (£)	…of which to Waste Mgt Companies**	…of which to Reuse Organisations	…of which onward employment from ROs	…of which to householders / offices***	…of which to business****
Reuse pathway	£5,580,000	£1,190,000	£4,400,000			
- of which collection						
- of which site operation	£4,400,000		£4,400,000			
*- of which disposal of residuals**	£1,190,000	£1,190,000				
Preparation for reuse pathway	£1,590,000	£720,000	£870,000			
- of which collection	£433,000		£433,000			
- of which site operation	£438,000		£438,000			
*- of which disposal of residuals**	£720,000	£720,000				
Disposal pathway	£9,650,000	£9,650,000				
- of which landfill	£9,650,000	£9,650,000				
- of which incineration						
- of which recycling						
Displacement effects and sales	-£308,000	-£308,000	-£17,500,000		£5,710,000	£11,700,000
Onward employment from reuse orgs	-£5,000			-£5,000		
TOTAL	£16,507,000	£11,252,000	-£12,230,000	-£5,000	£5,710,000	£11,700,000

Notes:
negative figures denote income or avoided purchase, based on approximately 90,000 new desks displaced (7% of total arisings avoid new purchases)

* this includes the disposal of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (assumed landfill). It includes treatment costs, collection costs and revenue from recyclate, where applicable.

** for the private metric this includes landfill tax.

*** benefits accruing to businesses as a result of the sale of items through paid exchange and through avoiding the purchase of new items. This is net of the income to charity shops/PFR organisations, which is assumed to come from householders/offices purchasing reused items.

**** cost to manufacturers/retailers of displaced new desks in terms of lost revenue from sales.

By purchasing second hand desks in place of new desks, householders / offices currently save £8.2 million per year. However, 80% of purchase are modelled as additional purchases (i.e. displacing nothing), costing / offices £13.9 million per year. This means that overall there is a net cost of £5.7 million to businesses of purchasing reused desks.

Table 5 Business-as-usual management: Financial cost

Scale	Private Metric (inc. landfill tax) (£)	Social Metric (no landfill tax) (£)
For total UK office desk arisings	£16,507,000	£14,613,000
Per tonne of office desks	£476	£422
Per office desk	£12.40	£11

Financial cost: Scenario analysis

As for the environmental criteria, it is useful to compare the status quo with a range of possible scenarios. Again, costs are considered on a per-item basis, as opposed to considering the unlikely event of a wholesale shift in the treatment of end-of-life desks. Table 6 presents net costs and benefits 'per office desk' for a range of scenarios. Costs include collection, operation (rent, utilities, labour), sales, disposal of residuals and defunct parts, eventual disposal of reused items at end-of-life and the avoided disposal of new items displaced.

Table 6 Scenario analysis: **Financial** costs per tonne of office desks

Scenario	Private Metric (£)	Social Metric (£)
Business as usual	£476	£422
100% direct reuse	£1,730	£1,630
100% preparation for reuse	£776	£682
100% recycling	£204	£204
100% landfill	£325	£277
Current rates of disposal	£325	£277

Note: negative figures denote a net saving, through displacement of other products/materials and their avoided production

Table 6 shows that all pathways for the management of end-of-life office desks result in a net cost to the UK economy as a whole – the highest via the direct reuse pathway. Both reuse pathways provides benefit to businesses through avoided cost of purchase and delivers a profit through sales. However, sales through second-hand shops are considered to incur higher costs in running premises. For both reuse routes, profits to the organisations facilitating reuse are at the expense of retailers of new desks and so the net benefit of these sales is zero.

Note that much of the displaced retail cost will actually be borne by manufacturers overseas. It was not possible in the scope of this assessment to apportion costs in this respect, and so they are included for completeness, and to maintain a conservative perspective. However, it is interesting to note the net cost/benefit of reuse operations in isolation from the wider implications to offices, householders or businesses. Based on the cost data provided by WRAP (sources and assumptions set out in Table A2 in Appendix A), the net costs for reuse pathways were calculated as follows.

100% direct reuse = £1,730 per tonne of desks.
100% preparation for reuse = £776 per tonne of desks.

These comparative costs reflect the higher reported income to preparation for reuse organisations for office desk sales and the higher operational costs of second-hand shops.

1.3.3 Employment opportunities

Employment opportunities: Business-as-usual

This section describes the employment opportunities of desks for the business-as-usual case. The background to this analysis is set out in more detail in methodology document (WRAP 2011). Analysing the business-as-usual case, as set out in Figure 1, yields the following results with regard to employment opportunities.

Table 7 Business-as-usual: **Total UK** employment (full time equivalents, excluding volunteers**)**

Activity	Total UK Net Cost/Benefit (FTE)	...of which to Waste Management Companies	...of which to Reuse Organisations
Reuse pathway	121	1	120
- of which collection	-	-	-
- of which site operation	120	-	120
*- of which disposal of residuals**	1	1	-
Preparation for reuse pathway	30	1	30
- of which collection	10	-	10
- of which site operation	20	-	20
*- of which disposal of residuals**	1	1	-
Disposal pathway	157	157	-
- of which landfill	157	157	-
- of which incineration	-	-	-
- of which recycling	-	-	-
Displacement effects (UK)	-104	-	-
	-	-	-
TOTAL full time equivalents	204	158	149

Notes:
negative figures denote loss of employment
for preparation for reuse, it is assumed that volunteer labour is used in both collection and on site operations
* this includes the recycling of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (assumed landfill)

This analysis indicates that there is a net UK gain of about 200 jobs from current levels of reuse of desks alone. As noted in section 1.2.2, this finding is sensitive to the assumptions on labour for preparation and checking.

Key points from the results are as follows.

- The principal employment benefits currently associated with the end-of-life management of office desks are associated with waste management operations, - and landfill and bulky waste collections in particular.
- Reuse via second-hand shops and preparation for reuse require more labour per tonne than disposal. An increase in reuse activity via these pathways could therefore lead to a benefit in terms of employment.
- The scale of employment is uncertain, for the direct reuse pathway in-particular, where data for employment for charity shops have been substituted for second-hand shops (see Table A3 in Appendix A).
- As for other criteria, there are uncertainties around 'business-as-usual' flows, and so these values should be treated with some caution in their absolute sense.

1.4 Conclusions: Office Desks

Approximately 5,000 tonnes of desks (ca 100-200,000 units) are reused in some way in the UK every year. This is approximately 14% of desks reaching the end of their life each year. The remainder go to landfill, energy recovery and recycling.

The key environmental, financial and employment benefits associated with this reuse activity are:

- Current levels of reuse of desks avoids 3,600 tonnes CO_2-eq per year.
- Providing 1 tonne of desks for direct reuse e.g. second hand shop or eBay can result in a net GHG savings of 0.4 tonnes CO_2-eq when compared to landfill.
- Providing 1 tonne of desks to a preparation for reuse network can result in a net GHG saving of 0.2 tonnes CO2-eq compared to landfill.
- Each desk reused can yield over £80 net revenue to reuse organisations / government in combination (discounting wider costs or losses to householders, offices or businesses)
- Businesses are estimated to spend £9 million per annum disposing of desks to landfill.
- Businesses benefit by £8.2million per year as a result of purchasing reused desks in place of new desks. However, they also spend £13.9 million per year on reused desks which do not displace new products, giving a net cost to purchasing businesses of £5.7 million.
- The net employment benefit of dealing with all desks that reach the end of their life today (business-as-usual) is 200 jobs. There are 149 jobs in reuse organisations.
- The most important parameter for all indicators is the extent of avoiding the purchase of new desks as a result of reuse – the so-called displacement effect. If all desks reused through the preparation for reuse pathway were bought in place of new items, the greenhouse gas savings could increase to 2.5 tonnes CO_2-eq per tonne desks.

The results for business-as-usual management of office desks are overwhelmingly influenced by impacts associated with disposal to landfill, reflecting the low proportion of reuse that currently occurs for office furniture. GHG emissions are high because of the degradation of the wooden components of the desk in landfill. As a result, reuse pathways show significant GHG emissions reductions in comparison with disposal.

Financial costs, as with environmental impacts, are dominated by costs associated with disposal (in particular bulky waste collections) and in view of this the majority of the financial burden associated with the business-as-usual scenario falls to local authorities. When the net cost/benefit of reuse operations is isolated from wider economic implications to offices, householders or businesses, net profits are seen for both reuse pathways – in particular preparation for reuse. This reflects the higher reported income to preparation for reuse organisations for office desk sales and the higher operational costs of second-hand shops.

These findings are not without uncertainty, and the absolute values presented should be treated only as estimates. The following unknowns, or known variations in the different systems assessed, were found in particular to have the potential to affect the overall conclusions:

- the proportion of displacement of new items;
- refurbishment rates for office desks;
- costs and environmental impacts/benefits associated with furniture recycling; and
- costs and employment associated with waste collection and reuse activities.

It is recommended that any further work is focused on enabling better quantification of these elements.

2.0 Office Furniture: Office Chairs

This chapter discusses office chair reuse in the UK and provides an estimate of the net environmental and economic, both financial and social, benefits of the current levels of office chair reuse and the potential impact of increases in reuse.

An 'average' chair is assumed to be the item replaced by reuse of office chairs. This is modelled as being made of plastic (polypropylene/nylon/polyester) (44%), steel (36%), aluminium, (11%), foam (6%) and other materials (ABS/PBT/rubber) (3%).

The chapter outlines:

- An overview of office chair reuse in the UK, including material flows from the end of their first life through the various reuse and disposals routes.
- The methodology and data quality issues relating to this analysis of the benefits
- The current business-as-usual situation today for office chairs with some scenario analysis for:
    - environmental benefits
    - financial benefits
    - employment opportunities
- The key conclusions

2.1 Office Chair Reuse in the UK

Office chair reuse in the UK follows the same pathways as described for office desks. WRAP has developed estimates of annual office chair waste arisings and subsequent fates, and this is shown in Figure 4. This sets out the 'business-as-usual' profile modelled in the assessment, with 'direct reuse' characterised by local reuse through second-hand shops and 'preparation for reuse' characterised by a furniture reuse network, such as Green-Works. As the same flows of furniture have been used to inform both the office desk and chair mass flows, the proportion of items reused and sent to disposal is shown to be the same. However, information from reuse organisations suggests that the fate of items disposed of from preparation for reuse is different, and so the quantities sent to recycling, energy recovery and landfill is different.

The Figure can be used to trace the fate of office chairs - approximately 26,000 tonne/year – passing through the various pathways. Key estimates are made of the percentage of new office chair purchases that are avoided as a result of the reuse action. This is called the displacement effect.

Figure 5 shows the final destination of office chairs which pass through the different pathways identified in Figure 4. Only 14% of office chairs that reach the end of their life are reused.

Figure 4 Office chair annual mass flows – 'business-as-usual'

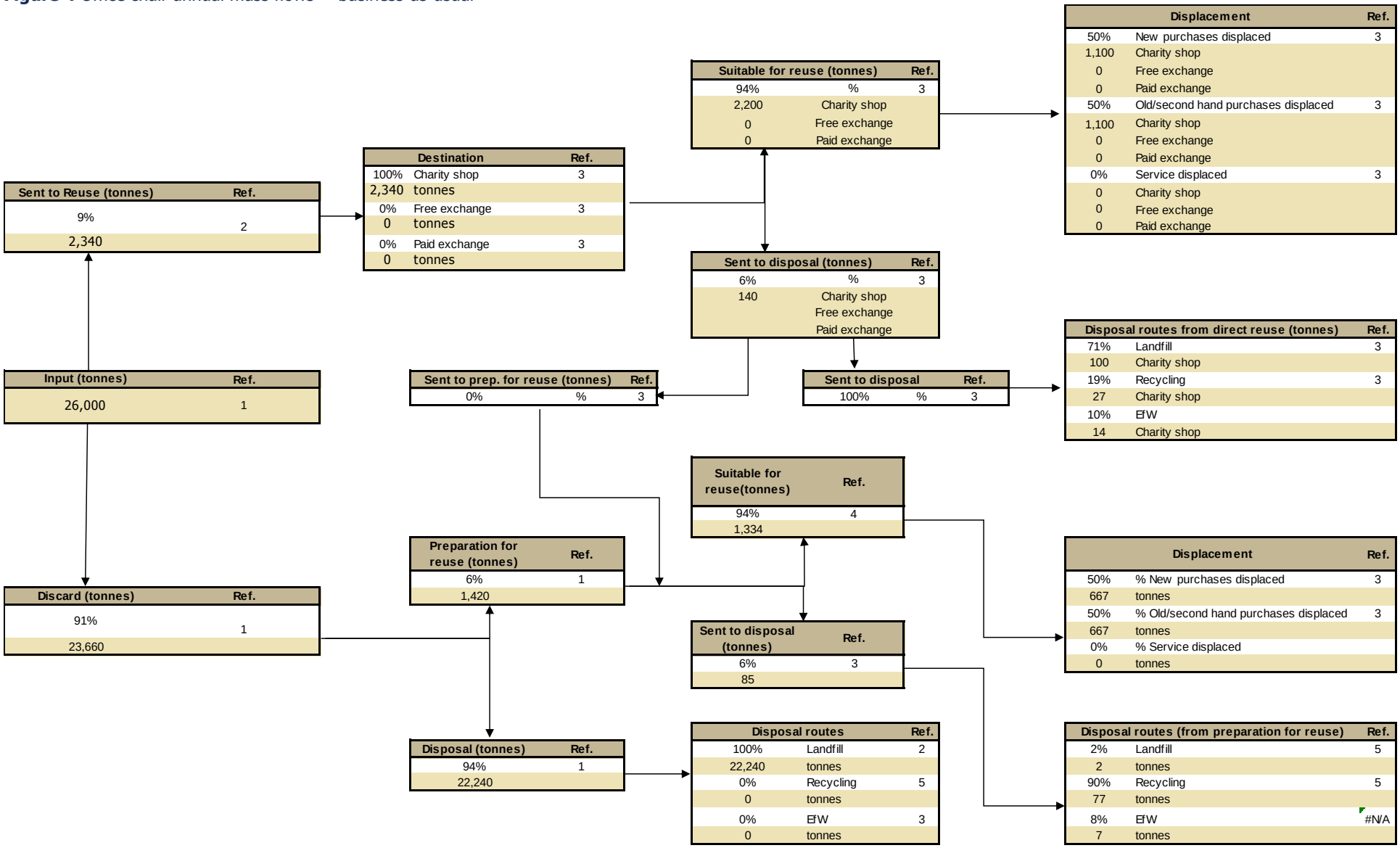
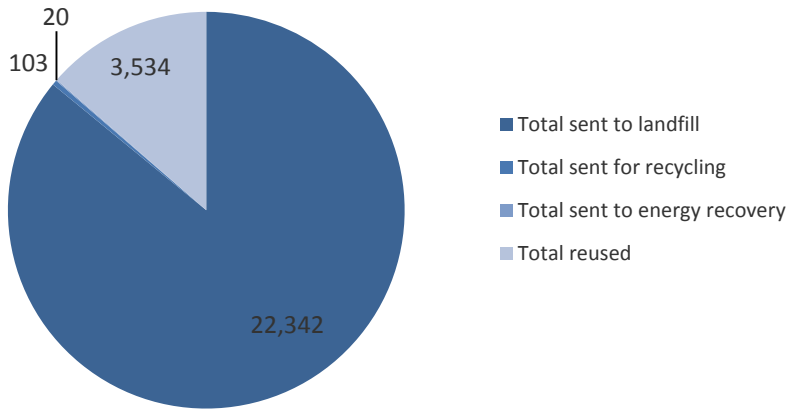


Figure 5 Final Destination of office chairs– 'business-as-usual' (tonnes)



2.1.1 What does 'direct reuse' look like for office chairs in this assessment?

Direct reuse for office chairs is characterised in the same way as described for office desks – see section 1.1.1. The key characteristics for office chairs are:

- The principal pathway is via **second-hand shops**. The burdens and costs associated with operating a **charity shop and a second-hand shop are assumed to be similar**, with the exception that second-hand shops are assumed not to take on volunteers.
- Furniture passing via the second-hand shop pathway is assumed to come **free of collection burdens**.
- Financial, employment and environmental costs are incurred through sorting, refurbishment and resale overheads, and management of any residual items that are not considered suitable for reuse.
- As well as generating income for second-hand shops, the benefits of direct reuse come through the displaced need to produce equivalent items elsewhere in the economy (the '**avoided cost of production**'). With regard to product displacement, the following have been assumed as a default.
- **50% of reuse is displacement of a new item**. In the case of office chairs, 'displacement of new' assumes that the reused item will directly **avoid the production of a typical office chair** of equivalent weight. The environmental burdens associated with the production of a typical office chair were sourced from a CRR report (Chapman, 2010). The CRR study presents the results of a full life cycle carbon footprint of a standard five-point base office chair, as well as a breakdown of the materials required, and associated embodied impacts, for a refurbishment operation involving the replacement of seat and arm foam sections. As with office desks, it was assumed that on average **10% of re-sold items undergo refurbishment**.
- **50% of reuse is displacement of an old item**. This route assumes that a reused item will replace another reused item (e.g. another purchase from a second-hand shop), rather than a new item. In this case, no avoided production is allocated, to avoid the double-counting of such benefits.

A full list of data and assumptions used to characterise the direct reuse pathway is set out in Tables A1, A2 and A3 in Appendix A.

2.1.2 What does 'preparation for reuse' look like for office chairs in this assessment?

The preparation for reuse pathway for office chairs, as well as other furniture, models the collection, refurbishment and sale of chairs recovered by centralised networks, such as FRN-affiliated organisations (e.g. Green-Works). This includes the financial, employment and environmental burdens of:

- **collection** – e.g. via waste management collection, bring sites or direct delivery from businesses;
- **sorting and refurbishment** operations at handling facilities;

- **delivery of items suitable for reuse** for sale, or gifted;
- **recycling of items unsuitable for reuse**; and
- **avoided impacts or benefits** due to the displacement of new items – using the same profile as for direct reuse.

A full list of data and assumptions used to characterise the preparation for reuse pathway is set out in Tables A1, A2 and A3 in Appendix A.

2.1.3 What does 'disposal' look like for office chairs in this assessment?

As discarded furniture does not typically end up in the regularly collected residual waste stream due to its size, no office chairs are sent to incineration. As a result, disposal in this study is characterised into just two routes, as follows.

- **Landfill** (the primary direct disposal route) – including collection and subsequent disposal in landfill. Emissions associated with materials degrading in a landfill over an infinite time period are accounted for wherever relevant (no credits are given for carbon storage in landfill).

- **Recycling** (rejects from direct reuse and preparation for reuse activities) – as noted elsewhere, recycling is not typically considered as a disposal route, but is assumed to be so in this study to enable differentiation between reuse at the top of the waste hierarchy, and management routes lower down the hierarchy. Furniture recycling is not well characterised in existing literature, and so it was assumed that all items are dismantled by hand into their constituent materials and that separated materials are recycled for low grade applications as applicable (e.g. recycling of low quality recovered wood for use in particle board manufacture, recycling of mixed low grade plastics into plastic lumber, shredding of low quality recovered textiles to produce rags or filling materials).

A full list of data and assumptions used to characterise the disposal pathway is set out in Tables A1, A2 and A3 in Appendix A.

2.2 Quantifying the Benefits of Reusing Office Chairs

The section describes the methodology used and data quality issues in the estimation of the environmental and economic benefits of reusing office chairs.

2.2.1 Approach to the assessment

For an overview of the approach adopted for this case study please refer to WRAP (2011) *A methodology for quantifying the environmental and economic impacts of reuse.*

2.2.2 Data quality

Tables A1, A2 and A3 in Appendix A set out all of the data sources and assumptions used in the assessment of environmental, financial cost and employment criteria, along with a consideration of their quality and applicability for the study.

The most up-to-date information available has been sourced. However, we note that some considerable uncertainties remain. In particular, there are the following sources of error or variability.

- Current arisings data are very uncertain on an individual-item basis. The mass flow data for office chairs gathered by WRAP suggest that around 15–20% of office chairs currently in circulation enter the waste or reuse stream annually, based on approximately 10 million office workers in the UK (Flexibility, undated).

- Of particular significance for the findings reported is the proportion of displacement of new items that is assumed. Currently, there are no empirical data to support these assumptions.

- With regard to environmental impacts, data relating to the displacement value that can be attributed both to reuse (displacing new) and to recycling are of significance. The data used for reused items are from a good source and are considered to be a reasonable representation, but reused items will vary by mass and material composition. Data for furniture recycling are lacking and further research is recommended if specific comparisons are to be made.

- Cost and employment data were provided to WRAP for steering group partners for the assessment. The best currently available sources have been gathered, but the significant uncertainty and high potential variability of the values used is noted.

2.3 Results and Discussion

2.3.1 Environmental impacts

This section describes the environmental benefits of office chairs for the business-as-usual case, as set out in Figure 4. The indicators are greenhouse gas emissions, resource depletion and global energy demand. The background to these is set out in more detail in methodology document (WRAP 2011).

Environmental impacts: Business-as-usual

Table 8 presents the **environmental impacts and benefits associated with the current management, including direct reuse, preparation of reuse and disposal, of all end-of-life office chairs estimated to arise in the UK each year**. This includes the impacts associated with waste management activities occurring in the UK, and the benefits of avoided production of materials through reuse and recycling (occurring in the UK or abroad). Due to the uncertainty associated with estimates of yearly waste arisings, net impacts/benefits are also presented for a single chair and a tonne of chairs in Table9.

Table 8 Business-as-usual management: **Total UK** environmental impacts

Activity	Total UK Office Chairs – GHG Emissions (tonnes CO_2-eq)	Total UK Office Chairs – Resource Depletion (tonnes Sb-eq)	Total UK Office Chairs – Global Energy Demand (MJ-eq)
Reuse pathway	696	9	17,200,000
- of which collection	0	0	0
- of which site operation (inc. refurbishment)	490	8	14,900,000
*- of which disposal of residuals**	206	1	2,330,000
Preparation for reuse pathway	670	4	7,840,000
- of which collection	209	1	3,010,000
- of which site operation (inc. refurbishment)	448	3	4,500,000
*- of which disposal of residuals**	13	0	317,000
Disposal pathway	2,210	11	24,700,000
- of which landfill	2,210	11	24,700,000
- of which incineration	0	0	0
- of which recycling	0	0	0
Reuse displacement effects	-12,100	-98	-182,000,000
	0	0	0
TOTAL	-8,470	-74	-132,000,000

Note: negative figures denote a net saving, through displacement of other products/materials and their avoided production
* this includes the recycling of items unsuitable for reuse, or of parts removed following refurbishment. It also includes the ultimate disposal of reused items at the end of their second life (assumed to be landfilled).

Table 9 Business-as-usual management: Environmental impacts

Scale	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
For total UK office chair arisings	-8,470	-74	-132,000,000
Per tonne of office chair	-0.33	-0.00283	-5080
Per office chair	-0.00391	-0.00003	-60.9

Note: negative figures denote a net saving, through displacement of materials/energy, and their avoided production

Table 8 and Table 9 show that **current UK management of office chairs results in net GHG savings** of approximately 8,500 tonnes CO_2-eq, or 4kg CO_2-eq per chair handled. This reflects the relatively inert nature of office chair materials in landfill and the high displacement benefits associated with reuse, discussed further below.

The key finding from these results is that all impact indicators for the 'business as usual' case are negative – ie a net environmental saving. Reasons for this include the following.

- The levels of displacement associated with current levels of reuse. A relatively small proportion of office furniture arisings are reported currently to enter reuse pathways (15% in total). However, the proportion of recovered items that are suitable for reuse is estimated to be high (over 90%) and, of these, 50% are assumed to displace new items. This latter figure is an assumption which has a considerable influence on these findings and it is recommended that its verification be the subject of further research.

- The high displacement benefit associated with the avoided production of new office chairs. The environmental impact associated with the production of new office chairs is high, due to the large proportion of plastic and metal components. As a result, the displacement of these impacts yields a significant environmental benefit. Office chair production impacts were the subject of a study by CRR in 2010, and are thought to be broadly representative of this type of product. However, the weight and material composition of items can vary.

As noted for other products, there are considerable uncertainties around the 'business-as-usual' flows and so the values should be treated with caution in their absolute sense. The best available data have been used in this respect, but are difficult to determine on an item-by-item basis.

Despite the uncertainties noted, there are clear environmental benefits associated with the reuse pathways for end-of-life office chairs. This is because the benefits associated with displacing new items, avoiding the production of new materials, outweigh any impacts associated with transport or handling. This holds true in the majority of cases even if only 5% of recovered items displace new items (see analysis below).

Environmental impacts: Scenario analysis

Table 10 shows the net environmental impacts associated with a range of hypothetical scenarios for office chair management, on a 'per item' basis.

Table 10 Scenario analysis: **Environmental** impacts per tonne of office chairs

Scenario	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
Business as usual	-0.33	-0.00283	-5080
100% direct reuse	-2.96	-0.0224	-41800
100% preparation for reuse	-2.65	-0.0225	-41500
100% recycling	-0.91	-0.00522	-8730
100% landfill	0.10	0.00049	1110
Current rates of disposal*	0.10	0.00049	1110

Note: negative figures denote a net saving, through displacement of materials/energy, and their avoided production

* 100% disposal at current residual management rates (assumed 100% landfill)

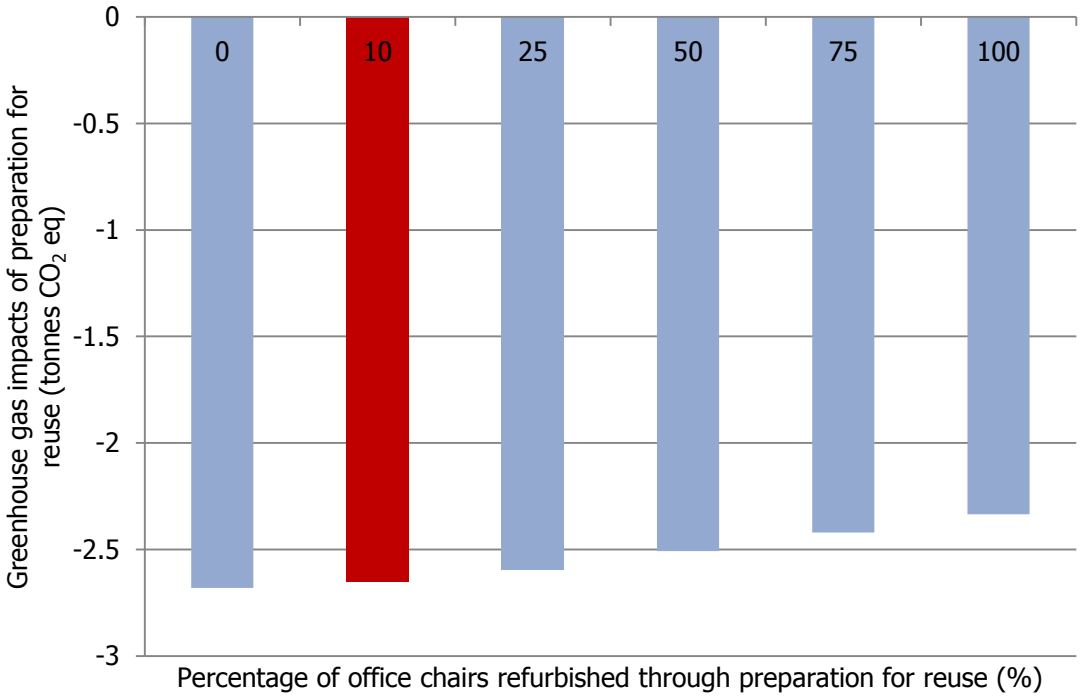
Table 10 shows that the net **environmental impact associated with recycling and both reuse pathways is considerably lower than those associated with landfill**.

These findings are sensitive to the same variables earlier identified. In particular:

- In the 'direct reuse' scenario, if the quantity of 'displace new items' is reduced from 50% to 15%, recycling becomes favourable in comparison with reuse. However, even if 5% displacement of new product is achieved, reuse results in net environmental savings.

- In the 'preparation for reuse' scenario, if the quantity of 'displace new items' is reduced from 50% to 20%, recycling becomes favourable in comparison with reuse. If reduced further to 5%, net GHG impacts (instead of savings) are seen.
- The difference in performance between the direct reuse and preparation for reuse scenarios are subject to the data uncertainties with regard to collection and site operations (Table A1 in Appendix A).
- Assumptions relating to the quality and eventual use of materials recovered for recycling are relatively conservative in this assessment (see Table A1). Conversely, the rate of material recovery for recycling may be optimistic. It is recommended that further research is carried out wherever specific comparisons between reuse and recycling pathways are needed.
- It was assumed that 10% of items passing through reuse pathways require refurbishment (WRAP, 2010). This was represented in the assessment by a replacement of foam sections, modelled according to a scenario presented in the CRR 2010 report (materials only). The remainder of items are assumed to require no further material input, only labour. Should either greater, or lesser, refurbishment be required, results for the reuse pathways will be affected accordingly – but only to a minimal degree. This is illustrated in Figure 6. If all chairs passing through preparation for reuse required some material replacement, net GHG emissions would change from -2.65 tonnes CO_2-eq to -2.3 tonnes CO_2-eq per tonne of chairs.

Figure 6 Change in environmental impact at different levels of refurbishment of office chairs through preparation for reuse (tonnes CO_2 eq per tonne of chairs)



2.3.2 Financial costs

Financial cost: Business-as-usual

This section describes the financial benefits of office chairs for the business-as-usual case, as set out in Figure 4. The background to this analysis is set out in more detail in methodology document (WRAP 2011). However, it is important to note there are two approaches, private metric accounting, which includes landfill tax, and social metric accounting, which does not.

Table 11 presents costs for each pathway and core activity, split according to the party to which costs and benefits accrue. These present estimates for the current overall UK annual situation. Due to the uncertainty surrounding total UK arisings, net costs and benefits on a unit item or unit mass basis are also presented (Table 12).

Key points from the results are as follows.

- Financial costs are dominated by costs associated with waste management activities, principally disposal, and, in view of this, most of the financial burden associated with the business-as-usual scenario falls to waste management companies.
- A significant proportion (>50%) of waste management costs are associated with waste collection – predominantly through bulky waste collections. The uncertainty associated with collection costs, and their importance for the financial cost model, has been noted for other products and has even greater significance for the assessment of office chairs due to the high bulky waste collection cost that has been apportioned to office chairs (see Table A2 in Appendix A for sources and quality considerations).
- The reuse organisations and householders/offices are the main financial beneficiaries of reuse activities, as may be expected. For the reuse organisations, a net income of about £3m per year is seen, because estimated sales exceed operating costs.
- Both reuse organisations sales estimates and householder/office avoided purchases can be considered, at best, a high-level estimate. Data sources and quality considerations are presented in Table A2.
- Savings to householders/offices are only achievable with an equal cost to retailers/industry through lost sales. Some of this lost revenue will occur outside the UK, but is recorded for completeness.
- The uncertainty associated with the quantification of financial savings from onward employment from reuse organisations is noted in the methodology (WRAP 2011). It is likely that in some circumstances furniture reuse will lead to additional savings on social welfare payments via the avoided purchase of new items through Social Fund Community Care Grants. This has not been quantified in this study.

There are uncertainties around 'business-as-usual' flows, and so these values should be treated with some caution in their absolute sense. As discussed for the environmental criteria, the overall findings are sensitive to the assumptions regarding current arisings and flows to different pathways, as well as to the amount of displacement that occurs.

Table 11 Business-as-usual: **Total UK** net cost/benefit (private metric)

Activity	Total UK Net Cost/Benefit (£)	…of which to Waste Mgt Companies**	…of which to Reuse Organisations	…of which onward employment from ROs	…of which to householders / offices***	…of which to business****
Reuse pathway	£4,730,000	£1,430,000	£3,300,000			
- of which collection						
- of which site operation	*£3,300,000*		£3,300,000			
*- of which disposal of residuals**	*£1,430,000*	£1,430,000				
Preparation for reuse pathway	£1,780,000	£846,000	£935,000			
- of which collection	*£537,000*		£537,000			
- of which site operation	*£398,000*		£398,000			
*- of which disposal of residuals**	*£846,000*	£846,000				
Disposal pathway	£12,400,000	£12,400,000				
- of which landfill	*£12,400,000*	£12,400,000				
- of which incineration						
- of which recycling						

Displacement effects and sales Onward employment from reuse orgs	-£967,000 -£4,000	-£967,000	-£7,240,000	-£4,000	-£6,660,000	£13,900,000
TOTAL	£17,939,000	£13,709,000	-£3,005,000	-£4,000	**-£6,660,000**	£13,900,000

Notes:
negative figures denote income or avoided purchase, based on approximately 150,000 new desks displaced (7% of arisings avoid new purchases)

* this includes the disposal of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (assumed landfill). It includes treatment costs, collection costs and revenue from recyclate, where applicable.

** for the private metric this includes landfill tax.

*** benefits accruing to business as a result of the sale of items through paid exchange and through avoiding the purchase of new items. This is net of the income to second hand shops/PFR organisations, which is assumed to come from businesses purchasing reused items.

**** cost to manufacturers/retailers of new chairs in terms of lost revenue from sales

Unlike office desks, the level of displacement of new products is sufficient to yield a net saving to households / businesses.

Table 12 Business-as-usual management: financial cost

Scale	Private Metric (inc. landfill tax) (£)	Social Metric (no landfill tax) (£)
For total UK office chair arisings	£17,939,000	£16,542,000
Per tonne of office chairs	£689	£636
Per office chair	£8.27	£7.64

Financial cost: Scenario analysis

As with the environmental criteria, it is useful to compare the status quo with a range of possible scenarios. Again, costs are considered on a per-item basis, as opposed to considering the unlikely event of a wholesale shift in the treatment of end-of-life chairs. Table 13 presents net costs and benefits 'per office chair' for a range of scenarios. Costs include collection, operation (rent, utilities, labour), sales, disposal of residuals and defunct parts, eventual disposal of reused items at end of life and the avoided disposal of new items displaced.

Table 13 Scenario analysis: Financial costs per tonne of office chairs

Scenario	Private Metric (£)	Social Metric (£)
Business as usual	£689	£636
100% direct reuse	£1760	£1680
100% preparation for reuse	£1000	£925
100% recycling	£396	£396
100% landfill	£556	£508
Current rates of disposal	£556	£508

Table 13 shows that all pathways for the management of end-of-life office desks result in a net cost to the UK economy as a whole – the highest via the direct reuse pathway due to the higher cost of operating shops compared to the preparation for reuse route. This pathway provides benefit to offices/households through avoided cost of purchase and delivers a profit to second-hand shops through sales. However, it is at the expense

of retailers of new chairs and so the net benefit of these sales is zero – and the costs in Table 13 are positive rather than negative.

Note that much of the displaced retail cost will actually be borne by manufacturers overseas. It was not possible in the scope of this assessment to apportion costs in this respect, and so they are included for completeness, and to maintain a conservative perspective. However, it is interesting to note the net cost/benefit of reuse operations in isolation from the wider implications to offices, householders or businesses.

100% direct reuse = £1,760 per tonne of office chairs.
100% preparation for reuse = £1,000 per tonne of office chairs.

These comparative costs reflect the higher operational costs of second-hand shops modelled.

2.3.3 Employment opportunities

Employment opportunities: Business-as-usual

Analysing the business-as-usual case, as set out in Figure 4, yields the following results with regard to employment opportunities.

Table 14 Business-as-usual: **Total UK** employment (full time equivalents, excluding volunteers**)**

Activity	Total UK Net Cost/Benefit (FTE)	…of which to Waste Management Companies	…of which to Reuse Organisations
Reuse pathway	91	1	90
- of which collection	-	-	-
- of which site operation	90	-	90
*- of which disposal of residuals**	1	1	-
Preparation for reuse pathway	4	1	4
- of which collection	1	-	1
- of which site operation	2	-	2
*- of which disposal of residuals**	1	1	-
Disposal pathway	118	118	-
- of which landfill	118	118	-
- of which incineration	-	-	-
- of which recycling	-	-	-
Displacement effects	-191	-	-
	-	-	-
TOTAL full time equivalents	22	119	93

Notes:
negative figures denote loss of employment
for preparation for reuse, it is assumed that volunteer labour is used in both collection and on site operations
* this includes the recycling of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (assumed landfill).

This analysis indicates that there is a net UK gain of about 20 jobs from current levels of reuse of office chairs alone. As noted in section 1.2.2, this finding is sensitive to the assumptions on labour for preparation and checking.

Key points from the results are as follows.

- The principal employment benefits associated with the end-of-life management of office chairs are associated with waste management operations, and waste collections in particular.

- Reuse via second-hand shops and preparation for reuse require more labour per tonne than disposal. An increase in reuse activity via these pathways could therefore lead to a benefit in terms of employment.
- The scale of employment is uncertain, for the direct reuse pathway in particular, where data for employment in charity shops have been substituted for second-hand shops (see Table A3 in Appendix A).
- As for other criteria, there are uncertainties around 'business-as-usual' flows, and so these values should be treated with some caution in their absolute sense.

2.4 Conclusions: Office Chairs

Approximately 295,000 office chairs (3,534 tonnes) are reused in some form in the UK every year. This is about 14% of all the office chairs reaching the end of their life each year. The remaining 86% are sent to recycling, energy recovery or landfill.

The key environmental, financial and employment benefits associated with this reuse activity are:

- Current levels of reuse of office chairs avoids 12,000 tonnes CO_2-eq per year.
- Providing 1 tonne of office chairs for direct reuse e.g. second-hand shop or eBay can result in a net GHG saving of 3 tonnes CO_2-eq. This is just over 35kg CO_2-eq per chair.
- Providing 1 tonne of office chairs to a preparation for reuse network can result in a net GHG saving of 2.6 tonnes CO_2-eq net. This is about 32kg CO_2-eq per chair.
- The proportion of chair requiring refurbishment does not significantly alter the environmental benefits of preparation for reuse.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each chair reused can yield over £6 net revenue to reuse organisations (discounting wider costs or losses to householders, offices or businesses)
- Business users and Households benefit by over £6m per year as a result of sale of items through reuse exchange and avoiding purchase of (more expensive) new items.
- The *net* employment benefit of dealing with all office chairs that reach the end of their life today (business-as-usual) is 20 jobs.

The results of this study show that there are likely to be environmental benefits associated with the current management of office chairs in the UK – realised through the displacement of new office chairs as a result of reuse activities. These benefits are greater than the impacts associated with transport and handling of recovered items by preparation for reuse organisations and second-hand shops. The net environmental impacts associated with reuse pathways were also shown to be considerably lower than those associated with other management routes (recycling or landfill).

These environmental benefits come at a net financial cost, primarily to local authorities through waste management costs, and potentially to business through loss of sales of chairs. However, within these overall net costs, benefits are accrued by the reuse organisations in terms of employment, financial benefits associated with second-hand sales and potential savings on social welfare payments associated with the creation of training opportunities in reuse organisations.

These findings are not without uncertainty, and the absolute values presented should be treated only as estimates. The following unknowns, or known variations in the different systems assessed, were found in particular to have the potential to affect the overall conclusions:

- the proportion of displacement of new items;
- costs and environmental impacts/benefits associated with furniture recycling; and
- costs and employment associated with waste collection and reuse activities.

It is recommended that any further work is focused on enabling better quantification of these elements.

3.0 References

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Appendix A

Table A1 Environmental criteria – data sources, quality and assumptions

Name	Datapoint	Unit	Data Quality Score	Source	Justification
GHG emissions – landfill	Desk = 820 Chair = 100	kg CO_2e per tonne	Medium	Emissions from the landfilling of wood, plastics, metals and other materials as relevant were sourced from DEFRA and DECC (2011). Emissions from the landfilling of textiles were modelled using the Environment Agency's WRATE tool. These figures all includes emissions from transport to landfill, landfill operations, non-biogenic CO_2 emissions and non-CO_2 emissions from the landfill itself. Emissions avoided by flaring and energy produced from landfill gas are taken into account.	A sound data source is used, but environmental impacts associated with landfilling biodegradable materials in particular are known to be inherently uncertain, as they are dependent on a number of variables that cannot be accurately determined (eg degradation profiles and gas capture) and are uncertain with regard to future projection. This affects greenhouse gas emissions estimates in particular, and so data quality is considered to be lower for this criterion – and is more relevant for biodegradable materials.
Resource depletion – landfill	Desk = -1.4 Chair = 0.5	kg Sb-eq per tonne	Medium		
Energy demand – landfill	Desk = -2745 Chair = 1109	MJ-eq per tonne	Medium		
GHG emissions – recycling	Desk = -74 Chair = -905	kg CO_2e per tonne	Low	**General:** It was assumed that all items are dismantled by hand into their constituent materials and that separated materials are recycled for low-grade applications as applicable. **Wood** – modelled in line with the wood (min) scenario in DEFRA (2006). This represents the recycling of low quality recovered wood for use in particle board manufacture. Data were sourced from Ecoinvent and it was assumed that waste wood substituted the requirement for wood chips from alternative sources. The energy requirements of wood chipping were also taken into account (data from Ecoinvent). **Textiles** – modelled in line with the textiles (min) scenario in DEFRA (2006). This represents the shredding of low quality recovered textiles to produce rags or filling materials (see clothing case study for further detail). **Plastics** – modelled in line with the plastic, dense (min) scenario in the DEFRA (2006). This represents the recycling of mixed low grade plastics into plastic lumber. Account is taken of the energy requirements of washing,	A sound data source is used, but data quality is set as 'low' because the environmental benefits of recycling can be highly variable depending on the amount and type of material being displaced. This is uncertain for furniture items and has not been the focus of this study.
Resource depletion – recycling	Desk = 0.001 Chair = -5.2	kg Sb-eq per tonne	Low		
Energy demand – recycling	Desk = 37 Chair = -8723	MJ-eq per tonne	Low		

				sorting, granulating and thermoforming the recovered plastics into lumber product. The production of air dried, sawn timber is offset on a volumetric basis. Data for these processes are sourced from the Ecoinvent database and US Idemat life cycle database. Avoided burdens appear negative as the processing requirements of cleaning and reforming are greater than the offset burdens of wood production.	
GHG emission – collection for preparation for reuse	All – 147	kg CO_2e per tonne	Medium	Modelled as a 100km round trip travelling in a medium sized van for all collection routes. The Ecoinvent inventory for Transport, van <3.5t was used.	Assumed same for all collection routes – based on the assumption that collection networks are all likely to be nationally-based, and that a refuse collection vehicle is unlikely to be used for bulky items. This assumption was found not to be sensitive in results.
Resource depletion – collection for prep for reuse	All – 0.9	kg Sb-eq per tonne	Medium		
Energy demand – collection for preparation for reuse	All – 2123	MJ-eq per tonne	Medium		
GWP of preparation for reuse	281	kg CO_2e per tonne	Low	Modelled using cost data from FRN and US Input/Output database- £149 per tonne on rent, £19.66 per tonne on electricity US I/O database is from 1998 1 2010GBP = 1.59 2010USD 1 2010 USD = 1.338 1998USD (Inflation adjusted) 1 2010GBP = 1.1883 1998 USD I/O database uses sector-wide data to estimate environmental impacts based on dollars spent on services	While cost data are from a reliable source, the Input/Output database uses sector-wide data to estimate environmental impacts based on dollars spent on services. Further research is recommended in this area.
ARD of preparation for reuse	3.4	kg Sb-eq per tonne	Low		
MJF of preparation for reuse	5842	MJ-eq per tonne	Low		
GWP of charity shop	173	kg CO_2e per tonne	Medium	Based on primary data collected through Charity Retail Association, Charity shops spend £1299 on electricity. At 12p per kWh, this equals 11MWh. Divided by donated sales, this equates 357kWh per tonne. DEFRA / DECC (2011) stat that 1 kWh consumed equates to 0.48kg kWh, therefore 173kg CO2 eq emitted per tonne of goods sold.	Source is generic to all items sold through a similar shop.
ARD of charity shop	3.3	kg Sb-eq per tonne	Medium		
MJF of charity shop	5842	MJ-eq per tonne	Medium		
GWP of free exchange	0.01	kg CO_2e per tonne	Low	Assumption – nominal amount	Uncertain datapoint, but it makes an insignificant contribution to the results.
GWP of paid exchange	0.01	kg CO_2e per tonne	Low		

GWP of refurbishment	Desk – 3.6 Chair – 0.5	kg CO_2e per desk kg CO_2e per chair	Medium	Modelled based on the following sources and assumptions and in all cases assuming 10% refurbishment rate – from Bartlett (2009) **Office desk:** Includes the production, transport and fitting of a new 30kg, melamine lined chipboard desk top to the desk. GWP estimates sourced directly from CRR's carbon footprint of office desks (Chapman, 2010). Proportion of emissions from materials only were taken and scaled from 47.95kg (weight in CRR report) to 26kg to be consistent with FRN average weights. Figures for ARD and MJF were reverse engineered from the CO_2-eq values quoted in the report by assuming impact essentially arises from energy use. Values for CO_2-eq emissions were equated to the amount of electricity required to produce that CO_2-eq impact for materials and diesel required to product the CO_2-eq impact for transport. This electricity and diesel was then modelled in SimaPro to get ARD and MJF figures. **Office chair:** Includes the replacement of foam parts. GWP estimates sourced directly from CRR's carbon footprint of office chairs (Chapman, 2010). Proportion of emissions from materials only were taken. Figures for ARD and MJF were reverse engineered from the CO_2-eq values quoted in the report by assuming impact essentially arises from energy use. Values for CO_2-eq emissions were equated to the amount of electricity required to produce that CO_2-eq impact for materials and diesel required to product the CO_2-eq impact for transport. This electricity and diesel was then modelled in SimaPro to get ARD and MJF figures.	Good data sources used, but refurbishment rate is uncertain, and the material requirements of refurbishment can also vary and so data quality is considered to be 'medium' only.
ARD of refurbishment	Desk – 0.03 Chair – 0.004	kg CO_2e per desk kg CO_2e per chair	Medium		
MJF of refurbishment	Desk – 51 Chair – 7	kg CO_2e per desk kg CO_2e per chair	Medium		
GWP of new product displacement	Desk – 79.17 Chair - 82	kg CO_2e per desk kg CO_2e per chair	Medium	Modelled based on the following sources and assumptions. **Office desk:** GWP figure for embodied emissions associated with office desk materials production, processing and transport sourced directly from CRR's carbon footprint of office desks (Chapman, 2010). This value was scaled from	Good data sources used, but material composition, weight, manufacturing method, source and transport mode can all vary and so data quality is considered to be 'medium' only.
ARD of new product displacement	Desk - 0.62 Chair – 0.67	kg CO_2e per desk kg CO_2e per chair	Medium		

MJF of new product displacement	Desk - 1031 Chair - 1241	kg CO_2e per desk kg CO_2e per chair	Medium	47.95kg (weight in Chapman 2010) to 26kg to be consistent with FRN average weights. Figures for ARD and MJF were reverse engineered from the CO_2-eq values quoted in the report by assuming impact essentially arises from energy use. Values for CO_2-eq emissions were equated to the amount of electricity required to produce that CO_2-eq impact for materials and diesel required to product the CO_2-eq impact for transport. This electricity and diesel was then modelled in SimaPro to get ARD and MJF figures. **Office chair:** GWP figure for embodied emissions associated with office chair materials production, processing and transport sourced directly from CRR's carbon footprint of office desks (Chapman, 2010). Figures for ARD and MJF were reverse engineered as described above.	

Table A2 Financial cost data sources, quality and assumptions

Name	Datapoint	Unit	Data Quality Score	Source	Justification
Cost of landfill	70	£/tonne	High	Based on WRAP (2010). Median value excluding landfill tax and haulage	Up-to-date source, so data quality considered high
Cost of recycling	Desk 3.8 Chair 42	£/tonne	Medium	Based on WRAP (2010), with additional data on wood gate fees from WRAP website	Gate fee for wood used for desks, highest recycling cost used for chairs due to lack of specific data.
Cost of incineration	92	£/tonne	Medium	Based on WRAP (2010)Median value excluding haulage	Up-to-date source, but potential for variability so data quality considered medium
Cost of bulky waste collection	Desk 247 Chair 536	£/tonne	Medium	Based on review of all Local Authority information on bulky waste charges, assumed to represent costs	Based on review of all Local Authority information on bulky waste charges, assumed to represent costs
Cost of civic amenity collection	300	£/tonne	Medium	Wastesavers	Considered to be a reasonable assumption, with relatively little influence on the results
Cost of other collection	48	£/tonne	Medium	Eunomia calculation – cost of fortnightly residual collection with wheeled bin	Considered to be a reasonable assumption, with relatively little influence on the results
Preparation for reuse – site rental	149	£/tonne	High	Based on data supplied by FRN and REalliance as part of this study	Specific data from sound source, but likely to be variable, so considered to be medium data quality.
Site maintenance	20.90	£/tonne	Medium	Based on data supplied by REalliance as part of this study	Reasonable assumption with little significance for the results.
Labour costs of preparation for reuse – employed	9.45	£/hour	Medium	Data from FRN. Calculated using FRN data of £117890 per year for 9 staff of whom 65% are FT and 35% are part time. Assuming the FTs work a 35 hour week and the PTs work a 17.5 hour week, working 48 weeks per year gives an hourly cost of £9.45. This value correlates well with the value given by CREATE, £18,000 per annum, which gives an hourly rate of £10.72 and is the same as that calculated for Oxfam Wastesaver using different data.	Reasoned datapoint, although based on assumptions

Labour costs of PFR – volunteer labour	0.9	£/hour	Medium	Data from FRN gives a value of £681 per volunteer per annum. Assuming a 17.5 hour week (half time) and working 48 weeks per year gives a cost of £0.81 per hour. However, for consistency, we take the average of this and the Wastesavers figure. Data from Oxfam Wastesaver, relating to clothing, shows a slightly higher hourly cost for volunteers of £0.99.	Reasoned datapoint and good agreement, although based on assumptions.
Labour costs of PFR – welfare to work	1.32	£/hour	Medium	Calculated using the value of £20,000 per annum to employ 9 FTEs at Oxfam Wastesaver, assumed to work 48 weeks a year and 35 hours per week.	Reasoned datapoint, although based on assumptions
Labour costs of PFR – learning difficulties	-0.75	£/hour	Medium	Data from FRN gives a cost of £681 per year per volunteer. On an hourly basis, assuming a 17.5 hour week, this is £0.75.	Reasoned datapoint, although based on assumptions
Utility costs of preparation for reuse	19.66	£/tonne	High	Data from FRN collected for this study.	Reasoned datapoint, although based on assumptions
Cost of customer drop-off	0	£/tonne	Low		Some uncertainty around this value.
Cost of doorstep collection	Desks -235 Office Chairs -389	£/tonne	High	FRN based on a cost of £7-£10 per tonne	Some uncertainty around this value.
Cost of dedicated reuse banks (e.g. area at Household Waste Recycling Centre)	Desks -117 Office Chairs -278	£/tonne	Medium	FRN - £5 per item - based on average weight	Some uncertainty around this value.
Cost of other collection	Desks -117 Office Chairs -278	£/tonne	Low	FRN – assumed to be the same as reuse banks	Some uncertainty around this value.
Revenue generated from sale – preparation for reuse	Desk: -3692 Chair -2083	£/tonne	Medium	Green-Works sale prices as website June 2011.	Data based on specific products.
Displaced new purchase – avoided cost	Desk: -12,400 Chair: -8000	£/unit	Low	Mean of 15 most popular items from http://www.kelkoo.co.uk/ on 7th Feb 2011	Data may not be representative of average but no typical cost data available
Cost of running charity shop	1410	£/tonne	Low	Sim (2010) Charity Retail Survey 2010	Mixed data sources
Cost of free exchange	1	£/tonne	Low	Nominal value	Assumption
Cost of paid exchange	1	£/tonne	Low	Nominal value	Assumption
Revenue generated from sale – direct reuse	Desk: -3692 through shop, -1782 through online exchange	£/tonne	Medium	Online sale prices from WRAP (2011b) Sale prices through retail assumed to be the same as through Preparation for Reuse in the absence of other data	Data based on sample of sales

	Chair -2083 through shop, 1993 through online exchange				

Table A3 Employment data sources, quality and assumptions

Name	Datapoint	Unit	Data Quality Score	Source	Justification
Labour of landfill	0.00007	FTE/tonne	Low	Based on three unnamed studies	Source references unavailable
Labour of recycling	0.0004	FTE/tonne	Low	Based on Murray, 1998	Source references unavailable
Labour of incineration	0.00017	FTE/tonne	Low	Based on three unnamed studies	Source references unavailable
Labour of bulky waste collection	0.00635	FTE/tonne	Low	Based on Caroline Lee-Smith assumption,	Assumption
Labour of civic amenity collection	0.0032	FTE/tonne	Low	Assumed as dedicated reuse banks (prep for reuse pathway)	Assumption
Labour of doorstep collection	0.000635	FTE/tonne	Low	Based on Caroline Lee-Smith assumption	Assumption
Labour of dedicated reuse banks	0.0032	FTE/tonne	Low	Based on Caroline Lee-Smith assumption	Assumption
Labour of other collection	0.0032	FTE/tonne	Medium	AWC residual – National Assembly for Wales (2001)	Reasonable source, but likely to be variable.
Labour composition – employed	62.5	%	Medium	Green-Works	Single source so data quality reduced
Labour composition – volunteer labour	12.5	%	Medium	Green-Works	Single source so data quality reduced
Labour composition – welfare to work	25	%	Medium	Green-Works	Single source so data quality reduced
Labour composition – learning difficulties	0	%	Medium	Green-Works	Single source so data quality reduced
Preparation for reuse – initial checking employment intensity	0.008	FTE/tonne	Low	Calculated using WRAP assumptions regarding hours/tonne (13 hours, based on 0.2 mins per item) and assuming a 35 hour working week/48 working weeks per year. In the assessment, this is assumed to be equivalent to UK sorting/checking requirements.	Assumption

Preparation for reuse – preparation employment intensity	0.011864	FTE/tonne	Low	Calculated using hours/tonne and assuming a 35 hour working week and 48 working weeks per year	Assumption
UK Employment intensity of displaced products	0.011	FTE/tonne	Low	ONS (2011b) identifies that 22,000 were employed in the furniture industry in 2008. Based on a consumption of 200,000 tonnes p.a. 0.11 FTE UK jobs are associated with a tonne of office furniture.	Reasoned Assumption
Labour of charity shop	0.038	FTE/tonne	Medium	Sim (2010) Charity Shops Survey 2010.	Based on some assumptions, although reasoned
Labour of free exchange	0	FTE/tonne	Medium	Assumed will be negligible	Reasoned assumption
Labour of paid exchange	0	FTE/tonne	Medium	Assumed will be negligible	Reasoned assumption

FTE = Full time equivalent

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