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Final Report

Benefits of Reuse
Case Study: Domestic Furniture

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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 the costs and jobs accrue 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 domestic furniture products.

The products chosen were a two seater sofa and a dining table.

Sofas

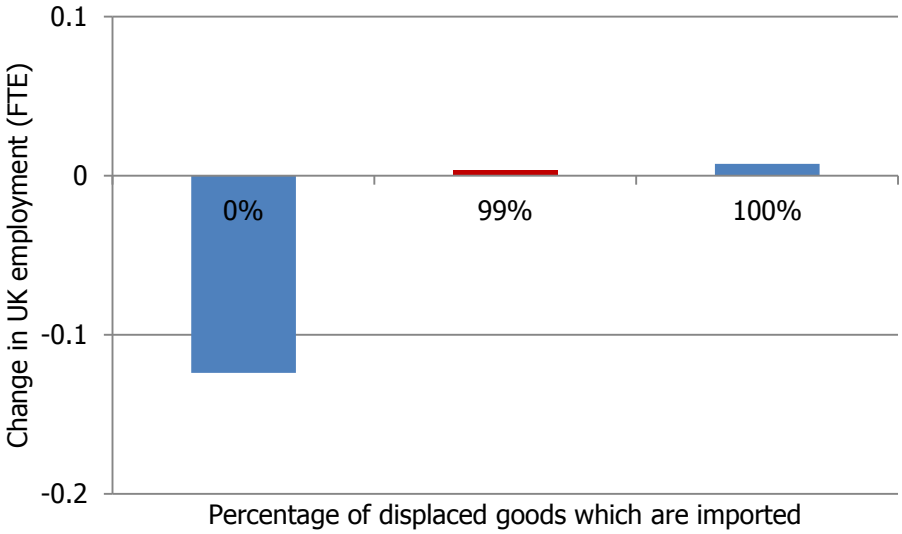
Up to 1,000,000 sofas (ca 37,000 tonnes) are reused in some form in the UK every year. This is about 17% of all the sofas reaching the end of their life each year. The remaining 83% are sent to recycling, energy recovery or landfill.

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

- Current levels of reuse of sofas avoid 52,000 tonnes CO_2 eq per year
- Providing 1 tonne of sofas for direct reuse e.g. second-hand shop or eBay can result in a net GHG saving of 1.45 tonnes CO_2-eq. This is approximately 55kg CO_2-eq per sofa.
- Providing 1 tonne of sofas to a preparation for reuse network can result in a net GHG saving of 1.05 tonnes CO_2-eq net. This is about 40kg CO_2-eq per sofa.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each sofa reused can yield over £18 net revenue to reuse organisations (discounting wider costs or losses to householders and businesses)
- Households benefit by over £320 million per year as a result of sale of items through reuse exchange and avoiding purchase of (more expensive) new items.
- The *net* employment impact of dealing with all sofas that reach the end of their life today (business-as-usual) is marginally positive. Sofas reused through a charity shop route leads to the greatest net increase in jobs. Figure i highlights that the impact on jobs is highly dependent on whether the sofa displaced is imported or manufactured in the UK. The red bar represents the proportion of imports used in this study.

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

Figure i Change in estimated impact on jobs with fraction of imported sofas displaced – 'preparation for reuse' (FTE per tonne)

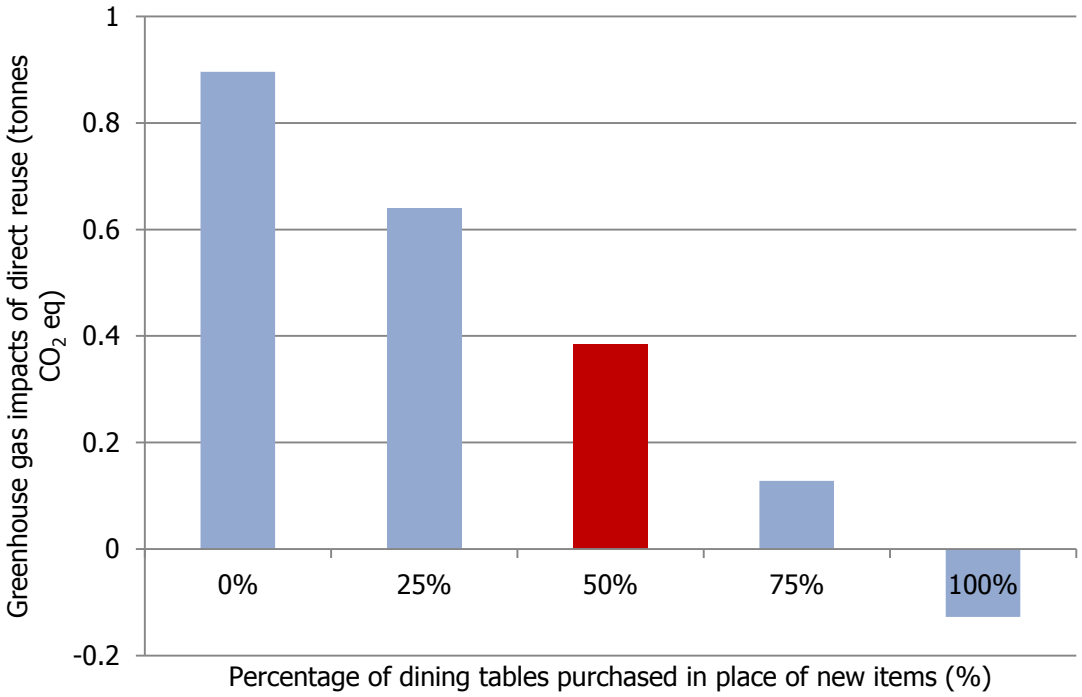


Dining Tables

Approximately 100,000 dining tables (2,800 tonnes) are reused in some form in the UK every year. This is about 17% of all the dining tables reaching the end of their life each year. The remaining 83% 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 dining tables lead to emissions (as opposed to savings) of 1,500 tonnes CO_2 eq per year. These emissions are lower than if the tables had otherwise been sent to landfill (2,800 tonnes CO_2 eq)
- Providing 1 tonne of dining tables for direct reuse e.g. second-hand shop or eBay results in net GHG emissions (as opposed to savings) of 0.38 tonnes CO_2 eq. This is approximately 10kg CO_2-eq per table. However, these are lower than landfill emissions (1 tonne CO_2 eq per tonne dining tables).
- Providing 1 tonne of dining tables to a preparation for reuse network can result in a net GHG emissions (as opposed to savings) of 0.76 tonnes CO_2 eq. This is approximately 20kg CO_2-eq per table. However, these are lower than landfill emissions (1 tonne CO_2 eq per tonne dining tables).
- Figure ii highlights the GHG impacts of direct reuse at different levels of displacement of new products. The red bar represents the assumption used in this study, that 50% of reused dining tables are purchased in place of new tables. If all reused dining tables displaced new purchases, there would be net GHG savings.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each dining table reused can yield over £2 net revenue to reuse organisations (discounting wider costs or losses to householders businesses), and £33 for preparation for reuse organisations. This is due to the higher reported sale price and lower operating costs.
- Households benefit by over £20 million per year as a result of sale of items through reuse exchange and avoiding purchase of (more expensive) new items.
- The *net* employment impact of dealing with all dining tables that reach the end of their life today (business-as-usual) is positive. Dining tables reused through a charity shop route lead to the highest net increase in jobs.



Domestic Furniture

We estimate that sofas and dining tables account for around 34% and 3% of all domestic furniture respectively that reaches the end of its life each year. Other domestic furniture items not assessed here (wardrobes, cabinets, drawers, beds, chairs, and tables other than dining tables) are more likely to resemble dining tables than sofas as they may generally be characterised as 'simple' wooden products. The net impact of reusing domestic furniture obviously exceeds that of any particular product. In understanding the employment impacts of reuse, it is necessary to further understand more about the origins of furniture likely to be displaced by reused items.

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 to make the conclusions more robust. WRAP would like to work with stakeholders to improve the quality of this data on clothing contained in the tool. In particular, we encourage research for or sourcing of better quality data on:

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

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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 Domestic Furniture: Sofas

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

An 'average' sofa is assumed to be the item replaced by reusing a sofa. This is modelled as being made of particleboard (63%), foam (PUR) (9%), woven cotton (8%), softwood (8%), low alloyed steel (8%), polyester (3%), phosphorous (used in flame retardants) (1%) and melamine (1%).

This chapter outlines:

- An overview of sofa 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 sofas with some scenario analysis for:
    - environmental benefits
    - financial costs
    - employment opportunities
- The key conclusions

1.1 Sofa Reuse in the UK

Domestic furniture reuse is thought to pass through a wider range of pathways than office furniture. Sofas are handled by both charity shops and furniture reuse networks, in a similar way to other products assessed. It is also estimated that a reasonable proportion passes through free and paid exchanges, such as ebay or freecycle.

Whilst there is readily available data on the financial turnover of the furniture industry in the UK, information on quantities of furniture sold and disposed of in general and sofas in particular. A key data source in this study is Curran (2008), based upon which it is estimated that 10 million items of furniture are discarded in the UK every year, of which over a third are sofas.

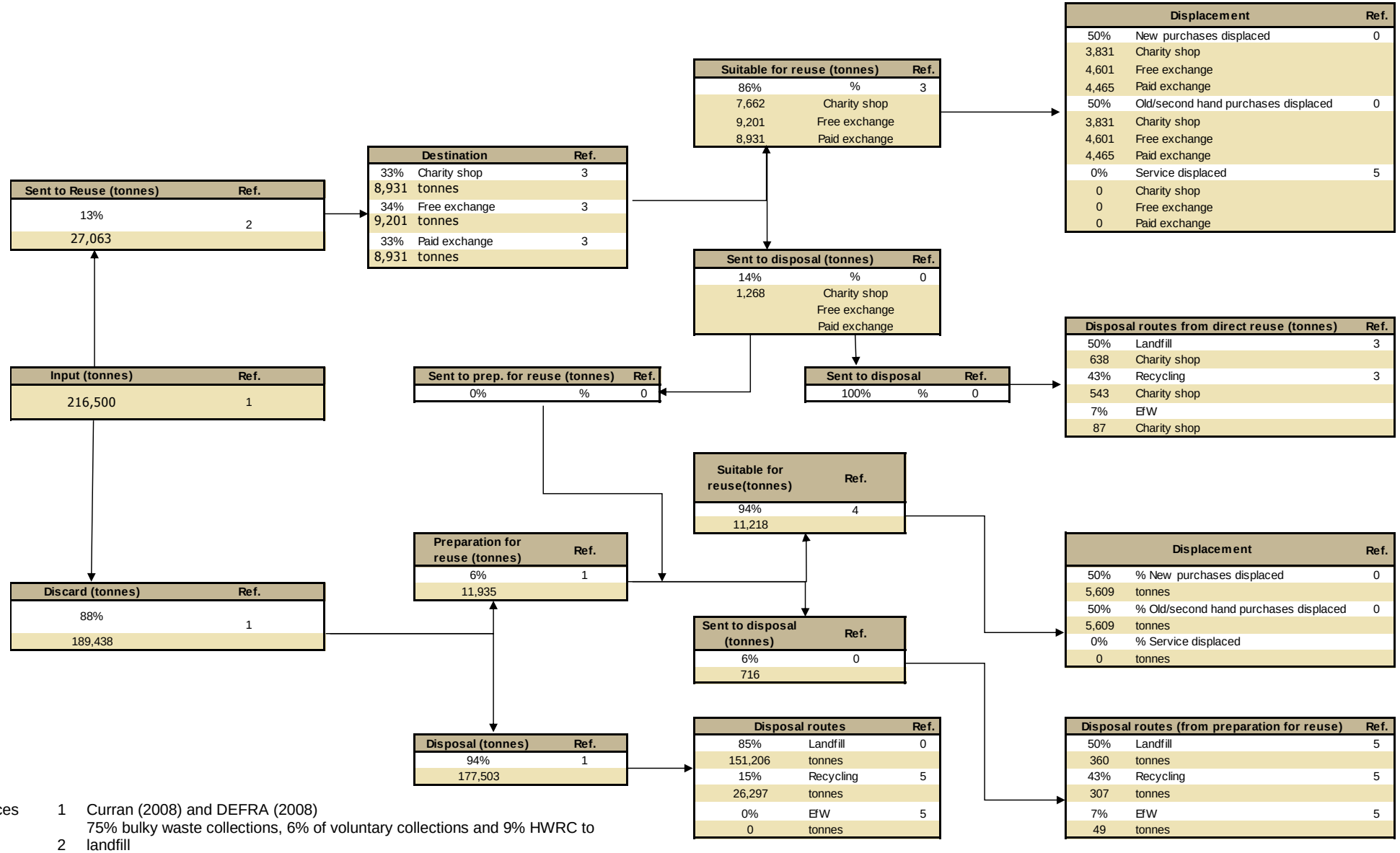
WRAP has developed estimates of annual sofa waste arisings and subsequent fates, as outlined in Figure 1. This sets out the 'business-as-usual' profile modelled in this assessment, with 'direct reuse' characterised by local donation to charity shops or free/paid exchanges and 'preparation for reuse' characterised by a furniture reuse network.

The Figure can be used to trace the fate of sofas - approximately 216,500 tonnes per year – passing through the various pathways. Key estimates are made of the percentage of new sofa purchases that are avoided as a result of the reuse action. This is called the displacement effect.

Figure 2 shows the final destination of sofas which pass through the different pathways identified in Figure 1. Only 17% of sofas that reach the end of their life are reused.

The following sections briefly describe each pathway, as modelled in the assessment.

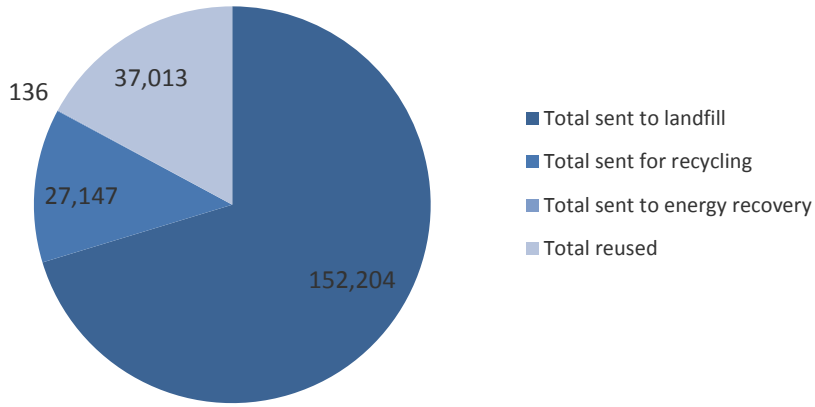
Figure 1 Sofa annual mass flow – 'business-as-usual'



References

1 Curran (2008) and DEFRA (2008)
75% bulky waste collections, 6% of voluntary collections and 9% HWRC to landfill
2
3 Curran (2008) and Charity Retail Association data
4 FRN
5 Assumption - sensitivity conducted in report
6 Defra (2011)

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



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

Direct reuse for sofas is characterised as follows;

- There are three direct reuse pathways: **charity shops**, **paid exchange networks** and **free exchange networks**.
- Furniture passing via each of these pathways is assumed to come **free of collection burdens**, as it is difficult to apportion journeys made, principally by householders, to a charity shop for donation or to an exchange network for collection.
- 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. These are assumed to be minimal for exchange networks.
- As well as generating income for charity shops and from paid exchanges, 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 sofas, 'displacement of new' assumes that the reused item will directly **avoid the production of a typical sofa chair** of equivalent weight. The environmental burdens associated with the production and transportation of a typical sofa were sourced from the Defra product lifetimes study. A two-seater model with wooden frame, cotton cover and treated PUR foam was modelled. As described for office desks, it was assumed that, on average, **10% of resold items undergo refurbishment.** For sofas, this refurbishment reflects the replacement of the cotton covers with new – the environmental burdens for which were sourced from the Defra product lifetimes study.
- **50% of reuse is displacement of an old item**. This route assumes that a reused item will replace another reused item (eg another purchase from a charity 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, A3 in Appendix A.

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

The preparation for reuse pathway for sofas, as well as other furniture, models the collection, refurbishment and sale of desks recovered by centralised networks, such as FRN-affiliated organisations. This includes the financial, employment and environmental burdens of:

- **collection** – e.g. via bulky 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;
- onwards **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.

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

As discarded furniture does not typically end up in the regularly collected residual waste stream, no sofas are assumed to be 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 (eg 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 Sofas

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, 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 sofas gathered by WRAP suggest that around 10–20% of sofas currently in circulation enter the waste or reuse stream annually (based on approximately 26 million households in the UK) (ONS 2011a).

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

- In comparison with other furniture items, sofas are relatively less hard-wearing and so there is uncertainty over whether a reused item has enough remaining 'wear' for an equivalent second life. The only empirical data available in this respect from internal research by WRAP suggests that furniture donors keep an item for the same amount of time as furniture recipients anticipate housing the item. As such, we have assumed like-for-like displacement. However, other studies, such as DEFRA (2011), assume that the second lifetime is approximately half as long as the first – and so only half of the lifetime a new item would, in effect, be displaced. This is considered this further in sensitivity analysis (Section 3.3.1).

- 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 is 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: Sofas

Environmental impacts: Business-as-usual

Analysing the business-as-usual case, as set out in Figure 1, yields the following results for the environmental indicators assessed. The methodology document (WRAP 2011) describes the background to these indicators in more detail.

Table 1 presents the **environmental impacts and benefits associated with the current management of all end-of-life sofas estimated to arise in the UK each year**. They include the impacts associated with waste management activities in the UK, and the benefits of avoided production of materials through reuse and recycling (whether 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 sofa and a tonne of sofas in Table 2.

Note that these are the **absolute** impacts/benefits associated with current levels of disposal versus recycling and reuse. Different management pathways are compared in Table 3.

Table 1 and Table 2 show that **current UK management of sofas results in net GHG emissions** of over 60,000 tonnes CO_2-eq, equivalent to 10kg CO_2-eq per sofa handled. This reflects the high proportion of biodegradable materials in sofas that are disposed to landfill, discussed further below.

Table 1 Business-as-usual management: **Total UK** environmental impacts

Activity	Total UK Sofas – GHG Emissions (tonnes CO_2-eq)	Total UK Sofas – Resource Depletion (tonnes Sb-eq)	Total UK Sofas – Global Energy Demand (MJ-eq)
Reuse pathway	24,600	39	58,700,000
- of which collection	0	0	0
- of which site operation (inc. refurbishment)	8,200	72	121,000,000
*- of which disposal of residuals**	16,400	-33	-62,700,000
Preparation for reuse pathway	15,200	35	59,900,000
- of which collection	1,760	11	25,300,000
- of which site operation (inc. refurbishment)	6,250	38	62,100,000
*- of which disposal of residuals**	7,180	-14	-27,500,000
Disposal pathway	114,000	-179	-346,000,000
- of which landfill	114,000	-183	-359,000,000
- of which incineration	0	0	0
- of which recycling	-31	4	12,400,000
Reuse displacement effects	-91,400	-530	-948,000,000
	0	0	0
TOTAL	62,000	-635	-1,180,000,000

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 (85% landfill, 15% recycling)

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 sofa arisings	62,000	-635	-1,180,000,000
Per tonne of sofas	0.29	-0.00293	-5430
Per sofa	0.0106	-0.00011	-201.0

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

As found for office desks, a product with a similar use profile composed of predominantly biodegradable materials, the results for business-as-usual management of sofas are **heavily influenced by impacts associated with disposal to landfill**, in particular for GHG emissions.[1] This reflects the particular significance of landfilling biodegradable materials on GHG emissions. The difference in profile observable between the different impact indicators in this respect was also discussed earlier for office desks.

Other key contributors to business-as-usual impacts/savings are as follows:

- **The levels of displacement associated with current levels of reuse**. Approximately 20% of sofas are currently estimated to enter either direct reuse or preparation for reuse pathways, and the proportion of recovered items that are suitable for reuse is estimated to be high (over 80–90%). Whilst based on informed estimates, these proportions are likely to be at the high end for an item such as a sofa. Of those items reused, 50% are assumed to displace new items. This latter figure, as for other furniture items, is an assumption which has a considerable influence on these findings and it is recommended that this is the subject of further research.

- **The relatively high displacement benefit associated with the avoided production of new sofas.** The environmental impact associated with the production of new sofas is relatively high, due to contributions from metal, textile and plastic components, as well as transportation from production sites overseas and avoided disposal. Avoided sofa production impacts were modelled consistent with the recent Defra product lifetimes study and are thought to be broadly representative of this type of product. However, the weight and material composition of items can vary.

As for the other products assessed in this research, there are considerable uncertainties around these 'business-as-usual' flows and so the values should be treated with caution in their absolute sense. The best available data have been used, 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 sofa management, on a 'per item' basis.

Table 3 Scenario analysis: Environmental impacts per tonne of sofas

Scenario	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
Business as usual	0.29	-0.00293	-5430
100% direct reuse	-1.45	-0.0122	-22300
100% preparation for reuse	-1.05	-0.0106	-19100
100% recycling	0.00	0.000144	471
100% landfill	0.75	-0.00121	-2370
Current rates of disposal*	0.64	-0.00101	-1950

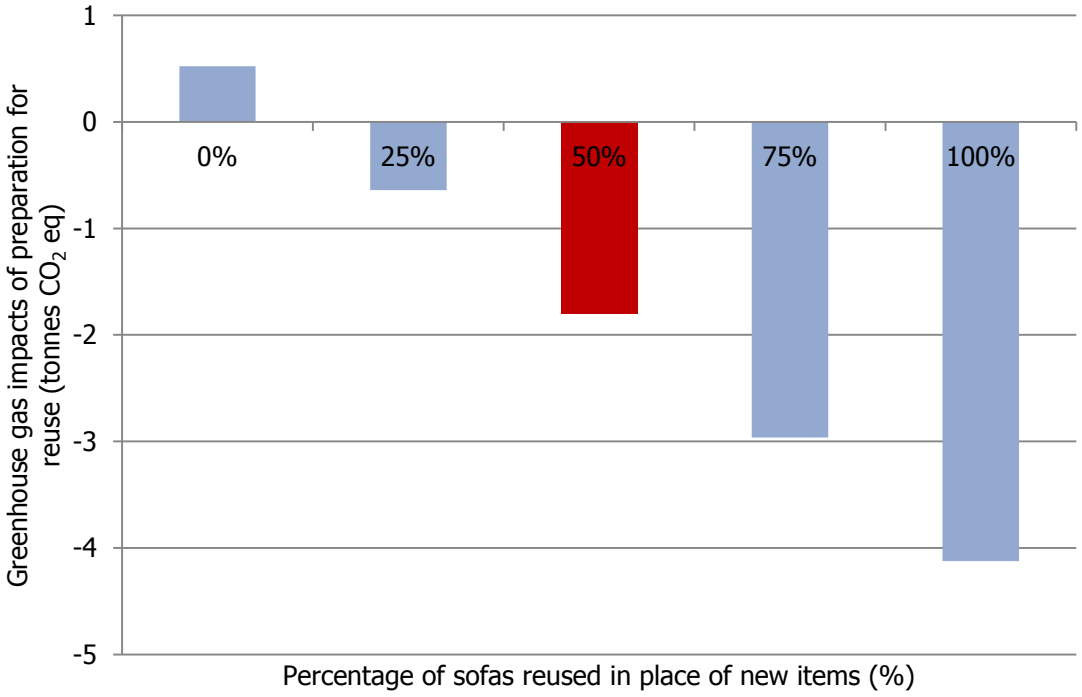
Note: negative figures denote a net saving, through displacement of other products/materials and their avoided production
* 100% disposal at current recycling rates (15% recycling, 85% landfill)

Table 3 shows the net **environmental impacts associated with both reuse pathways** to be **considerably lower than those associated with other management routes** (recycling or landfill). For greenhouse gas emissions, recycling is also found to have a net balance of zero. This means that the savings associated with avoided materials are equal to the emissions from the recycling process. For landfill, greenhouse gas emissions are shown, yet net reductions in resource depletion and energy demand exist. This is because although methane is emitted from landfill, some is captured and used to generate electricity, avoiding the combustion of fossil fuels.

([1]) Note that 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 also the uncertainties with regard to oxidation rates for gas escaping some time in the future. The data used in this assessment are consistent with current best estimates (DEFRA DECC 2011, the Environment Agency WRATE tool), but this uncertainty is noted.

Figure 3 compares different levels of product displacement through preparation for reuse with landfill. This shows that where no products are displaced through reuse, net greenhouse gas emissions occur. Where a tonne of items is provided for reuse and all items displace new products, over 4 tonnes CO_2eq are avoided. The average scenario (highlighted in red) suggests savings of 1.8 tonnes CO_2 eq compared to landfill.

Figure 3 Change in greenhouse gas impacts of preparation for reuse versus landfill at different levels of displacement of new sofas (tonnes CO_2 eq per tonne sofas)



- The assessment assumes that the lifetime of a new and reused item are the same. Excluding alternate waste disposal, (e.g. landfill) if the second life of the sofa is instead halved (thereby only displacing half of a new item), net GHG emissions for 100% direct reuse change from -1.45 tonnes CO_2-eq to -0.42 tonnes CO_2-eq per tonne sofas and net GHG emissions for 100% preparation for reuse change from -1.05 tonnes CO_2-eq to -0.04 tonnes CO_2-eq per tonne sofas. This assumption is therefore particularly sensitive for the preparation for reuse pathway.

- 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 (see Table A1 in Appendix A).

- It was assumed that 10% of sofas passing through reuse pathways require refurbishment (from Bartlett 2009 – relating to office furniture, but also assumed for sofas). This was represented in the assessment by a replacement of the sofa covers, modelled consistent with the sofa refurbishment scenario in the Defra product lifetimes project. The remainder of items are assumed to require only labour, and not further material input. Should either greater or lesser refurbishment be required, results for the reuse pathways will be affected accordingly. For example a doubling of refurbishment requirements results in a change in net GHG emissions from -1.05 tonnes CO_2-eq to -0.81 tonnes CO_2-eq per tonne sofas for the preparation for reuse pathway. Importantly, **if over 50% of sofas require replacement of covers before subsequent reuse, net GHG impacts (instead of savings) are seen.**

- Recycled sofas are assumed to be dismantled into their component parts and recovered as relatively low grade materials – for example, wood for particle board and textiles for rags. This is a reasonable assumption, as the materials are likely to be relatively hard to recover in a complete and uncontaminated form. However, if recycled materials from the sofa were instead assumed to displace solid wood, virgin fibres and plastics, the environmental savings seen for this pathway would increase. It is recommended that further research is carried out wherever specific comparisons between reuse and recycling pathways are needed.

1.3.2 Financial costs and benefits: Sofas

Financial cost: Business-as-usual

Analysing the business-as-usual case, as set out in Figure 3, yields the following results for the private metric accounting approach (landfill tax included).

Table 4 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 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 5).

Key points from the results are as follows.

- Financial costs, as with environmental impacts, are dominated by costs associated with waste management and so most of the financial burden associated with the business-as-usual scenario falls to local authorities. It is estimated that sending sofas to landfill costs local authorities almost £50 million per year.
- A significant proportion (>50%) of waste management costs are associated with waste collection, predominantly through bulky waste collections.
- 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 £18 million is seen because estimated sales exceed operating costs. For householders, a net saving of £327 million through avoided purchases is seen.
- Savings to householders are achievable however there is an equal cost to retailers/industry through lost sales. Some of this lost revenue will occur outside the UK, but is recorded for completeness and due to a lack of information on the proportion of sofas imported.
- Almost £2 million is saved by Government through the onward employment enabled by reuse organisations. 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.

Data sources and quality considerations are presented in Table A2 in Appendix A. There are uncertainties around several data points (e.g. collection costs, sales estimates and avoided purchases), 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. Despite these uncertainties, the financial data clearly indicates where savings can be made and where costs are incurred.

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

Activity	Total UK Net Cost/Benefit (£)	...of which to Local Authorities**	...of which to Reuse Organisations	...of which onward employment from ROs	...of which to households***	...of which to business****
Reuse pathway	£22,200,000	£9,580,000	£12,600,000			
- of which collection						
- of which site operation	£12,600,000		£12,600,000			
*- of which disposal of residuals**	£9,580,000	*£9,580,000*				
Preparation for reuse pathway	£11,400,000	£4,220,000	£7,220,000			
- of which collection	£4,000,000		£4,000,000			
- of which site operation	£3,220,000		£3,220,000			
*- of which disposal of residuals**	£4,220,000	*£4,220,000*				
Disposal pathway	£54,700,000	£54,700,000				
- of which landfill	£47,000,000	*£47,000,000*				
- of which incineration	£0					
- of which recycling	£7,690,000	*£7,690,000*				
Displacement effects and sales	-£5,700,000	-£5,700,000	-£38,000,000		-£327,000,000	£365,000,000
Onward employment from reuse	-£1,930,000			-£1,930,000		
TOTAL	**£80,670,000**	**£62,800,000**	**-£18,180,000**	**-£1,930,000**	**-£327,000,000**	**£365,000,000**

Notes:
negative figures denote income or avoided purchase, based on approximately 500,000 new sofas displaced (9% 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 (15% recycling, 85% landfill). It includes treatment costs, collection costs and revenue from recyclate, where applicable.

** for the private metric this includes landfill tax.

*** benefits accruing to householders 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 purchasing reused items.

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

Table 5 Business-as-usual management: Financial cost

Scale	Private Metric (inc. landfill tax) (£)	Social Metric (no landfill tax) (£)
For total UK sofa arisings	£80,670,000	£70,730,000
Per tonne of sofas	£373	£327
Per sofa	£13.80	£12.10

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 sofas. Table 6 presents net costs and benefits 'per sofa' for a range of scenarios. The 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. The sources and assumptions used herein are set out in Table A2 in Appendix A.

Table 6 Scenario analysis: **Financial** costs per tonne of sofas

Scenario	Private Metric (£)	Social Metric (£)
Business as usual	£373	£327
100% direct reuse	£673	£604
100% preparation for reuse	£652	£583
100% recycling	£293	£293
100% landfill	£311	£263
Current rates of disposal	£308	£267

Table 6 shows that all pathways for the management of end-of-life sofa desks result in a net cost to the UK economy as a whole – the highest via the direct reuse pathway. This pathway provides benefit to householders through avoided cost of purchase and delivers a profit to charity shops and exchange network users through sales. However, it is at the expense of retailers/manufacturers of new sofas and so the net benefit of these sales is zero – and the costs in Table 6 are positive rather than negative.

The difference in cost between reuse and preparation for reuse reflects the greater reported income to preparation for reuse organisations for sofa sales, the higher operational costs of charity shops and the relatively high proportion of sofas that pass via free exchanges in the direct reuse pathway (and so generate no income but do displace new sales).

It should be noted 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.

1.3.3 Employment opportunities: Sofas

Employment opportunities: Business-as-usual

Analysing the business-as-usual case, as set out in Figure 3, 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 Local Authorities	...of which to Reuse Organisations
Reuse pathway	349	7	343
*- of which collection**	-	-	-
- of which site operation	343	-	343
*- of which disposal of residuals**	7	7	-
Preparation for reuse pathway	89	4	86
- of which collection	28	-	28
- of which site operation	58	-	58
*- of which disposal of residuals***	4	4	-
Disposal pathway	896	896	-
- of which landfill	886	886	-
- of which incineration	-	-	-
- of which recycling	11	11	-
Displacement effects	-601	-	-
	-	-	-
TOTAL full time equivalents	734	906	428

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
* For furniture there may be some collection cost even though many charities will charge to make the collection
**this includes the recycling of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (15% recycling, 85% landfill)
**

Key points from the results are as follows:

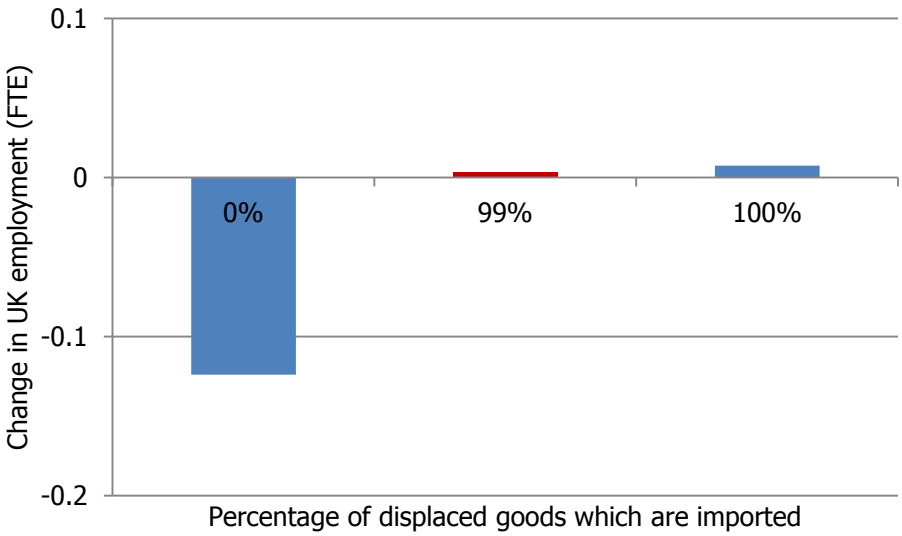
- The principal employment benefits associated with the current end-of-life management of sofas are associated with local government waste management operations, and bulky waste collections in particular. Although these jobs are defined here as Local Authorities, they may also be within reuse organisations or private businesses carrying out collections.

- Overall, there is a net employment gain from current levels of reuse. This is because the reuse routes assessed require more employees to process a unit of sofas than average manufacture.

- The existing data on employment in furniture manufacturing has been used against the ONS (2011b) standard industrial classification of other furniture (SIC3109). This has been averaged against all furniture types. It may be that certain items are more labour intensive to produce than others, and so average results may not represent specific products.

- The impact on UK employment is dependent upon the displacement rate and the propensity to displace UK manufactured or imported sofas. ONS (2011b and c) estimate that 60% of domestic furniture is imported. Using the same data sources, and assuming that UK manufacture accounts for 18% of exports (i.e. some sofas are imported and re-exported), we estimate that UK manufacture accounts for less than 1% of UK sales. Figure 4 below illustrates the effect on jobs if reused sofas displace UK manufacturing, imports, or the average mix as used in this study (highlighted in red). This shows that the employment figures are highly sensitive to assumptions about displacement of imports or domestic manufacture.

Figure 4 Change in estimated impact on jobs with fraction of imported sofas displaced – 'preparation for reuse' (FTE per tonne)



- Reuse via charity shops and preparation for reuse pathways requires 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 for reuse pathways is, however, uncertain and data quality is low (see Table A3 in Appendix A for sources and assumptions).
- If volunteer employment were to be included in Table 7, net employment opportunities for the reuse organisations increase to 6,610, under the assumptions modelled (see Table A3). This is associated with the high volume of volunteer labour at charity shops.
- 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: Sofas

Approximately 37,000 tonnes of sofas are reused in some form in the UK every year. This is about 17% of all the sofas reaching the end of their life each year. The remaining 83% 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 sofas are insufficient to create a net saving in greenhouse gas emissions due to the high emissions associated with landfill.
- Providing 1 tonne of sofas for direct reuse e.g. second-hand shop or eBay can result in a net GHG saving of 1.45 tonnes CO_2-eq. This is just over 54kg CO_2-eq per sofa.
- Providing 1 tonne of sofas to a preparation for reuse network can result in a net GHG saving of 1.05 tonnes CO_2-eq net. This is about 39kg CO_2-eq per sofa.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each sofa reused can yield over £18 net revenue to reuse organisations (discounting wider costs or losses to householders businesses)

- Households benefit by over £320 million per year as a result of sale of items through reuse exchange and avoiding purchase of (more expensive) new items.

- The *net* employment impact of dealing with all sofas that reach the end of their life today (business-as-usual) is positive. Sofas reused through a charity shop route lead to the highest number of jobs being created.

The results of this study show that there are likely to be environmental benefits associated with the current management of sofas in the UK – realised through the displacement of new sofas 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).

Financial costs, as with environmental impacts, are dominated by costs associated with local authority waste management activities and contracts (in particular bulky waste collections) and hence most 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 householders or businesses, net profits are seen for the reuse pathways.

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;
- the relative lifetime of new and reused items;
- refurbishment rates for sofas;
- 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 be focused on enabling better quantification of these elements.

2.0 Domestic Furniture: Dining Tables

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

An 'average' dining table is assumed to be the item replaced by reusing a dining table. This is modelled as being made completely of wood.

This chapter outlines:

- An overview of dining table 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 dining tables with some scenario analysis for:
    - environmental benefits
    - financial costs
    - employment opportunities
- The key conclusions

2.1 Dining Table Reuse in the UK

As noted for sofas, domestic furniture reuse is thought to pass through a wider range of pathways than office furniture. Dining tables, among other domestic furniture items, are handled by both charity shops and furniture reuse networks, as well as passing through other free and paid exchange networks, such as ebay or freecycle.

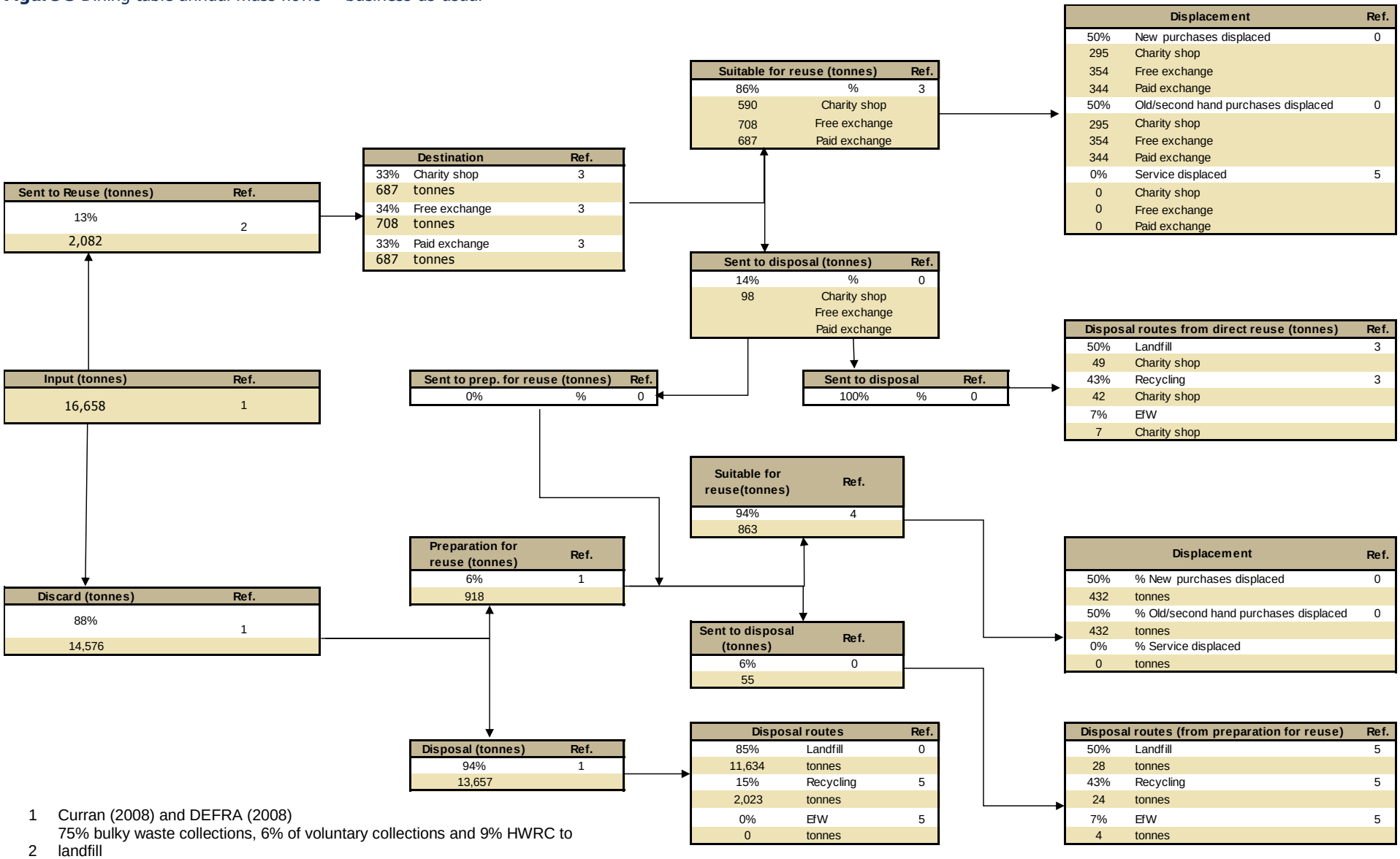
WRAP has developed estimates of annual dining table waste arisings and subsequent fates, as outlined in Figure 5. This sets out the 'business-as-usual' profile modelled in this assessment, with 'direct reuse' characterised by local donation to charity shops or free/paid exchanges and 'preparation for reuse' characterised by a furniture reuse network. Please note that the mass flows for all items of domestic furniture are identical; no information specific to sofas or dining tables was identified.

The Figure can be used to trace the fate of dining tables - approximately 2,848 tonnes per year – passing through the various pathways. Key estimates are made of the percentage of new dining table purchases that are avoided as a result of the reuse action. This is called the displacement effect.

Figure 6 shows the final destination of dining tables which pass through the different pathways identified in Figure 5. Only 17% of dining tables that reach the end of their life are reused.

The following sections briefly describe each pathway, as modelled in the assessment.

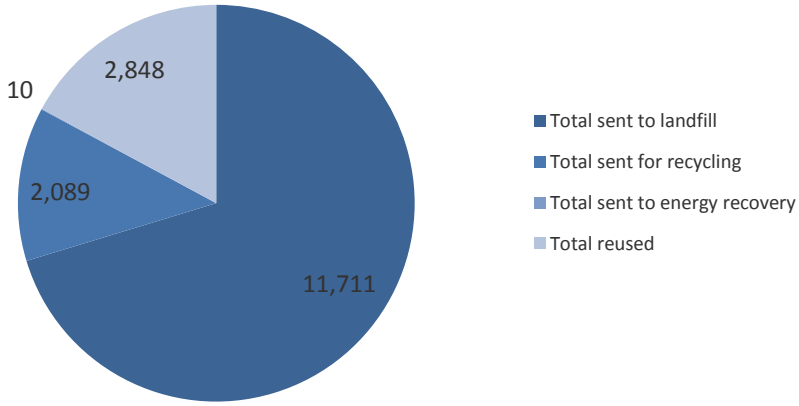
Figure 5 Dining table annual mass flows – 'business-as-usual'



References

1 Curran (2008) and DEFRA (2008)
75% bulky waste collections, 6% of voluntary collections and 9% HWRC to
2 landfill
3 Curran (2008) and Charity Retail Association data
4 FRN
5 Assumption - sensitivity conducted in report
6 DEFRA (2011)

Figure 6 Final Destination of Dining Tables – 'business-as-usual' (tonnes)



2.1.1 What does 'direct reuse' look like for dining tables in this assessment?

Direct reuse for dining tables is characterised in the same way as described for sofas.

- There are three direct reuse pathways: **charity shops**, **paid exchange networks** and **free exchange networks**.
- Furniture passing via each of these pathways is assumed to come **free of collection burdens**.
- Financial, employment and environmental costs are incurred through collection, sorting, refurbishment and resale overheads, and management of any residual items that are not considered suitable for reuse. These are assumed to be minimal for exchange networks.
- As well as generating income for charity shops and from paid exchanges, 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 dining tables, 'displacement of new' assumes that the reused item will directly **avoid the production of a solid wood table** of equivalent weight. The environmental burdens associated with the production and transportation of a wooden table were sourced from the Ecoinvent life cycle assessment database, with assumptions made regarding manufacturing burdens (minimal) and transportation (mostly from Asia and Europe). It was assumed that refurbishment burdens are minimal, requiring only labour for cleaning/minor touch-ups, as opposed to additional materials.
- **50% of reuse is displacement of an old item**. This route assumes that a reused item will replace another reused item (eg another purchase from a charity 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 dining tables in this assessment

The preparation for reuse pathway for dining tables, as well as other furniture, models the collection, refurbishment and sale of dining tables recovered by centralised networks, such as FRN-affiliated organisations. This includes the financial, employment and environmental burdens of:

- **collection** – e.g. via bulky waste collection, bring sites or direct delivery from businesses;
- **sorting** operations at handling facilities;
- **delivery of items suitable for reuse** for sale, or gifted;
- onwards **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 dining tables in this assessment?

As discarded furniture does not typically end up in the regularly collected, no dining tables are modelled as sent to energy recovery. 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** (some direct disposal, plus 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. It was assumed that the wood within the tables is recovered and chipped for use in particle board manufacture and, potentially, biomass – particle board is now competing with biomass as a market as biomass has, I believe, spare capacity especially in the North of England/ Scotland.

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 Dining Tables

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 dining tables gathered by WRAP suggest that around 2% of dining tables currently in circulation enter the waste or reuse stream annually (based on approximately 26 million households in the UK) (ONS 2011a).

- 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 both are considered to be a reasonable representation, but in general are lacking for wood-based materials and products.

- 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.

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

2.3 Results and Discussion

2.3.1 Environmental impacts: Dining tables

Environmental impacts: Business-as-usual

Analysing the business-as-usual case, as set out in Figure 4, yields the following results for the environmental indicators assessed. The methodology document (WRAP 2011) describes the background to these indicators in more detail.

Table 8 presents the **environmental impacts and benefits associated with the current management of all end-of-life dining tables estimated to arise in the UK each year**. They include 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 dining table and a tonne of dining tables in Table 9.

Note that these are the **absolute** impacts/benefits associated with current levels of disposal versus recycling and reuse. Different management pathways are compared in Table 10.

Table 8 and Table 9 show that **current UK management of dining tables results in net GHG emissions** of 13,000 tonnes CO_2-eq, equivalent to 23kg CO_2-eq per table handled, or 0.8 tonnes CO_2-eq per tonne of tables handled. This reflects the high proportion of tables currently estimated to be landfilled, and the impacts associated with disposing biodegradable materials (wood) to landfill.

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

Activity	Total UK Dining Tables – GHG Emissions (tonnes CO_2-eq)	Total UK Dining Tables – Resource Depletion (tonnes Sb-eq)	Total UK Dining Tables – Global Energy Demand (MJ-eq)
Reuse pathway	1,870	-1	-2,440,000
- of which collection	0	0	0
- of which site operation (inc. refurbishment)	119	2	4,010,000
*- of which disposal of residuals**	1,750	-3	-6,460,000
Preparation for reuse pathway	1,160	1	1,570,000
- of which collection	135	1	1,950,000
- of which site operation (inc. refurbishment)	258	2	2,460,000
*- of which disposal of residuals**	766	-1	-2,840,000
Disposal pathway	11,700	-22	-42,900,000
- of which landfill	11,700	-22	-43,100,000
- of which incineration	0	0	0
- of which recycling	22	0	256,000
Reuse displacement effects	-1,530	0	-11,800
	0	0	0
TOTAL	13,200	-21	-43,800,000

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 and the ultimate disposal of reused items at the end of their second life (15% recycling, 85% landfill)

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 dining table arisings	13,200	-21	-43,800,000
Per tonne of dining tables	0.79	-0.00128	-2630
Per dining table	0.023	-0.00004	-76.2

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

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 wood** (from which the dining table is made) **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.

In the case of dining tables, the findings also reflect the **relatively low displacement benefit associated with the avoided production of new tables**. The same levels of displacement were assumed for dining tables as for sofas (20% entering direct reuse/preparation for reuse; 80–90% suitable for reuse; 50% displacement of new). However, considerably higher displacement savings are seen for sofas. This reflects the higher materials/production intensity of a sofa, in comparison with a table comprising solid wood – a relatively low intensity material, with relatively minimal intervention required in the production of the final product.

A series of assumptions were made in modelling the avoided production burdens of a dining table, as no existing estimates were available. It was assumed that the table is solid wood, has low manufacturing burdens and is transported predominantly by sea from Asia and Europe. The sensitivity of these assumptions was tested by alternatively modelling the displacement of a more processed, particulate board-based product of equivalent weight (and using the same displacement rates). This was found to influence results only to a minimal degree (changing GHG emissions from 0.79kg CO_2-eq per tonne of tables to 0.76kg CO_2-eq). This is mainly because, on account of the nature of this product, most displacement benefit comes from avoiding the eventual landfill of a new item, as opposed to avoiding its production.

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

([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.

Environmental impacts: Scenario analysis

Table 10 shows the net environmental impacts associated with a range of hypothetical scenarios. These results are reported on a per item basis.

Table 10 Scenario analysis: Environmental impacts per tonne of dining tables

Scenario	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
Business as usual	0.79	-0.00128	-2630
100% direct reuse	0.38	-0.000387	-1180
100% preparation for reuse	0.76	0.00109	1710
100% recycling	0.01	0.0000739	127
100% landfill	1.00	-0.00186	-3710
Current rates of disposal*	0.86	-0.00157	-3140

Note: negative figures denote a net saving, through displacement of other products/materials and their avoided production. The figures exclude avoided waste management activities.

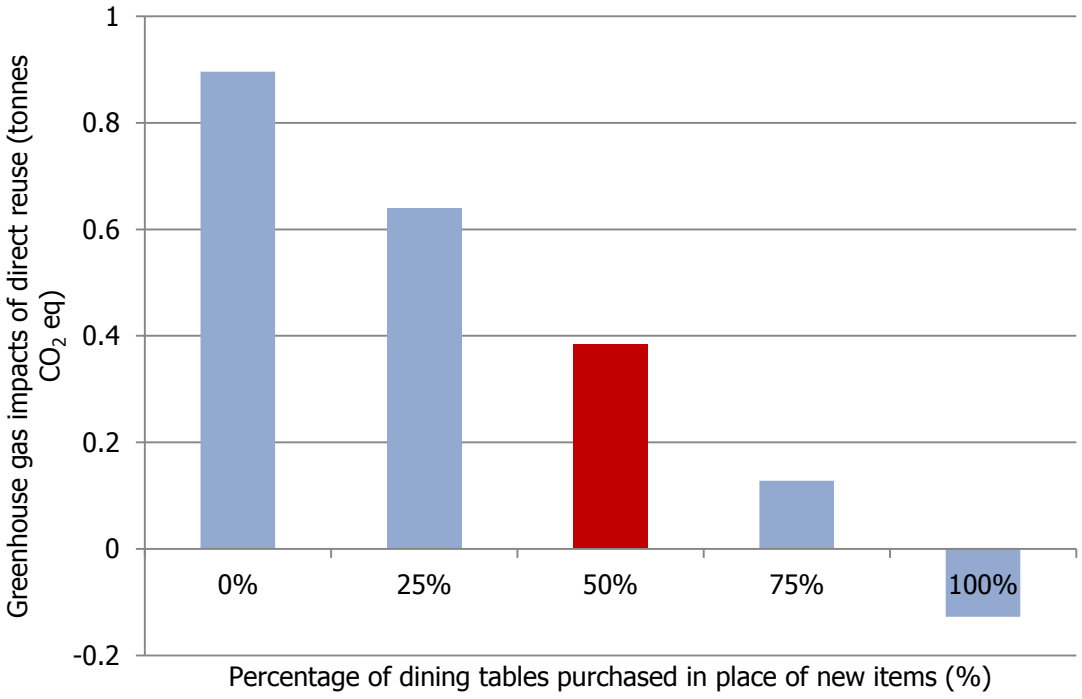
* 100% disposal at current recycling rates (15% recycling, 85% landfill)

Table 10 shows the net environmental impacts associated with both reuse pathways to be lower than landfill, but higher than recycling for GHG emissions. The comparative profile for this product is different to that for other furniture items, for two principal reasons:

- The low benefit allocated to new table displacement is such that landfill emissions dominate the GHG impact profile of different pathways. In accordance with the study method, the benefit of reused products is quantified over two lifetimes only (first and second). Disposal is delayed until after this period, but not avoided entirely, and so the landfill of items at the end of their second life is included. The disposal of displaced new items is avoided, but less than 50% of reused items are assumed to displace new. **For the direct reuse pathway, to achieve net GHG savings across two lifetimes, the levels of new product displacement would need to be approximately 80%.** This is illustrated in figure 7 below. Under the assumptions and data modelled, the preparation for reuse pathway does not achieve net GHG savings even with 100% product displacement. However, the paucity of data to describe the environmental impacts of preparation for reuse activities is noted. This is particularly sensitive for the assessment of dining table reuse (as well as other products with low embodied impacts).

- The low production intensity of avoided new products is such that reused products and recycled materials are awarded a similar displacement benefit. Reuse pathways, in particular preparation for reuse, also have additional collection and operational burdens and so incur greater emissions. There is also a methodological inconsistency that precludes a sound comparison between reuse and recycling pathways, in that the disposal of a reused item is included in its impacts, but for recycling the boundary is drawn at the point where the material is put into use. This is because of the considerable uncertainty associated with the timing and form of this disposal, as opposed to the defined lifetimes considered for reused items. In view of this, **we recommend that direct comparisons should not be drawn between recycling and reuse pathways.**

Figure 7 Change in greenhouse gas emissions from direct reuse (average mix) with a change in displacement of new products, excluding alternative disposal (tonnes CO_2 eq per tonne dining tables)



2.3.2 Financial costs and benefits: Dining tables

Financial cost: Business-as-usual

Analysing the business-as-usual case, as set out in Figure 4, yields the following results for the private metric accounting approach (landfill tax included).

Table 11 presents costs for each pathway and core activity, split according to whom costs and benefits accrue. These present estimates for the current overall UK 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, as with environmental impacts, are dominated by costs associated with waste management and, as such, 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 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 is also significant for the assessment of dining tables.
- The reuse organisations and householders are the main financial beneficiaries of reuse activities, as may be expected. For the reuse organisations, a net income 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 householder avoided purchases can be considered, at best, a high-level estimate. Data sources and quality considerations are presented in Table A2.
- Savings to householders are achievable but with an equal cost to retailers/industry through lost sales. Some of this lost revenue will occur outside of the UK, but is recorded for completeness.

- The uncertainty associated with the quantification of financial savings from onward employment from reuse organisations was discussed for the textiles products. It was also noted for washing machines that there are likely to be additional savings on social welfare payments associated with the avoided purchase of new items through Social Fund Community Care Grants. This also applies to furniture items, but 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 Local Authorities**	...of which to Reuse Organisations	...of which onward employment from ROs	...of which to households***	...of which to business****
Reuse pathway	£1,750,000	£782,000	£578,000			
- of which collection						
- of which site operation	£970,000		*£578,000*			
*- of which disposal of residuals**	£782,000	*£782,000*				
Preparation for reuse pathway	£786,000	£344,000	£442,000			
- of which collection	£225,000		*£225,000*			
- of which site operation	£217,000		*£217,000*			
*- of which disposal of residuals**	£344,000	*£344,000*				
Disposal pathway	£4,480,000	£4,480,000				
- of which landfill	£4,010,000	*£4,010,000*				
- of which incineration	£0					
- of which recycling	£469,000	*£469,000*				
Displacement effects and sales	-£467,000	-£467,000	-£2,220,000		-£20,200,000	£22,800,000
Onward employment from reuse	-£148,000			-£148,000		
TOTAL	**£6,401,000**	**£5,139,000**	**-£1,200,000**	**-£148,000**	**-£20,200,000**	**£22,800,000**

Notes:
negative figures denote income or avoided purchase, based on approximately 50,000 new dining tables displaced (9% 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 (15% recycling, 85% landfill). It includes treatment costs, collection costs and revenue from recyclate, where applicable.

** for the private metric this includes landfill tax.

*** benefits accruing to householders 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/exchange networks/PFR organisations, which is assumed to come from householders purchasing reused items.

**** cost to manufacturers/retailers of new dining tables in terms of lost revenue from sales.

Table 12 Business-as-usual management: Financial cost

Scale	Private Metric (inc. landfill tax) (£)	Social Metric (no landfill tax) (£)
For total UK dining table arisings	£6,401,000	£5,638,000
Per tonne of dining tables	£384	£338
Per dining table	£11.10	£9.81

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 dining tables. Table 13 presents net costs and benefits 'per tonne of dining tables' 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 dining table

Scenario	Private Metric (£)	Social Metric (£)
Business as usual	£384	£338
100% direct reuse	£685	£616
100% preparation for reuse	£540	£471
100% recycling	£232	£232
100% landfill	£345	£297
Current rates of disposal	£328	£287

Table 13 shows that all pathways for the management of end-of-life dining tables result in a net cost to the UK economy as a whole – the highest via the direct reuse pathway. This pathway provides benefit to householders through avoided cost of purchase and delivers a profit to charity shops and exchange network users through sales. However, it is at the expense of retailers/manufacturers of new dining tables 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.

2.3.3 Employment opportunities: Dining tables

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 Local Authorities	...of which to Reuse organisations
Reuse pathway	27	1	26
- of which collection	-		
- of which site operation	26		*26*
*- of which disposal of residuals**	1	*1*	
Preparation for reuse pathway	5	0.3	5
- of which collection	2		*2*
- of which site operation	3		*3*
*- of which disposal of residuals**	0	*0.3*	
Disposal pathway	73	73	
- of which landfill	72	*72*	
- of which incineration	-		
- of which recycling	1	*1*	
Displacement effects	-46		
	-		
TOTAL full time equivalents	59	**74**	**31**

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 (15% recycling, 85% landfill)

Key points from the results are as follows.

- The principal employment benefits associated with the current end-of-life management of dining tables are associated with local government waste management operations, and their contractors, including reuse organisations operators and bulky waste collections in particular.
- Reuse via charity shops and preparation for reuse require more labour per tonne than disposal (recycling, landfill and energy recovery). An increase in reuse activity via these pathways could therefore lead to a benefit in terms of employment.
- The scale of employment for reuse pathways is, however, uncertain and data quality is low (see Table A3 in Appendix A for sources and assumptions).
- If volunteer employment were to be included in Table 14, net employment opportunities for reuse organisations increase to 509, under the assumptions modelled (see Table A3). This is associated with the high volume of volunteer labour at charity shops.
- 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: Dining Tables

Approximately 2,848 tonnes of dining tables are reused in some form in the UK every year. This is about 17% of all the dining tables reaching the end of their life each year. The remaining 83% are sent to recycling, energy recovery or landfill.

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

- Providing 1 tonne of dining tables for direct reuse e.g. second-hand shop or eBay results in net GHG emissions of 0.38 tonnes CO_2 eq. However, these are lower than landfill emissions (1 tonne CO_2 eq per tonne dining tables). This is just over 11kg CO_2-eq per table.
- Providing 1 tonne of dining tables to a preparation for reuse network can result in a net GHG emissions of 0.76 tonnes CO_2 eq. However, these are lower than landfill emissions (1 tonne CO_2 eq per tonne dining tables). This is about 22kg CO_2-eq per table.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each dining tables reused can yield over £2 net revenue to reuse organisations (discounting wider costs or losses to householders businesses), and £33 for preparation for reuse organisations. This is due to the higher reported sale price and lower operating costs.
- Households benefit by over £20 million per year as a result of sale of items through reuse exchange and avoiding purchase of (more expensive) new items.
- The *net* employment impact of dealing with all dining tables that reach the end of their life today (business-as-usual) is positive, with job increases through reuse infrastructure exceeding any losses in manufacturing. Dining tables reused through a charity shop route lead to a net increase in jobs.

The results for business-as-usual management of dining tables are overwhelmingly influenced by impacts associated with disposal to landfill, reflecting high rates of disposal and the significance of GHG emissions from landfilling biodegradable materials. As a result, reuse pathways show GHG emissions reductions in comparison with disposal. However, these are not as significant as seen for other products because of the relatively low displacement benefit associated with the avoided production of new tables.

Financial costs, as with environmental impacts, are dominated by costs associated with waste management (in particular bulky waste collections) and hence most of the financial burden associated with the business-as-usual scenario falls to local authorities. When the net cost/benefit of reuse operations are isolated from wider economic implications to householders or businesses, net profits are seen for the preparation for reuse pathway, but not direct reuse. This reflects the greater reported income to preparation for reuse organisations for dining table sales, the higher operational costs of charity shops and the relatively high proportion of dining tables that pass via free exchanges in the direct reuse pathway.

The results presented are not without their sensitivities, and the absolute values reported 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;
- the displacement value awarded to new dining tables;
- the environmental impacts of preparation for reuse activities;
- costs and environmental impacts/benefits associated with furniture recycling;
- the implication of ultimate disposal for recycled items; and
- costs and employment associated with waste collection, waste disposal and reuse activities.

It is recommended that any further work be 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	Sofa = 752 Table = 1004	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	Sofa = -1.2 Table = -1.9	kg Sb-eq per tonne	Medium		
Energy demand – landfill	Sofa = -2372 Table =-3709	MJ-eq per tonne	Medium		
GHG emissions – recycling	Sofa = -1.2 Table = 11	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 textiles chapter for further detail). **Plastics** – modelled in line with the plastic, dense (min) scenario in DEFRA (2006). This represents the recycling of mixed low grade plastics into plastic lumber. Account is taken of the energy requirements of washing, sorting,	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	Sofa = 0.1 Table = 0,1	kg Sb-eq per tonne	Low		
Energy demand – recycling	Sofa = 471 Table = 127	MJ-eq per tonne	Low		

				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 clean textiles. 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	Sofa – 9.6 Table N/A	kg CO_2e per sofa	Medium	Modelled based on the following sources and assumptions and in all cases assuming 10% refurbishment rate – from Bartlett (2009) **Sofa:** Models the re-upholstering of a sofa, based on the replacement of 2.6kg of cotton covers. Data sourced from the Defra product lifetimes project and modelled in Sima Pro 7.2.4 using the ReCiPe (v 1.04) impact assessment method.	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	Sofa – 0.06 Table N/A	kg CO_2e per sofa	Medium		
MJF of refurbishment	Sofa – 99 Table N/A	kg CO_2e per sofa	Medium		
GWP of new product displacement	Sofa - 159 Table -6.3	kg CO_2e per sofa kg CO_2e per table	Medium	Modelled based on the following sources and assumptions. **Sofa:** The production of a two-seater sofa was modelled, based on the materials composition/wastage described in the Defra product lifetimes study and scaled according to FRN reported average weights for sofas (37kg). Manufacturing and transportation data were also sourced from the Defra product lifetimes project. All materials production, energy and transportation data were sourced from the Ecoinvent LCI database and modelled in SimaPro 7.2.4 using the ReCiPe (v 1.04) impact assessment method. **Dining table:** Assumed to be made by hand from pre-sawn timber with negligible manufacturing energy; and transported from Asia (50% and Europe (50%) by sea. All materials production and transportation data were sourced from the Ecoinvent LCI database and modelled in Sima Pro 7.2.4 using the ReCiPe (v 1.04) impact assessment method.	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	Sofa – 1.1 Table -0.042	kg CO_2e per sofa kg CO_2e per table	Medium		
MJF of new product displacement	Sofa - 1968 Table – 91.31	kg CO_2e per sofa kg CO_2e per table	Medium		

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	Sofa 100 Table 5	£/tonne	Medium	Based on WRAP (2010), with additional data on wood gate fees from WRAP website	Charity rags and shop collections can command a considerably higher price, but the conservative value was assumed in all cases.
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	Sofa £174 Table £222	£/tonne	Medium	Based on review of all Local Authority information on bulky waste charges, assumed to represent costs	Considered to be a reasonable assumption, with relatively little influence on the results
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	Sofa 486 Table 345	£/tonne	High	FRN based on a cost of £7-£10 per tonne	Relatively good agreement between different sources
Cost of dedicated reuse banks	Sofa 135 Table 32	£/tonne	Medium	FRN - £5 per item - based on average weight	Some uncertainty around this value.
Cost of other collection	Sofa 135 Table 32	£/tonne	Low	FRN – assumed to be the same as reuse banks	Some uncertainty around this value.
Revenue generated from sale – preparation for reuse	Sofa 1081 Table 324	£/tonne	Medium	Green-Works sale prices as website June 2011.	Generic value for all textiles, and relatively old for cost data
Displaced new purchase – avoided cost	Sofa 729 Table 465	£/unit	Low	Mean of 15 most popular items from http://www.kelkoo.co.uk/ on 7th Feb 2011	Good data source, but not specific to T-shirts
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	Sofa: -3378 through shop, -2975 through online exchange Table -1897 through shop, 2093 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	Reasoned estimate

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	0.010	FTE/tonne	Low	Based on Caroline Lee-Smith assumption, but adjusting for higher collection cost of textiles (Oxfam vs FRN data)	Assumption
Labour of civic amenity collection	0.0076	FTE/tonne	Low	Assumed as dedicated reuse banks (prep for reuse pathway) – but reference unavailable	Assumption/source references unavailable
Labour of doorstep collection	0.010	FTE/tonne	Low	Based on Caroline Lee-Smith assumption, but adjusting for higher collection cost of textiles (Oxfam vs FRN data)	Assumption
Labour of dedicated reuse banks	0.0076	FTE/tonne	Low	Based on assumptions for washing machines, but adjusting for higher collection cost of textiles (Oxfam vs FRN data)	Assumption

Labour of other collection	0.0015	FTE/tonne	Medium	AWC residual – National Assembly for Wales (2001)	Reasonable source, but likely to be variable.
Labour composition – employed	29	%	Medium	FRN Survey Data	Single source so data quality reduced
Labour composition – volunteer labour	45	%	Medium	FRN Survey Data	Single source so data quality reduced
Labour composition – welfare to work	26	%	Medium	FRN Survey Data	Single source so data quality reduced
Labour composition – learning difficulties	0	%	Medium	FRN Survey Data	Single source so data quality reduced
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
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
UK Employment intensity of displaced products	0.032	FTE/tonne	Low	Other furniture is taken to be domestic furniture. Employment in this sector is 49000 (ONS 2011b), Tonnes of other furniture consumed is 1.5 million. Domestic furniture consumed is estimate to be 644,462 tonnes.	Assumptions, plus high uncertainty for a significant figure in the assessment.
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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