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Final Report

Benefits of Reuse
Case Study: Clothing

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Front cover photography: Recycle items 56 (ID: 17384) (Donald Maclellan)

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 clothing products.

The clothing products chosen were cotton T-shirt and woollen jumpers.

Cotton T-shirts

- About 120 million T-shirts (ca 30,000 tonnes) are reused in some form in the UK every year. This is about 50% of all the T-shirts reaching the end of their life each year. The other 50% go to recycling, energy recovery or landfill.
- The key environmental, financial and employment benefits associated with this reuse activity are:
    - Current levels of reuse of T-shirts avoid 450,000 tonnes CO_2-eq per year.
    - Providing 1 tonne of T-shirts for direct reuse e.g. charity shop or eBay can result in a net GHG saving of 13 tonnes CO_2-eq. This is approximately 3kg CO_2-eq per T-shirt.
    - Providing 1 tonne of T-shirts to a preparation for reuse network can result in a net GHG saving of 11 tonnes CO_2-eq net. This is about 2.5kg CO_2-eq per T-shirt.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each T-shirt reused can yield over £1 net revenue to reuse organisations / government in combination (discounting wider costs or losses to householders, offices or businesses)
- Households can benefit by over £170m 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 T-shirts that reach the end of their life today (business-as-usual) is 500 jobs. There are 700 jobs in reuse organisations.
- The most important parameter for all indicators is the extent of avoiding the purchase of new T-shirts as a result of reuse – the so-called displacement effect. The graph below shows how greenhouse savings vary with different displacement effects for direct reuse, with the current, business-as-usual situation highlighted in red. If all directly reused T-shirts were bought in place of new items, the greenhouse gas savings could increase to 21 tonnes CO_2-eq.

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

Figure i Effect of changing the percentage of new products displaced by reused T-shirts

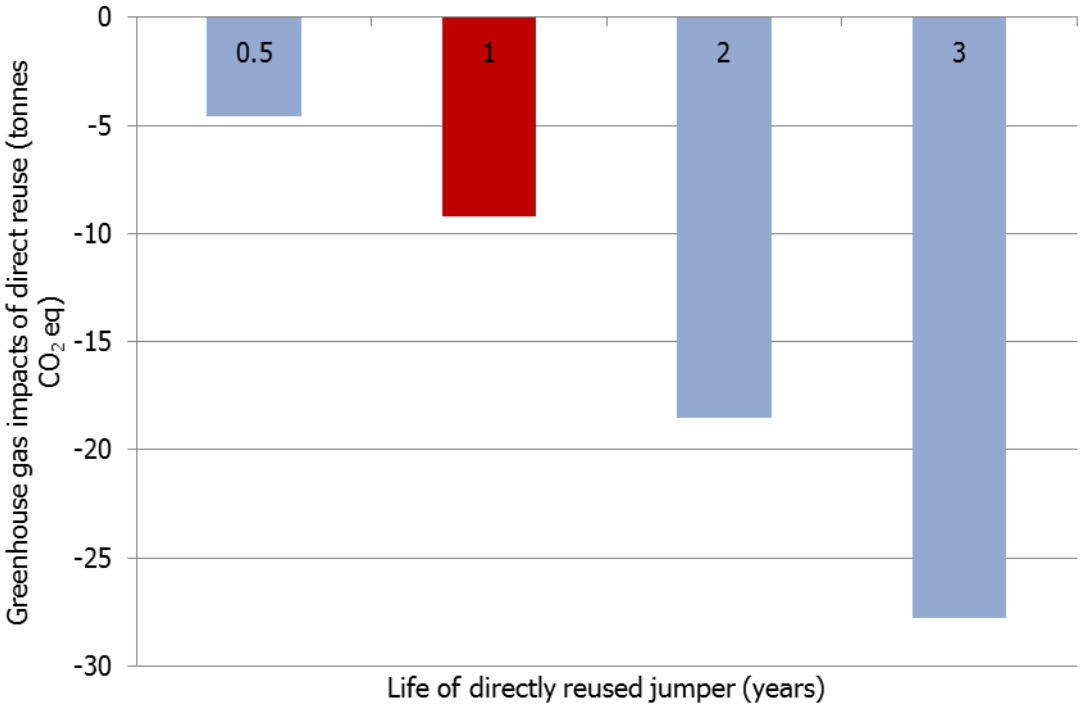
Woollen Jumpers

Approximately 84 million woollen jumpers (42,000 tonnes) are reused in some form in the UK every year. This is about 50% of all the jumpers reaching the end of their life each year. The remaining 50% 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 jumpers avoids 470,000 tonnes CO_2-eq per year.
- Providing 1 tonne of Jumpers for direct reuse e.g. charity shop or eBay can result in a net GHG saving of 9 tonnes CO_2-eq. This is just over 4.5kg CO_2-eq per jumper.
- Providing 1 tonne of Jumpers to a preparation for reuse network can result in a net GHG saving of 8 tonnes CO_2-eq net. This is about 4kg CO_2-eq per jumper.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each jumper reused can yield over £1 net revenue to reuse organisations / government in combination (discounting wider costs or losses to householders, offices or businesses)
- Households can benefit by over £20m 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 jumpers that reach the end of their life today (business-as-usual) is 1,000 jobs.
- The graph below shows how greenhouse savings vary if the lifetime of a jumper is changed from the current assumption of 1 year, which is highlighted in red. This shows the greenhouse gas benefits of reuse could increase threefold if all direct reuse displaced new items for an equivalent lifetime (assumed to be 3 years).

Figure ii Effect of changing the lifetime of a jumper in second life



Clothing

We estimate that T-shirts and woollen jumpers account for about 12% and 9% respectively of all clothing that reaches the end of life. The benefits of reusing all clothing are obviously even higher than for the individual categories above. The results above can be extrapolated for all clothing, especially for the financial benefits and employment opportunities. For the environmental benefits, we recommend more caution as the results are strongly dependent on the material composition of the product.

Next Steps

This project to understand the benefits of reuse has clearly indicated the need to improve the quality of the primary data used within 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 or sourcing of better quality data on:

- the quantity of reused items displacing new items;
- the manufacturing burdens associated with new clothing;
- the 'value' of recycled clothing, and what material recycled cloth displaces; and
- employment needs and costs for checking and preparing reused items in the UK and abroad.

It is recommended that future research be focused on enabling better quantification of these issues.

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 T-shirts

This chapter covers T-shirts and similar tops in the UK (collectively referred to here as T-shirts). It provides an estimate of the net environmental and economic, both financial and social, benefits of the current levels of T-shirt reuse and the potential impact of increases in reuse.

A cotton T-shirt manufactured in China was selected as the item replaced, as cotton is the predominant T-shirt fibre on the UK clothing market and China is an important source of clothing.

The chapter outlines:

- An overview of T-shirt 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 T-shirts with some scenario analysis for:
    - environmental benefits
    - financial costs
    - employment opportunities
- The key conclusions

1.1 T-Shirt Reuse in the UK

This section describes the UK material flows of T-shirts from the end of their first life through the various reuse and disposals routes. It also describes the characteristics of the various direct reuse, preparation for reuse and disposal pathways for T-shirts.

T-shirt reuse, along with the reuse of other textile products, is a well-established practice in the UK, with many easily available routes for householders and businesses to participate, for example:

- direct reuse within family/friendship networks;
- facilitated, internet-based exchanges (either free or paid) or small ads and car boot sales/jumble sales;
- charity shops;
- bring banks at household waste recycling centres, supermarkets, car parks and other public sites; and kerbside collection by charities and other private organisations.

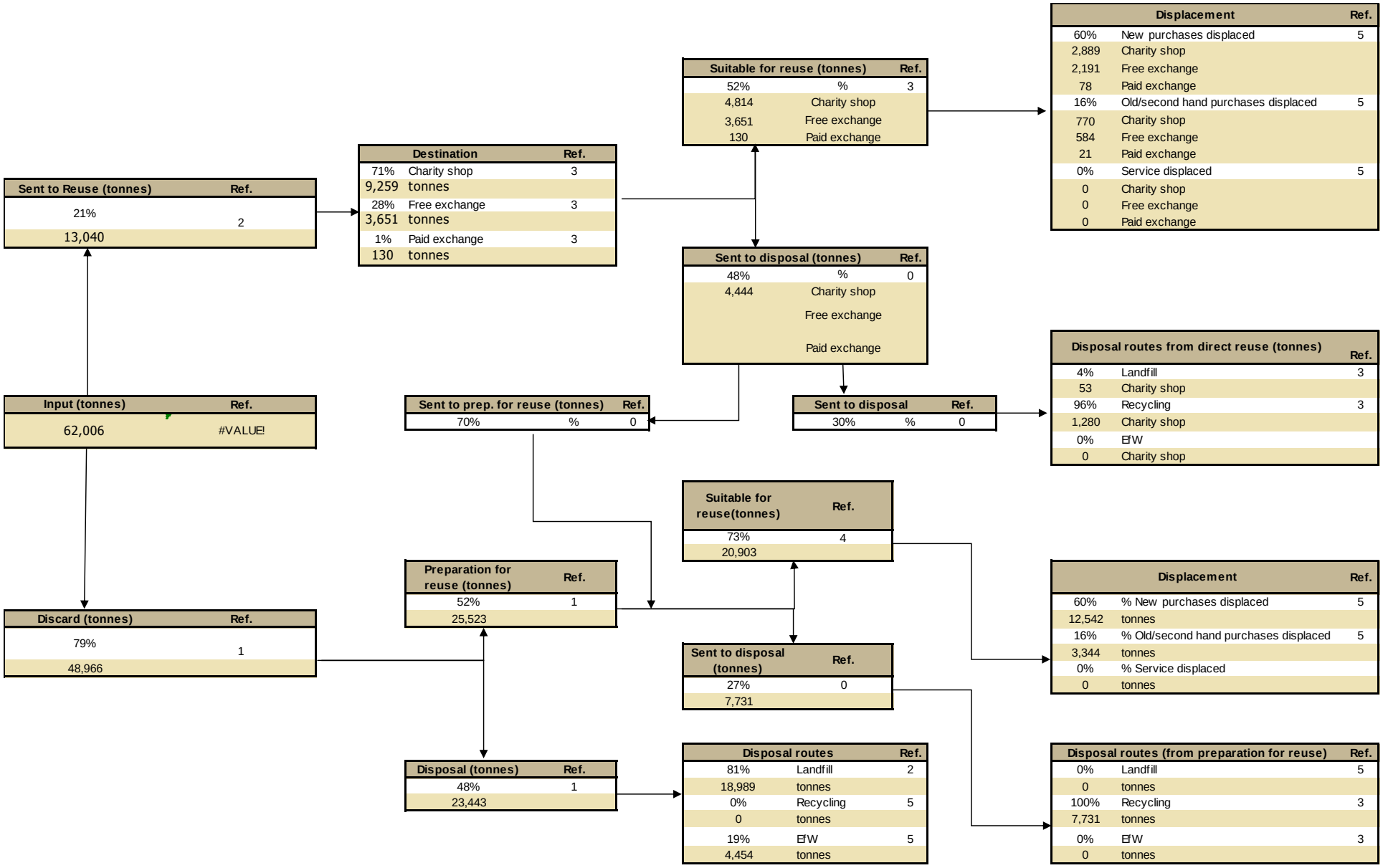
The trade in second-hand clothing is dominated by not-for-profit organisations such as charities or NGOs (Farrant, 2008). It is estimated that about 70% of their potential lifetime remains when clothes are discarded (Salvation Army, 2008). The potential for reuse is therefore significant.

The multitude of pathways for reuse, and the links between them, makes the clothing system difficult to characterise. Many studies have investigated the arisings and the ultimate fate of textiles at the end of their first life. In this study, we have used the following categories to group these different fates: direct reuse; preparation for reuse; and disposal (including recycling).

WRAP has developed estimates of annual T-shirt 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 sale/gifting via exchange networks, and 'preparation for reuse' characterised by a national, or regional, organisations such as Oxfam Wastesavers and textiles reclaimers/wholesalers.

The Figure can be used to trace the fate of T-shirts - approximately 62,000 tonne/year – passing through the various pathways. Key estimates are made of the percentage of new T-shirt purchases that are avoided as a result of the reuse action. This is called the displacement effect.

Figure 1 T-shirt mass flow – 'business-as-usual'



References

Euromonitor (2009) Forecast Sales of Clothing by Subsector: Volume 2008-2013. Total men's and women's tops (2011), adjusted for approx 14% in the 'national wardrobe' (Oakdene Hollins, 2009)

1

2 Oakdene Hollins (2009) Maximising Reuse and Recycling of UK Clothing and Textiles EV0421, Technical Report Appendix I

3 Farrant, Laura (2008) Env Benefits from reusing clothes

4 Defra 2008/09 waste management statistics

5 WRAP (2010), The Reuse Landscape

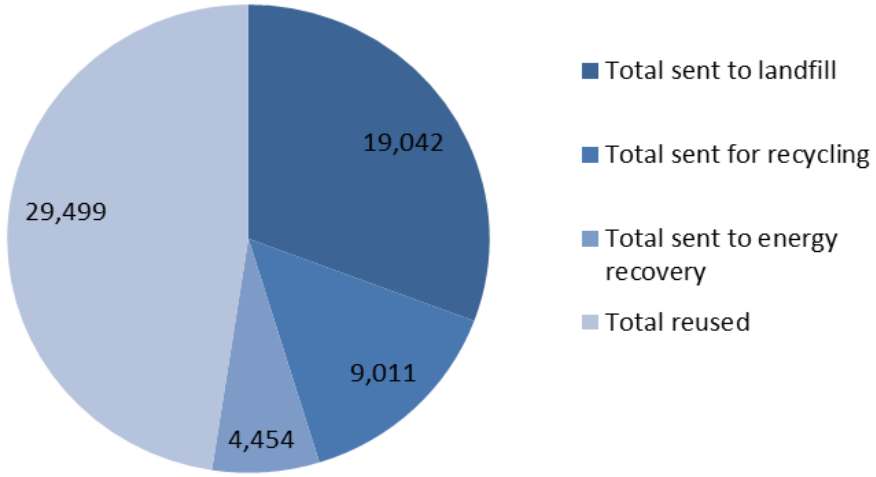
6 Charity Retail Association (2010), Stock Analysis Survey

Note that, in this business-as-usual scenario in Figure 1, the 48% of waste T-shirts that enter the disposal pathway are assumed to be residual waste and are not included in the recycling route. This is because there is considerable overlap in the literature between the preparation for reuse and recycling pathways. To avoid over-estimating the tonnage of material recycled, recycled clothing is assumed to arise from the preparation for reuse and direct reuse pathways only. This would appear to be reasonable, as there is relatively little kerbside collection of textiles from households, other than that associated with charities.

There are uncertainties around 'business-as-usual' flows and so these values should be treated with some caution in their absolute sense. In particular, overall findings are sensitive to the estimate of current arisings of end-of-life T-shirts in the UK. Impact estimates will increase or decrease in a linear correlation with this figure. We believe that a sound source has been used, but there is a lack of consistency in terminology between different sources available.

Figure 2 shows the final destination of T-shirts which pass through the different pathways identified in figure 1. This shows the total amount disposed of directly and indirectly through other routes. Approximately half of T-shirts are currently estimated to be reused.

Figure 2 Final Destination of T-shirts– 'business-as-usual' (tonnes)



The following sections briefly describe each pathway, as modelled in this assessment. Other studies provide a good overview of textiles reuse systems and second-hand clothing networks and they are not reproduced here. In particular:

- DEFRA's sustainable clothing roadmap provides a series of research projects and case studies, including a report recommending next steps to increase reuse and recycling of UK clothing and textiles (Oakdene Hollins, 2009): http://www.defra.gov.uk/environment/business/products/roadmaps/clothing/index.htm
- A masters thesis by Laura Farrant (DTU), provides a good overview of the global second-hand clothing network (Farrant, 2008): http://www.uffnorge.org/files/Laura%20Farrant-environmental%20benefits%20from%20reusing%20clothes.pdf

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

In this study, direct reuse includes those pathways in which the original owner makes a conscious choice, or takes direct action, to enable reuse. The principal routes for this are via **exchange networks** (free or paid, including family and social networks) and **charity shops**.

In terms of the significance of these routes, previous studies show that direct reuse within family/friendship networks is significant, but may be declining, whilst reuse facilitated by the internet is growing (Oakdene Hollins, 2009). Charity shops are ubiquitous on the UK high street and are a common means of enabling reuse. After sorting, a large proportion – estimated to be around 50% – of donations are sold (Charity Retail Association (2010) Stock Analysis Survey). The revenue from selling these clothes on the second-hand market provides funds

for financing development projects. The second-hand clothing trade is thus a significant way of raising funds for charities (Farrant, 2008).

In all cases, it is assumed that direct reuse pathways 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. There is a lack of empirical data upon which to do so, and the impact is likely to be relatively small because it is assumed that these are locally organised operations. In view of this, this is not likely to be a significant omission.

The financial, employment and environmental costs of direct reuse are incurred through **sorting/resale overheads** (which are minimal for exchange networks), and **management of any residual items** that are not considered suitable for reuse is predominantly either through recycling, or through passing on to the preparation for reuse pathway.

As well as generating income for charities, the benefits of direct reuse come through the displaced need to produce equivalent items elsewhere in the economy. This manifests itself as an '**avoided cost of production**' – be it either financial cost or environmental impact.

The amount of displacement that occurs is a key consideration – and one that is notoriously difficult to quantify with any certainty. For example, the difficulty of estimating the number of new clothes purchases avoided by second-hand clothing is well explored in Farrant, 2008. Consumers shopping in charity shops, or using exchange networks, are unlikely to be doing so as a direct alternative to other retail outlets. The types of clothes on sale and the price differential make this direct comparison unrealistic. For example, it is reasonable to consider that shoppers purchase a greater number of cheaper items in place of fewer 'new' items, or may use charity shops to supplement a wardrobe as an additional, rather than replacement, purchase. There are many replacement scenarios that could be explored, with little certainty as to a realistic outcome. The key issue of which one can be certain is that there is unlikely to be 100% displacement of new items.

In this assessment, we have assumed the following as a default based on Farrant (2008), and considered the sensitivity of these assumptions in reporting results. The reuse tool that supports this study allows users to alter these assumptions and to analyse the resulting implications.

- **60% of reuse is displacement of a new item**. In the case of T-shirts, 'displacement of new' assumes that the reused item will directly avoid the production of a cotton T-shirt of equivalent weight. The reused item is assumed to be of good enough quality to enable like-for-like replacement, and is assumed to have enough remaining 'wear' for a second use (i.e. only one reused item is needed to replace a new item). The 'use phase' of the new and reused item is assumed to be the same, as this is driven primarily by consumer behaviour (washing and drying practices), rather than the performance of the item. A cotton T-shirt manufactured in China was selected as the item replaced, as cotton is the predominant T-shirt fibre on the UK clothing market and China is an important source of clothing. All data used to quantify displacement of new items are shown in Tables 1 to 3.

- **16% 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.

- **24% of reuse is displacement of nothing**. This route assumed that a reused item is simply an additional purchase, and is not made in place of any other purchase. Again, in this case no avoided production is allocated.

Although 60% of reused items are assumed to displace new products, of the items donated for reuse or preparation for reuse, approximately a quarter are not suitable for reuse. As a consequence, approximately 45% of T-shirts entering the reuse and preparation for reuse pathways are assumed to displace new items.

A full list of data and assumptions used to characterise direct reuse for T-shirts is set out in Tables A1, A2 and A3 in Appendix A.

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

Preparation for reuse is a complex pathway for textiles. In this study, it is characterised by intermediary organisations, such as Oxfam Wastesavers and textiles reclaimers/wholesalers. There are a number of linkages and overlaps between this pathway and the direct reuse and recycling pathways. Collected materials will often have a number of secondary markets available, from direct use (e.g. charity shops reselling locally), sale to textile reprocessors in the UK, or export to be sorted and distributed overseas (Oakdene Hollins, 2009). Because of this, there is not always a clear distinction between direct reuse, preparation for reuse, or recycling. There is also a 'feedback' loop where items entering a direct use pathway (particularly a charity shop) will enter the preparation for reuse pathway if not sold. For example:

- Only 12% of the annual throughput at JMP Wilcox, the largest textile reclaimer in the UK, comes from bring banks and kerbside collections. The remainder are items that charity shops have been unable to sell. Wilcox is also able to accept textiles from clean materials recycling facilities (MRFs), provided that the materials are clean and dry and not contaminated by other materials (WRATE, 2005).

- Oxfam operates its own textile sorting facility that sorts clothing and resells it through a number of different routes (Oxfam 2011):

    - Oxfam shops;
    - direct to public on Oxfam online shop and pop-ups at festivals;
    - to designers who restyle garments and reuse fabrics in their collections;
    - to textile wholesalers in the UK and overseas; and
    - to recycling traders in bulk, where the low grade items not sold as clothing are used, for example, as mattress filler, carpet underlay, upholstery and car sound insulation.

For the purposes of assessment, in this study preparation for reuse is assumed to include the financial, employment and environmental burdens of:

- **Collection** – e.g. via kerbside collection, bring sites or direct delivery from businesses. This pathway represents predominantly commercial textile collectors that operate nationally;
- **Sorting** operations at handling facilities;
- **Export of items suitable for reuse** for sale abroad as second-hand clothing. Note that in the business-as-usual scenario, all items 'suitable for reuse' within preparation for reuse are assumed to be exported to Africa (the remainder are assumed to be recycled in the UK). There are other key overseas markets, in particular Eastern Europe – but flows to different markets change over time. African exports were used as a worst case scenario (with regard to distance travelled) and alternatives were considered in sensitivity analysis. Exported materials incur additional transport burdens, but may also lead to increased rates of displacing new items (eg Farrant, 2008, suggests that this might be as high as 85% in Africa). This latter consideration has not been modelled due to the associated uncertainty and the preference for a conservative assessment;
- **Recycling** of items unsuitable for direct reuse; and
- **Avoided costs** of displacing new items – using the same profile as for direct reuse.

For preparation for reuse, two figures have been identified for the fraction which is sent on to reuse or disposal:

- JMP Wilcox (2004) estimate that 90% of their feedstock is sent for reuse and 10% recycling;
- Oakdene Hollins (2009) estimate that 73% of items diverted through preparation for reuse in the UK are sent for reuse and 27% to recycling, with some disposal to landfill from sorting aboard.

The figure from Oakdene Hollins has been used as a conservative estimate of the route for reusing clothing. A full list of data and assumptions used to characterise direct reuse for T-shirts is set out in Tables A1, A2 and A3 in Appendix A.

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

Disposal in this study is characterised into three principal routes:

- **Recycling** – this is not typically considered as a disposal route. We do so in this study to enable differentiation between reuse at the top of the waste hierarchy, and management routes lower down the hierarchy. Typically, low quality and torn or stained clothes are sold to the textile recycling industry. These

items are then converted into wiping cloths, mainly for industrial purposes, or processed back into fibres. Uses for reclaimed fibres include filling materials for mattresses, car insulation, roofing felts or furniture padding (Waste online, 2006). Some reclaimed fibres can be re-spun into new yarns to make new fabric products (e.g. carpets, blankets). In this study, recycling is assumed to be low grade, as this is likely to be the principal route.

- **Landfill** – including collection and subsequent disposal in landfill. Emissions associated with materials degrading in a landfill over an infinite time period are accounted for (no credits are given for carbon storage in landfill); and
- **Incineration** – including collection and subsequent disposal in a waste incinerator with energy recovery through electricity generation.

1.2 Quantifying the Benefits of Reusing T-shirts

The section describes the methodology used and data quality issues in the estimation of the environmental and economic benefits of reusing T-shirts.

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, but we note that some considerable uncertainties remain. In particular:

- With regard to mass flows, the data extracted from existing sources are, for the most part, more applicable to textiles or clothing in general rather than representative of T-shirts.
- Current arisings data are very uncertain on an individual-item basis. The mass flow data for T-shirts gathered by WRAP suggest that, based on a UK population of 62 million (ONS 2011) around four T-shirts are discarded per person per year.
- Allwood et al. (2006) suggest that the UK consumes 460 million T-shirts per year (over 7 per person). However, Euromonitor (2009) suggests that 290 million tops and 440 million shirts and blouses would be sold in the UK in 2010.
- It is not clear whether T-shirts would be classified as tops or shirts by Euromonitor. However, in either case, the sales forecast appears to be lower than Allwood et al's estimate. As it is specific to T-shirts, the Allwood figure has been used but this is likely to be at the high end of estimated sales for this group.
- With regard to environmental impacts, data relating to the displacement value that can be attributed both to reuse (displacing new) and recycling are of greatest significance. The data used in the assessment are considered to be a reasonable representation, but their sensitivity is discussed further in Section 1.4.
- 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 uncertainty and high potential variability of the values used is noted.
- With regard both to costs and to employment impacts, assumptions relating to the amount of time spent checking, sorting and preparing items, as well as resale value are, in particular, subject to considerable uncertainty. It is recommended that further information is sought for these issues.
- Therefore, data describing the potential impacts on UK employment associated with new product displacement should be interpreted with caution.

1.3 Results and Discussion

1.3.1 Environmental impacts

Environmental impacts: Business-as-usual

This section describes the environmental benefits of T-shirts 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 T-shirts estimated to arise in the UK each year**. This includes the impacts associated with waste management activities occurring in the UK (and abroad where exported), 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 T-shirt and a tonne of T-shirts in Table 2.

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

Activity	Total UK T-shirts – GHG Emissions (tonnes CO_2-eq)	Total UK T-shirts – Resource Depletion (tonnes Sb-eq)	Total UK T-shirts – Global Energy Demand (MJ-eq)
Reuse pathway	564	14	21,600,000
- of which collection	0	0	0
- of which site operation	*1,600*	*31*	*54,100,000*
*- of which disposal of residuals**	*-1,040*	*-17*	*-32,500,000*
Preparation for reuse pathway	3,450	-2	21,500,000
- of which collection	*8,170*	*52*	*119,000,000*
- of which site operation	*1,730*	*14*	*31,200,000*
*- of which disposal of residuals**	*-6,440*	*-68*	*-129,000,000*
Disposal pathway	2,330	-18	-34,600,000
- of which landfill	*3,860*	*-4*	*-7,410,000*
- of which incineration	*-1,530*	*-14*	*-27,200,000*
- of which recycling	0	0	0
Reuse displacement effects	-455,000	-3,070	-4,920,000,000
	0	0	0
TOTAL	-449,000	-3,070	-4,910,000,000

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 and the ultimate disposal of reused items at the end of their second life (14% recycling, 70% landfill, 16% incineration). The method document provides more detail on this accounting approach.

Table 2 Business-as-usual management: environmental impacts

Scale	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
Per total UK T-shirt arisings	-449,000	-3,070	-4,910,000,000
Per tonne of T-shirts	-7.24	-0.0495	-79300
Per T-shirt	-0.00181	-0.00001	-19.8

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

Table 1 and Table 2 show that **current UK management of T-shirts results in net GHG savings** of around 450,000 tonnes CO_2-eq, or 1.8 kg CO_2-eq per T-shirt handled. The overall impact is very similar to the benefit of current levels of reuse allowing for emissions from preparation for reuse and direct reuse. This reflects the high levels of reuse and recycling currently occurring. Net benefits are also seen with regard to resource depletion and global energy demand, with the impact of the current mix of management dominated by the effect of displacing new products through reuse.

Results for all impact indicators show a net environmental benefit for a number of principal reasons.

- **The contribution of the displacement benefit associated with the avoided production of new T-shirts.** Both cotton yarn/cloth production and subsequent T-shirt manufacture (bleaching/dyeing etc.) are highly energy intensive and so 'avoiding' these processes brings significant environmental savings. These savings are well documented and we can have some confidence that there are net environmental savings associated with reuse.

- Residual textiles from direct reuse and preparation for reuse are assumed to be predominantly recycled. As such, they also incur net environmental savings through material displacement. However, we believe the approach taken to be a relatively conservative one. From the information collated in this study, we also believe that it is reasonable to consider that residues from, for example, charity shops and textiles wholesalers will be recycled rather than disposed to residual waste. Because of this, the uncertainty associated with these assumptions is not thought to be large.

- New T-shirt production is assumed to occur in China, and so transport to the UK is also displaced. Transport only contributes approximately 5–10% of the total displacement for all impact indicators, and so results are not considered to be sensitive to this assumption. However, energy for T-shirt manufacture is a significant contributor to the displacement benefit attributed, and so results are sensitive to both the energy demand of this stage (variable values are reported in literature) and the mix of energy used in production (Chinese electricity is heavily dependent on fossil energy sources). For example, if renewable energy sources were used in all stages of manufacture, the overall GHG savings shown in Table 1 would be less than half of those currently reported. This is an extreme example, as there are only a limited number of examples of this kind of practice – e.g. Continental Clothing's T-shirt range (Continental Clothing, undated). However, it serves to demonstrate the potential sensitivity of the displacement benefits applied.

- T-shirt recycling is assumed to yield low-grade textiles and displace paper filling materials. This is a reasonable assumption, as the displacement of higher value materials would, in this study, be more akin to the preparation for reuse pathway. However, this is a sensitive assumption, and if recycled T-shirts were instead assumed to displace virgin fibre (e.g. spun cotton), the net environmental impacts presented in Table 1 would be lowered (i.e. there would be greater benefit).

- In the business-as-usual scenario, a conservative scenario was to assume that **all items which pass through preparation for reuse and are 'suitable for reuse' are exported to Africa** (the remainder are assumed to be recycled in the UK). JMP Wilcox (2004) estimate that only 4% of their products are sold in Eastern Europe, with Asia being the other significant market.

Exports incur additional transport burdens in the preparation for reuse pathway, but may also lead to increased rates of displacing new items (e.g. Farrant, 2008 suggests that this might be as high as 85% in Africa). This latter consideration has not been modelled, due to its associated uncertainty and the preference for a conservative assessment. Export transportation burdens contribute approximately one-third of the 'collection' emissions shown in Table 1. Thus the assumption is a significant one in this respect. Most of the journey to Africa is likely to be by sea, with varying amounts of land-based travel, dependent on ultimate destination. Travel from Eastern Europe by lorry incurs approximately the same environmental burdens as shipping to West Africa and approximately 200km by light vehicle on arrival. If European markets are reached by sea, and African markets incur longer land transit, the emissions associated with preparation for reuse could vary by more than 50%.

Despite a number of assumptions and uncertainties, it is clear that there are environmental benefits associated with the current management of end-of-life T-shirts in the UK. This is because the benefits associated with displacing new items (and other materials through recycling), and so avoiding the production of new materials, outweigh any impacts associated with transport or handling. This holds true as long as 'displacement of new' does occur, even at levels of 5% or less. This is particularly likely to be the case for a short-lived/high-turnover item such as a T-shirt, where a reused item has sufficient 'wear' remaining.

Environmental impacts: Scenario analysis

Table 3 shows the net environmental impacts associated with a range of hypothetical scenarios for T-shirt end-of-life management, on a 'per tonne' basis. It shows that the net environmental benefits associated with both reuse pathways to be lower than those associated with recycling, and considerably lower than those for landfill or residual management. It can be used to do some basic scenario analysis of increasing the amount of reuse of T-shirts in the UK.

Table 3 Scenario analysis: Environmental impacts per tonne of T-shirts

Scenario	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
Business as usual	-7.24	-0.0495	-79300
100% direct reuse	-12.80	-0.0856	-137000
100% preparation for reuse	-11.10	-0.076	-121,000
100% recycling	-0.84	-0.00572	-10900
100% landfill	0.20	-0.000212	-390
Current rates of disposal	0.10	-0.000746	-1480

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

From a Local Authority perspective, items collected are most likely to be sent to a preparation for reuse organisation, who will sort out items suitable for reuse and recycling. Direct recycling would be a less common route.

The findings indicate that reuse of T-shirts offers significant benefits relative to recycling. To put this in perspective to achieve the same benefit as donating 1 tonnes of T-shirts to reuse would require 3 tonnes of food waste to be prevented, or 12 tonnes of plastic to be recycled (DEFRA and DECC 2011). In terms of greenhouse gas emissions, the impact of recycling T-shirts is similar to recycling paper and card (ibid).

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

- If the quantity of new items displaced is halved, the benefits of reuse are also halved. Conversely, if the quantity of new items displaced is increased, the benefits of reuse also increase. The scale of net impacts presented is highly dependent on the level of displacement assumed.

The most important parameter for all indicators is the extent of avoiding the purchase of new T-shirts as a result of reuse – the so-called displacement effect. Figure 3 below shows how greenhouse savings vary with different displacement effects for direct reuse, with the current, business-as-usual situation highlighted in red. If all directly reused T-shirts were bought in place of new items, the greenhouse gas savings could increase to 21 tonnes CO_2-eq.

Figure 3 Effect of changing substitution rate on greenhouse gas impacts of direct reuse

- **If T-shirt manufacturing burdens were reduced (e.g. through use of renewable energy), the business-as-usual scenario would show increased impact in comparison with 100% recycling.** This is because recycled materials are assumed always to displace other materials (with a small amount of loss in the system) and reused items are assumed to replace the same material.
- **If T-shirt recycling is assumed to displace virgin cotton fibres instead of paper filling materials, the business-as-usual scenario would show increased impact in comparison with 100% recycling.** This is again because recycled materials are assumed always to displace other materials and reused items are not.
- **If a T-shirt is recycled in Africa and displaces low grade paper filling materials, the net environmental benefits seen could instead become net impacts.** This is based on an extreme example, whereby waste textiles are transported by sea to the west coast of Africa and then by truck to central regions. The impacts associated with this level of transport outweigh the benefit of low grade recycling. Importantly, this is not the case where transport is predominantly by sea, or in the case of higher grade materials (e.g. cotton fibre or fabric).

1.3.2 Financial costs

Financial cost: Business-as-usual

This section describes the financial benefits of T-shirts 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. In addition, the methodology and tool have been developed to differentiate between domestic and international trade. Therefore, the effect of exporting items for reuse and recycling attributes a financial income to the UK from sale, but no effect on UK jobs or businesses is attributed.

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. Net costs and benefits on a unit item or unit mass basis are also presented in Table 5.

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	£14,000,000	£922,000	£13,100,000			
- of which collection	£0	*£0*	*£0*			
- of which site operation	£13,100,000	*£0*	*£13,100,000*			
*- of which disposal of residuals**	£922,000	*£922,000*	*£0*			
Preparation for reuse pathway	£11,400,000	-£1,470,000	£12,900,000			
- of which collection	£8,050,000	*£0*	*£8,050,000*			
- of which site operation	£4,820,000	*£0*	*£4,820,000*			
*- of which disposal of residuals**	-£1,470,000	*-£1,470,000*	*£0*			
Disposal pathway	£3,590,000	£3,590,000	£0			
- of which landfill	£3,000,000	*£3,000,000*	*£0*			
- of which incineration	£588,000	*£588,000*	*£0*			
- of which recycling	£0	*£0*	*£0*			
Displacement effects and sales	-£20,400,000	-£1,630,000	-£76,200,000		-£170,000,000	£227,000,000
Onward employment from reuse orgs	-£4,620,000	£0	£0	-£4,620,000	£0	
TOTAL	£3,970,000	£1,412,000	-£50,200,000	-£4,620,000	-£170,000,000	£227,000,000

Notes: negative figures denote income or avoided purchase.

* this includes the disposal of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (70% landfill, 14% recycling, 6% incineration). It includes treatment costs, collection costs and revenue from recyclate, where applicable. Due to lack of available data, ultimate disposal of items reused in the UK, and those exported, are assumed to be the same. Rejects for the preparation for reuse pathway arise in the UK and are reported to be predominantly recycled.

** 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 displaced new T-shirts 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 T-shirt arisings	£3,970,000	£3,060,000
Per tonne of T-shirts	£63	£48
Per T-shirt	£0.02	£0.01

Key points from the results are as follows:

- The reuse organisations and householders are the main financial beneficiaries of reuse activities, as may be expected. For the reuse organisations, an estimated net income of £50m per year is seen as sales exceed operating costs. For householders, an estimated net saving of £170m per year through avoided purchases is seen.

- Savings to householders 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.

- 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 in Appendix A, but are further considered as follows:

    - **Sales from charity shops and reuse networks**. Data from the literature and from the Charity Retail Association (2010) suggest that approximately 50% of clothing received at charity shops are suitable for reuse and can be sold to generate income. Revenue from sale of donated items through charity shops was reported to be over £444 million in 2009 (Sim 2010). Assuming this reflects typical performance, the total income to charity shops from T-shirt sales in this study (£57 million) represents 13% of total charity shop sales of donated items.
    - **Product displacement benefits associated with the avoided production of new T-shirts.** An 'avoided purchase cost' of £11 per item was allocated to the proportion of T-shirts that were assumed to be 'displaced new'. This value was based on data from Euromonitor (2009) for 'mens tops'. However, there is high degree of uncertainty to both the amount of displacement and the value of avoided items.

- The savings seen are balanced against, in particular, reuse organisations site, labour and transportation costs. It was assumed that there would be relatively minimal checking, sorting and preparation needs for T-shirts. In the preparation for reuse pathway these are split between UK sorting costs and the additional need for sorting overseas. Additional transport costs for export are also included (a high-level assumption of £2000 per container and 15 tonnes per container, based on personal communication with a textile recycler). A conservative assumption was made that all clothing that is 'suitable for reuse' from the preparation for reuse pathway is exported to Africa for resale. This increases the burdens for the preparation for reuse pathway, but not significantly (10% of PFR costs are from export).

Financial costs: Scenario analysis

As with the environmental criteria, it is useful to compare the business-as-usual scenario with a range of possible scenarios. Again, costs are considered on a per tonne basis, as opposed to considering the unlikely event of a wholesale shift in the treatment of end-of-life T-shirts. Table 6 presents net costs and benefits 'per T-shirt' for a range of scenarios. These include collection, operation (rent, utilities, labour), sales, disposal of residuals, 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 T-shirts

Scenario	Private Metric (£)	Social Metric (£)
Business as usual	£63	£48
100% direct reuse	£926	£896
100% preparation for reuse	-£461	-£446
100% recycling	-£190	-£190
100% landfill	£158	£110
Current rates of disposal	£153	£114

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

Table 6 shows that preparation for reuse and recycling pathways result in a net benefit to the UK economy as a whole – the highest via the preparation for reuse pathway. This is because preparation for reuse generates income through exports, so no displacement of UK manufactured-products occurs.

The direct reuse pathway and provides more benefit to UK households through avoided cost of purchase and delivers a profit to charity shops and reuse networks through sales, but also displaces some UK manufacturing, resulting in negative financial impacts.

The recycling pathway shows net financial savings because the revenue generated is not tangibly linked to a loss of revenue elsewhere (e.g. in the sale of paper wipers). Demand for end-of-life textiles is generally high (Letsrecycle, undated) and so clean materials a relatively high price. The value used for all recycling in this assessment is equivalent to the price of textile bank-collected materials, though it is acknowledged that many of these materials will enter preparation for reuse following sorting.

1.3.3 Employment opportunities

Employment opportunities: Business-as-usual

This section describes the employment opportunities of T-shirts 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 Local Authorities	...of which to Reuse organisations
Reuse pathway	358	3	355
- of which collection	-	-	-
- of which site operation	355	-	355
*- of which disposal of residuals**	3	3	-
Preparation for reuse pathway	372	15	358
- of which collection	57	-	57
- of which site operation	301	-	301
*- of which disposal of residuals**	15	15	-
Disposal pathway	37	37	-
- of which landfill	37	37	-
- of which incineration	1	1	-
- of which recycling	-	-	-
Displacement effects	-271	-	-
	-	-	-
TOTAL full time equivalents	497	55	713

Notes: negative figures denote loss of employment

* this includes the recycling of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (14% recycling, 70% landfill, 16% incineration)

This analysis indicates that there is a net UK gain of about 500 jobs from current levels of reuse of T-shirts 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 T-shirts are associated with the reuse organisations. Hence, any scenario that includes significant proportions of reuse will result in increased employment opportunities in comparison with other management routes.

- If volunteer employment were to be included in Table 7, net employment opportunities for the reuse organisations increase to 6500, under the assumptions modelled (see Table A3 in Appendix A).

- Employment associated with displacement is negative due to the reduced production of new items. This is an estimate, based on a series of assumptions (see Table A3). Because of this, care should be taken with regard to any conclusions draw from this estimate.

1.4 Conclusions: T-shirts

About 120 million T-shirts (ca 30,000 tonnes) are reused in some form in the UK every year. This is about 50% of all the T-shirts reaching the end of their life each year. The other 50% go to recycling, energy recovery or landfill.

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

- Current levels of reuse of T-shirts avoids 450,000 tonnes CO_2-eq per year.
- Providing 1 tonne of T-shirts for direct reuse e.g. charity shop or eBay can result in a net GHG saving of 13 tonnes CO_2-eq. This is just over 3kg CO_2-eq per T-shirt.
- Providing 1 tonne of T-shirts to a preparation for reuse network can result in a net GHG saving of 11 tonnes CO_2-eq net. This is about 2.5kg CO_2-eq per T-shirt.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each T-shirt reused can yield over £1 net revenue to reuse organisations / government in combination (discounting wider costs or losses to householders, offices or businesses)
- Households can benefit by over £170m 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 T-shirts that reach the end of their life today (business-as-usual) is 500 jobs. There are 700 jobs in reuse organisations.
- The most important parameter for all indicators is the extent of avoiding the purchase of new T-shirts as a result of reuse – the so-called displacement effect. Figure 3 shows how greenhouse savings vary with different displacement effects for direct reuse, with the current, business-as-usual situation highlighted in red. If all directly reused T-shirts were bought in place of new items, the greenhouse gas savings could increase to 21 tonnes CO_2-eq.

There are clear environmental, financial and employment benefits associated with the current levels of T-shirt reuse in the UK. This is because the benefits associated with displacing new items and the avoided production of new materials, outweigh any impacts associated with transport or handling. This holds true as long as 'displacement of new' does occur, even to a small degree.

The financial impacts vary by organisation, with income to reuse organisations and savings to householders being at the expense of income to businesses selling new clothing. The cost of sending T-shirts to landfill (estimated at £3,000,000) is only partially offset by current levels of recycling. In addition, there are potential savings on social welfare payments associated with the creation of training opportunities in preparation for reuse organisations.

There are caveats on the quality of primary data available for this study, as noted in section 1.2.2, and this means that the findings are not without their sensitivities. The absolute values presented should be treated as estimates. The following variables were found in particular to have the potential to affect the overall conclusions:

- the quantity of reused items displacing new items;
- the manufacturing burdens associated with new T-shirts;
- the 'value' of recycled T-shirts, and what recycled cloth is assumed to displace; and
- employment needs and costs for checking and preparing reused items in the UK and abroad.

It is recommended that future research be focused on enabling better quantification of these issues.

2.0 Woollen Jumpers

This chapter discusses the reuse of woollen jumpers and similar items (collectively referred to here as woollen jumpers), and provides an estimate of the net environmental, financial and employment costs and benefits of current levels of jumper reuse in the UK.

In the absence of empirical data, where a reused jumper is used in place of a new item, it has been assumed that 50% new, high quality UK-produced woollen jumpers and 50% lower quality poly-cotton jumpers manufactured in China have been displaced.

The chapter outlines:

- An overview of jumper 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 jumpers with some scenario analysis for:
    - environmental benefits
    - financial benefits
    - employment opportunities
- The key conclusions

2.1 Woollen Jumper Reuse in the UK

The same pathways are available to jumper reuse in the UK as described for T-shirts, and so this information is not repeated here. Instead, consideration of potential differences between the management of T-shirts and woollen jumpers is presented. For example:

- It may be reasonable to consider that a higher proportion of direct reuse occurs for 'bigger ticket' items, such as woollen jumpers, because the price differential between new and reused items is likely to be considerable, and perhaps worth a greater investment of time and effort on the part of both those enabling reuse and those seeking reused items.
- The price differential between new and reused items may also be such that there may not be like-for-like displacement of products. A consumer may purchase a woollen jumper at low cost in a charity shop, or via an exchange network, but this does not necessarily mean that a new woollen jumper will be displaced (or even a fraction of one). Instead, the reuse purchase could displace a lower value equivalent, such as a cotton or man-made fibre garment.
- There is also potential for new and reused items to have a different lifespan. As it is a relatively high-cost item when purchased new and is likely to only be worn seasonally. The original purchase may be kept for a few years or more, whilst the same may not be said for a lower-cost reused item. Because of this, the reused item may not replace the full lifetime functionality of a new purchase.

There is no empirical evidence to support these considerations, and so the most appropriate approach for this assessment is to model a reasonable base case and explore the sensitivity of key assumptions and datapoints for any conclusions drawn. Given the lack of specific evidence for woollen jumpers, it was considered that the most reasonable base case – or 'business-as-usual' scenario – is to assume the **same core flows (% to different fates) as those for T-shirts**. As discussed previously, these flows are more generally applicable to 'textiles' and so could equally be taken as proxies for both T-shirts and woollen jumpers. The resulting business-as-usual scenario for woollen jumpers is shown in Figure 4.

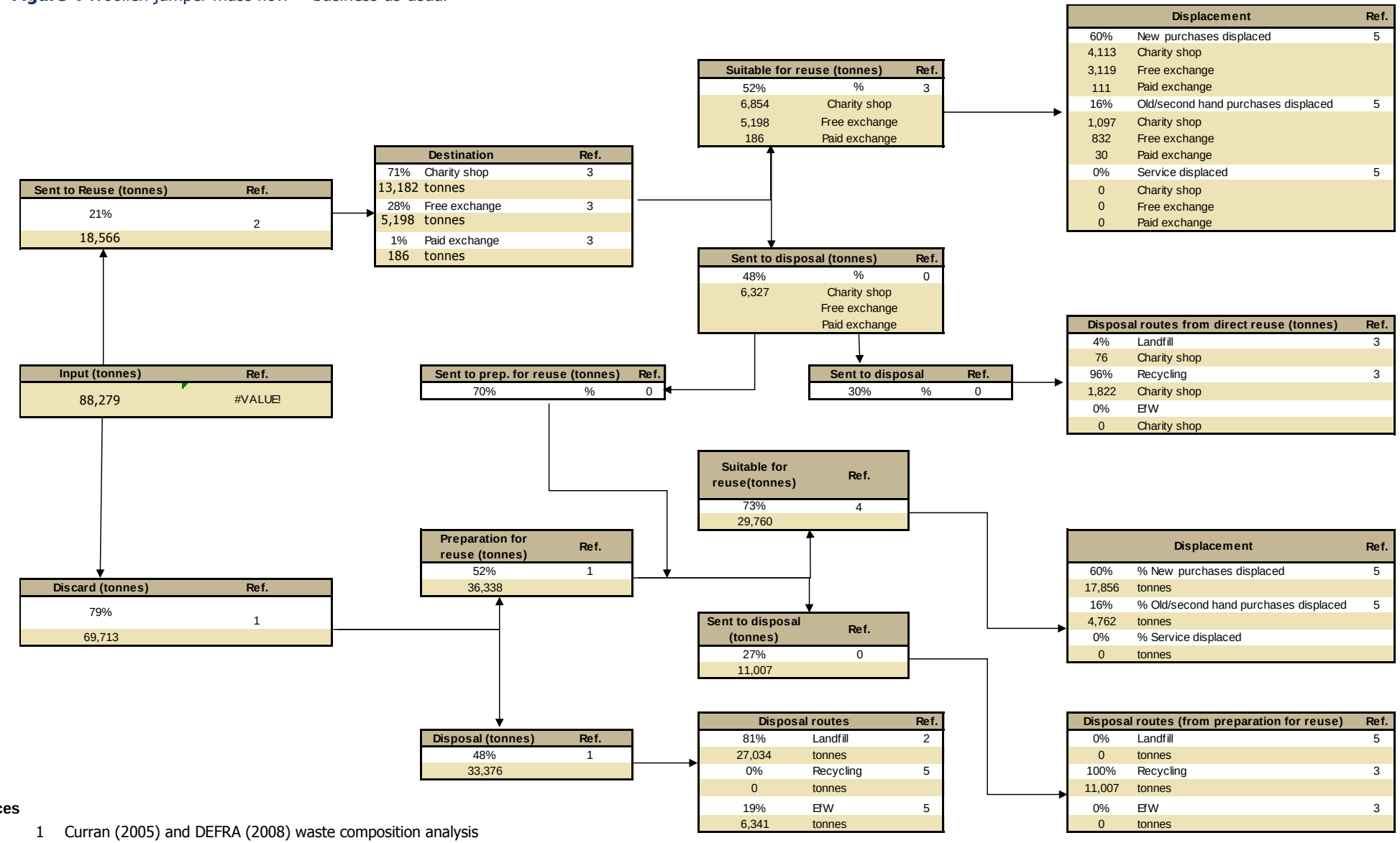
Some specific considerations for woollen jumpers that differ from those assumed for T-shirts were as follows:

- **Displacement of new items** is assumed at the same default rate of 40% as for T-shirts. However, it was assumed that the lifespan of a new item is three years (Wastewatch 2006), and the lifespan of a reused item is one year. In view of this, three reused items would be needed to fulfil the lifetime function of a new item, and only **one-third of new items are displaced**. With regard to displacement, it was assumed that reused items will displace **50% new, high quality UK-produced woollen jumpers and 50% lower quality poly-cotton jumpers** manufactured in China. The assumption was explored further in the sensitivity

analysis and all data used to quantify displacement of new items are shown in Table A1. As with T-shirts, the 'use phase' of the new and reused item is assumed to be the same, as this is driven principally by consumer behaviour (ie washing and drying practices), rather than the performance of the item.

- **Fate of exported items**. As for T-shirts, all items from the preparation for reuse pathway that are 'suitable for reuse' are assumed to be exported (the remainder are assumed to be recycled in the UK), as this is the principal, and growing, market for secondhand clothing not directly sold in charity shops. For heavier items like woollens, the predominant fate is Eastern Europe, as opposed to Africa (Wastewatch 2006), and so this was modelled instead.

Figure 4 Woollen jumper mass flow – 'business-as-usual'

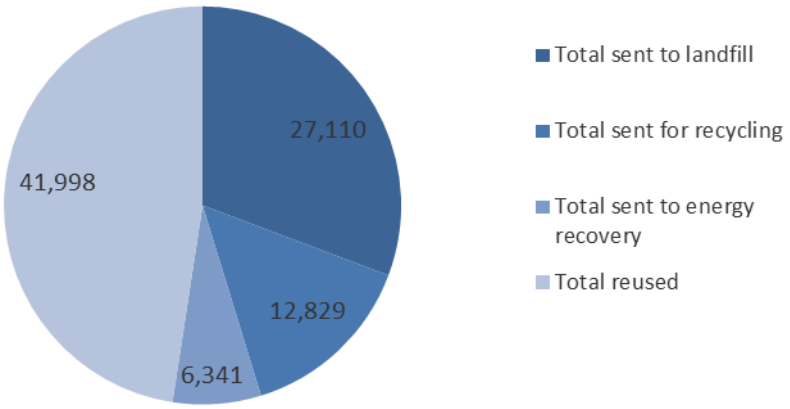


References

1 Curran (2005) and DEFRA (2008) waste composition analysis
2 75% bulky waste collections, 6% of voluntary collections and 9% HWRC to landfill
3 Curran (2005) and Charity Retail Association data
4 FRN
5 Assumption - sensitivity conducted in report
6 Defra data

Figure 5 shows the final destination of jumpers which pass through the different pathways identified in figure 4. As the same flows of clothing have been used to inform both the T-shirt and jumper mass flows, the proportion of items reused and sent to disposal is shown to be the same.

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



2.2 Quantifying the Benefits of Reusing Woollen Jumpers

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

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

The majority of datapoints used in the assessment of woollen jumpers are the same as for T-shirts, and so they are not repeated – see section 1.2.2 and Tables A1 to A3 in Appendix A.

The general data quality issues raised in section 1.2.2. are equally applicable to jumpers. The exceptions to this are:

- Only one data source has been identified for jumper mass flows. Euromonitor (2009) forecast sales of jumpers in the UK to be 204 million in 2010, approximately 3 per person based on ONS (2011) population statistics. In this model, all reused jumpers have been modelled as woollen, and it is acknowledged that many fibres may be used. It has also been assumed that the number of jumpers purchased is equal to discards.
- Of particular significance for the findings is the proportion of displacement of new items that is assumed. This is discussed further in Section 2.3.

2.3 Results and Discussion

2.3.1 Environmental impacts

Environmental impacts: Business-as-usual

This section describes the environmental benefits of woollen jumpers 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).

Table 8 presents the **environmental impacts and benefits associated with the current management of all end-of-life woollen jumpers estimated to arise in the UK each year**. This includes the impacts associated with waste management activities in the UK (and abroad where exported), and the benefits of avoided production of materials through reuse and recycling, whether - 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 jumper and a tonne of jumpers in Table 9.

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

Activity	Total UK Jumpers – GHG Emissions (tonnes CO_2-eq)	Total UK Jumpers – Resource Depletion (tonnes Sb-eq)	Total UK Jumpers – Global Energy Demand (MJ-eq)
Reuse pathway	803	20	30,800,000
- of which collection	0	0	0
- of which site operation	*2,280*	*44*	*77,000,000*
*- of which disposal of residuals**	*-1,480*	*-24*	*-46,200,000*
Preparation for reuse pathway	5,090	-3	30,600,000
- of which collection	*11,800*	*74*	*170,000,000*
- of which site operation	*2,460*	*20*	*44,400,000*
*- of which disposal of residuals**	*-9,180*	*-97*	*-184,000,000*
Disposal pathway	3,320	-25	-49,300,000
- of which landfill	*5,500*	*-6*	*-10,500,000*
- of which incineration	*-2,180*	*-19*	*-38,800,000*
- of which recycling	0	0	0
Reuse displacement effects	-468,000	-1,740	-2,840,000,000
	0	0	0
TOTAL	-459,000	-1,740	-2,830,000,000

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 and the ultimate disposal of reused items at the end of their second life (14% recycling, 70% landfill, 16% incineration)

Table 9 Business-as-usual management: Environmental impacts

Scale	GHG Emissions (tonnes CO_2-eq)	Resource Depletion (tonnes Sb-eq)	Energy Demand (MJ-eq)
Per total UK jumper arisings	-459,000	-1,740	-2,830,000,000
Per tonne of jumpers	-5.20	-0.0198	-32000
Per jumper	-0.0026	-0.00001	-16.0

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

Table 8 and Table 9 show that **current UK management of jumpers results in net GHG savings** of around 460,000 tonnes CO_2-eq, or 2.5kg CO_2-eq per jumper handled. This is similar to the net benefit of reuse, allowing for emissions from direct reuse and preparation for reuse activities. This reflects the high current levels of reuse

and recycling. Despite the lower quantity of jumpers in circulation, similar net environmental savings are seen for jumper reuse in comparison with T-shirts. Two opposing reasons for this similarity are:

- **Higher unit weight** –- each jumper is assumed to weigh twice as much as a t-shirt, so the quantity of material reused is higher; and
- **The displacement benefits associated with the avoided production of jumpers are lower.** This is because of the assumption that a reused item only displaces one-third of a new item (and is despite the fact that displacement benefits are considerably higher for woollen jumpers on a mass-for-mass basis).

It is clear that there are environmental benefits associated with reuse wherever new items are displaced. This holds true even for small degrees of displacement.

For woollen jumpers, we might have less confidence about displacement than for a lower value item, such as the T-shirt discussed earlier, as there is a bigger quality and price differential between new and reused items. In this case, we are not comparing like-for-like and could question whether the reuse purchase is more likely to be an additional one than a substitute. Because of this, although it is clear that there are environmental benefits, the exact magnitude of these warrants further analysis. However, it is reasonable to consider that the current level of reuse and increasing reuse will lead to reduced production of garments, and there are environmental benefits associated with this.

Environmental impacts: Scenario analysis

Table 10 presents net environmental costs and benefits 'per tonne for a range of scenarios.

Table 10 Scenario analysis: Environmental impacts per tonne of woollen jumpers

Scenario	GHG Emissions (tonne CO_2-eq)	Resource Depletion (tonne Sb-eq)	Energy Demand (MJ-eq)
Business as usual	-5.20	-0.0198	-32000
100% direct reuse	-9.22	-0.0334	-54500
100% preparation for reuse	-8.02	-0.0302	-48600
100% recycling	-0.84	-0.00572	-10900
100% landfill	0.20	-0.000212	-390
Current rates of disposal	0.10	-0.000746	-1480

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

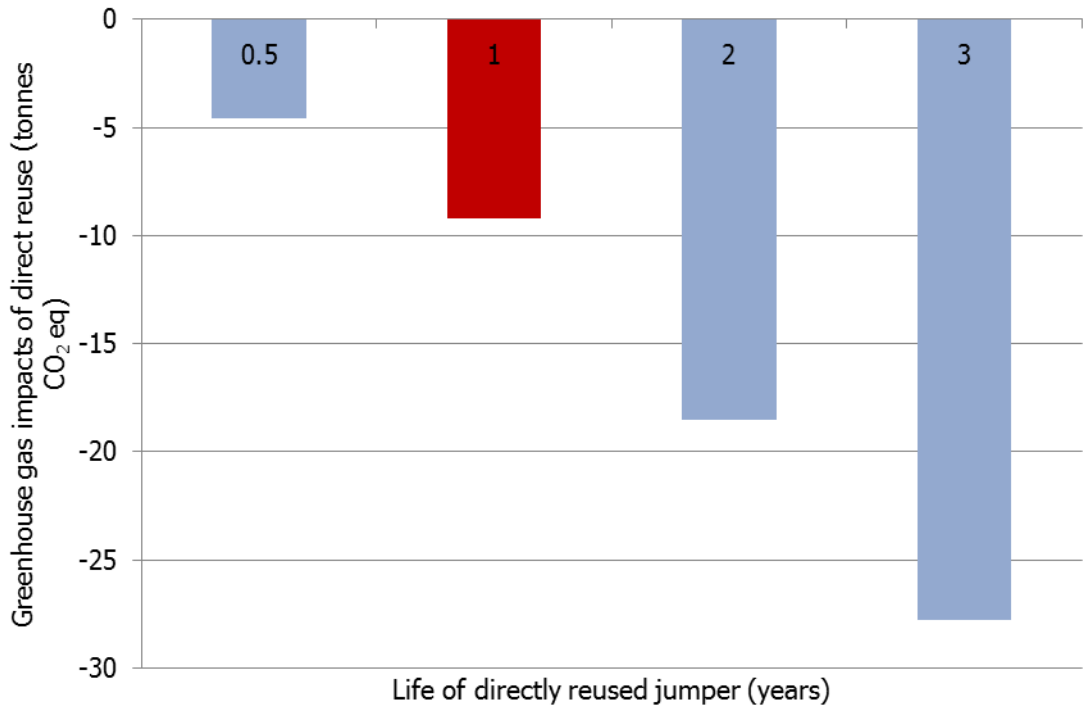
The findings indicate that reuse of jumpers offers significant benefits relative to recycling. To put this in perspective to achieve the same benefit would require 2 tonnes of food waste to be prevented, or 8 tonnes of plastic to be recycled (DEFRA and DECC 2011). In terms of greenhouse gas emissions, the impact of recycling jumpers is similar to T-shirts as the same process and product displacement are assumed.

Comparing reuse options with alternatives, the net environmental benefits are clear. As noted, these findings are subject to a number of uncertainties. Key sensitivities are as follows:

- If the life of a reused jumper is halved, both reuse pathways remain preferable to alternative options.

The most important parameter for all indicators is the extent of avoiding purchase of new jumpers as a result of reuse – the so-called displacement effect. In this case study, a reused jumper has been assumed to last one year, whilst a new jumper is kept for 3 years. This means that one reused jumper replaces one third of a new jumper. Figure 6 shows how greenhouse savings vary if the lifetime of a jumper is changed from the current assumption of 1 year, which is highlighted in red. This shows the greenhouse gas benefits of reuse could increase threefold if all direct reuse displaced new items for an equivalent lifetime.

Figure 6 Effect of changing the lifetime of a jumper in second life



- If jumper recycling is assumed to displace virgin cotton or wool fibres, instead of paper filling materials, the 100% recycling scenario would show lower impacts than either the business-as-usual or reuse scenarios. This is because recycled materials are assumed to always displace other materials and reused items are not. This is an important consideration for woollen jumpers, as Wasteonline suggests that, whilst unwearable cotton garments are likely to be sorted into grades to make wiping cloths and for use in paper manufacture, unwearable woollen garments are typically 'sold to specialist firms for fibre reclamation to make yarn or fabric' (Waste Watch 2006)

In view of this, it is recommended that further research be undertaken to understand the products avoided by recycling of textiles, as the conclusion that reuse is preferable to recycling is highly dependent on the materials avoided.

2.3.2 Financial costs

Financial costs: Business-as-usual

This section describes the financial benefits of T-shirts 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. In addition, the methodology and tool have been developed to differentiate between domestic and international trade. Therefore, the effect of exporting items for reuse and recycling attributes a financial income to the UK from sale, but no effect on UK jobs or businesses is attributed.

Analysing the business-as-usual case, as set out in *Figure 4*, Table 11 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. Net costs and benefits on a unit item or unit mass basis are also presented in Table 12.

Key points from the results are as follows.

- The reuse organisations and householders are the main financial beneficiaries of reuse activities. For the reuse organisations, an estimated net income of about £45m per year is seen as sales exceed operating costs. For householders, an estimated net saving of about £20m per year through avoided purchases is seen.

- Savings to householders 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.

- 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 in Appendix A, but are further considered as follows:

    - **Sales from charity shops and reuse networks**. Using the same 'sense check' data as for T-shirts, the total income to charity shops from jumper sales in this study (£45 million) represents 11% of total charity shop sales. This is likely to be more reflective of total jumper sales as opposed to woollen jumpers in particular – but is high even in this context. This reflects the likely overestimate of jumper arisings.
    - **Product displacement benefits associated with the avoided production of new jumpers.** An 'avoided purchase cost' of £36 per item was allocated to the approximate 20% of jumpers that were assumed to be 'displaced new'. This value was based on data from Euromonitor (2009) for 'mens jumpers'. However, there is a high degree of uncertainty as to both the amount of displacement and the value of avoided items.

- The savings seen are balanced against, in particular, reuse organisations site, labour and transportation costs. It was assumed that there would be relatively minimal checking, sorting and preparation needs for jumpers. In the preparation for reuse pathway these are split between UK sorting costs and the additional need for sorting overseas. Additional transport costs for export are also included (a high-level assumption of £750 per container and 15 tonnes per container, based on personal communication with a textile recycler). A conservative assumption was made that all clothing that is 'suitable for reuse' from the preparation for reuse pathway is exported to Eastern Europe for resale. This increases the burdens for the preparation for reuse pathway, but not significantly, and so the results are not considered to be sensitive in this respect.

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	£19,900,000	£1,310,000	£18,600,000			
- of which collection	£0	£0	£0			
- of which site operation	£18,600,000	£0	£18,600,000			
*- of which disposal of residuals**	£1,310,000	£1,310,000	£0			
Preparation for reuse pathway	£14,700,000	-£2,090,000	£16,800,000			
- of which collection	£8,990,000	£0	£8,990,000			
- of which site operation	£7,790,000	£0	£7,790,000			
*- of which disposal of residuals**	-£2,090,000	-£2,090,000	£0			
Disposal pathway	£5,110,000	£5,110,000	£0			
- of which landfill	£4,270,000	£4,270,000	£0			
- of which incineration	£837,000	£837,000	£0			
- of which recycling	£0	£0	£0			
Displacement effects and sales	-£29,100,000	-£2,320,000	-£80,500,000		-£20,800,000	£74,500,000
Onward employment from reuse	-£6,580,000	£0	£0	-£6,580,000	£0	
TOTAL	£4,030,000	£2,010,000	-£45,100,000	-£6,580,000	-£20,800,000	£74,500,000

Notes:
negative figures denote income or avoided purchase, based on approximately 22,000,000 new jumpers displaced (13% 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 (70% landfill, 14% recycling, 6% incineration). It includes treatment costs, collection costs and revenue from recyclate, where applicable. Due to lack of available data, ultimate disposal of items reused in the UK, and those exported, are assumed to be the same. Rejects for the preparation for reuse pathway arise in the UK and are reported to be predominantly recycled.

** 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 displaced new jumpers 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) (£)
Per total UK jumper arisings	£4,030,000	£2,630,000
Per tonne of jumpers	46	31
Per jumper	0.02	0.02

Note: negative figures denote a net income, through sales and displacement of other products/materials

Financial cost: Scenario analysis

As for environmental criteria, it is useful to compare the status quo with a world without reuse – be it current proportions of recycling/incineration/landfill, or an exclusive focus on each management route. Table 13 presents net costs and benefits 'per jumper' for a range of scenarios. These include collection, operation (rent, utilities, labour), sales, disposal of residuals, eventual disposal of reused items at end of life and the avoided disposal of new items displaced.

Table 13 Scenario analysis: Economic impacts per tonne of jumpers

Scenario	Private Metric (£)	Social Metric (£)
Business as usual	46	31
100% direct reuse	917	887
100% preparation for reuse	-498	-484
100% recycling	-190	-190
100% landfill	158	110
Current rates of disposal	153	114

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

Table 13 shows that, in a similar way to T-shirts, preparation for reuse and recycling pathways result in a net benefit to the UK economy as a whole – the highest via the preparation for reuse pathway. This is because preparation for reuse generates income through exports, so no displacement of UK manufactured-products occurs.

Direct reuse provides benefit to households through avoided cost of purchase and delivers a profit to charity shops and reuse networks through sales. However, it is at the expense of retailers of new jumpers and so the net benefit of these sales is zero –- and the costs in Table 13 are positive rather than negative.

The recycling pathway shows net financial savings because of the revenue that can be generated – and not tangibly linked to lost revenue elsewhere (e.g. in the sale of paper wipers). The value used for all jumper recycling in this assessment is equivalent to the price of textile bank-collected materials (Letsrecycle, undated) although it is acknowledged that many of these materials will enter preparation for reuse following sorting.

2.3.3 Employment opportunities

Employment opportunities: Business-as-usual

Analysing the business-as-usual case, as set out in Figure 2, 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 Government	…of which to Reuse organisations	…of which to business
Reuse pathway	509	4	506	
- of which collection	-	-	-	
- of which site operation	506	-	506	
*- of which disposal of residuals**	4	4	-	
Preparation for reuse pathway	608	21	588	
- of which collection	81	-	81	
- of which site operation	506	-	506	
*- of which disposal of residuals**	21	21	-	
Disposal pathway	53	53	-	
- of which landfill	52	52	-	
- of which incineration	1	1	-	
- of which recycling	-	-	-	
Displacement effects	-129	-	-	-1294
	-	-	-	
TOTAL full time equivalents	1,040	78	1,090	**-129**

Notes:
negative figures denote loss of employment
* this includes the recycling of items unsuitable for reuse and the ultimate disposal of reused items at the end of their second life (14% recycling, 70% landfill, 16% incineration)

This analysis indicates that there is a net UK gain of about 1,000 jobs from current levels of reuse of T-shirts alone. As noted in section 1.2.2, this finding is sensitive to the assumptions on labour for preparation and checking. This is twice as high as T-Shirts due to the drivers identified in section 2.3.1 (higher unit weight and lower displacement of new products).

Key points from the results are as follows:

- The principal employment benefits associated with the end-of-life management of jumpers are associated with the reuse organisations. Hence, any scenario that includes significant proportions of reuse will result in increased employment opportunities in comparison with other management routes.
- The scale of employment is uncertain. In particular for the preparation for reuse pathway, this is linked to assumptions around labour for preparation and checking.
- If volunteer employment were to be included in Table 14, net employment opportunities for the reuse organisations increase to 9,630, under the assumptions modelled (see Table A3 in Appendix A).
- Employment associated with displacement is negative due to reduced production of new items. This is an estimate, based on a series of assumptions, as data are unavailable. Because of this, care should be taken with regard to any conclusions draw from this estimate.
- 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: Woollen Jumpers

Approximately 84 million woollen jumpers (42,000 tonnes) are reused in some form in the UK every year. This is about 50% of all the jumpers reaching the end of their life each year. The remaining 50% 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 jumpers avoids 470,000 tonnes CO_2-eq per year.
- Providing 1 tonne of Jumpers for direct reuse e.g. charity shop or eBay can result in a net GHG saving of 9 tonnes CO_2-eq. This is just over 4.5kg CO_2-eq per jumper.
- Providing 1 tonne of Jumpers to a preparation for reuse network can result in a net GHG saving of 8 tonnes CO_2-eq net. This is about 4kg CO_2-eq per jumper.
- As well as the carbon benefits, there are parallel resource and energy savings as a result of this reuse activity.
- Each jumper reused can yield over £1 net revenue to reuse organisations / government in combination (discounting wider costs or losses to householders, offices or businesses)
- Households can benefit by over £20m 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 jumpers that reach the end of their life today (business-as-usual) is 1,000 jobs.
- The most important parameter for all indicators is the extent of avoiding purchase of new jumpers as a result of reuse – the so-called displacement effect. In this case study, a reused jumper has been assumed to last one year, whilst a new jumper is kept for 3 years. This means that one reused jumper replaces one third of a new jumper. Figure 6 shows how greenhouse savings vary if the lifetime of a jumper is changed from the current assumption of 1 year, which is highlighted in red. This shows the greenhouse gas benefits of reuse could increase threefold if all direct reuse displaced new items for an equivalent lifetime.

The results of this study show that there are environmental, financial and employment benefits associated with the current levels of jumper reuse in the UK. This is because the benefits associated with displacing new items and the avoided production of new materials, outweigh any impacts associated with transport or handling. This holds true as long as 'displacement of new' does occur, even to a small degree.

There are also employment benefits for reuse organisations, financial benefits associated with second-hand sales and potential savings of social welfare payments associated with the creation of training opportunities in reuse organisations. It was also found that the net environmental benefits associated with current levels of reuse in the UK are greater than those associated with landfill or residual management.

These findings are not without their sensitivities, and the values presented should be treated as estimates. In particular, for this product, the values presented are more likely to be reflective of the entire 'jumper' category, as opposed to 'woollen jumpers', as data for arisings of this specific item are unavailable.

In addition, there may also be less confidence about displacement for the woollen jumper than for a lower value item, such as a T-shirt, as there is a bigger quality and price differential between new and reused items. In this case, we are not comparing like-for-like and could question whether the reuse purchase is more likely to be an additional one than a substitute. However, it is reasonable to consider that the current level of reuse and increasing reuse lead to reduced production of garments, and there is, in particular, environmental benefit associated with this.

Other variables that were found to have the potential to affect the overall conclusions were:

- the 'value' of recycled woollen jumpers, and what recycled fibres are assumed to displace; and
- employment needs and costs for checking and preparing reused items in the UK and abroad.

It is recommended that any further research be focused on enabling better quantification of these issues.

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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	203	kg CO_2e per tonne	Medium	Emissions from the landfilling of cotton were modelled using the Environment Agency's WRATE tool. Cotton was assumed to fall under the category of 'natural textiles'. This figure includes emissions from transport to landfill (50km round trip in 21-tonne refuse collection vehicle), 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 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). This affects greenhouse gas emissions estimates in particular, and so data quality is considered to be lower for this criterion.
Resource depletion – landfill	-0.2	kg Sb-eq per tonne	High		
Energy demand – landfill	-396	MJ-eq per tonne	High		
GHG emissions – recycling	-844	kg CO_2e per tonne	Medium	Cotton recycling was modelled in line with the 'low grade' textiles scenario as set out in the Defra Carbon Balance Study (ERM, 2006b). This impact factor represents the shredding of low quality recovered textiles to produce rags or filling materials. Account is taken of the energy requirements of shredding (data from WRATE) and the production of packaging (Kraft) paper is offset on a mass basis and assuming 10% loss in production (1kg recovered material offsets 0.9kg virgin). Data for this process are sourced from the Ecoinvent database. A 100km transport distance in a 28-tonne HGV was assumed for collection.	A sound data source is used, but data quality is set as 'medium' because the environmental benefits of recycling can be highly variable depending on the material being displaced. The distance that materials are transported is also uncertain. Both of these issues are addressed in sensitivity analyses.
Resource depletion – recycling	-6	kg Sb-eq per tonne	Medium		
Energy demand – recycling	-10851	MJ-eq per tonne	Medium		
GHG emissions – incineration	-344	kg CO_2e per tonne	Medium	Data describing the impacts and benefits of incineration were taken from WRATE, as summarised in ERM (2006a). The output of non-biogenic CO_2 emissions and recovered electricity that result from EfW were calculated in WRATE for natural textiles. The marginal electricity displaced is assumed to be from CCGT gas, as this is the most likely source of additional electricity at the margin of demand in the UK.	A sound data source is used, but data quality is set as 'medium' because the net impacts from incineration are highly dependent on assumptions regarding net energy recovery.
Resource depletion – incin.	-3	kg Sb-eq per tonne	Medium		
Energy demand – incineration	-6114	MJ-eq per tonne	Medium		

GHG emission – collection for preparation for reuse	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	0.9	kg Sb-eq per tonne	Medium		
Energy demand – collection for preparation for reuse	2123	MJ-eq per tonne	Medium		
GWP of preparation for reuse	60.4	kg CO_2e per tonne	Medium	Woolridge *et al* 2006. LCA for reuse/recycling of donated waste textiles. 1,730,000kWh electricity consumption at depot for 19,535 tonnes clothing. 986000kWh gas consumption at depot for 19,535 tonnes clothing.	Source is specific to textiles depot, but a single value only. Corresponds relatively well with costs also reported.
ARD of preparation for reuse	0.5	kg Sb-eq per tonne	Medium		
MJF of preparation for reuse	1090	MJ-eq per tonne	Medium		
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 specific to textiles depot, but a single value only. Corresponds relatively well with costs also reported.
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	Assumption – nominal amount	
GWP of T-shirt displacement	6.4	kg CO_2e per 250g T-shirt	Medium	Modelled based on the following sources and assumptions. **Raw materials:** - 279g raw cotton per 250g T-shirt; 10g PE film packaging per T-shirt (Cambridge Institute for Manufacturing, 2006). Inventories from Ecoinvent database, specifically – Textile, woven cotton, at plant/GLO; Polyethylene, LDPE, granulate, at plant/RER SNI Extrusion, plastic film/RER SNI. **Manufacturing:** - 2.2 kWh per 250g T-Shirt (Steinberger *et al*). Life cycle inventory for SE ASIA Electricity 2007 Medium Voltage Import **Transport:** - transportation modelled assuming cotton production in the US and manufacture in China. Ecoinvent transport datasets applied. Modelled in Sima Pro 7.2.4 using the ReCiPe (v 1.04) impact	A model developed as part of ERM/Defra product lifetimes project was used to represent the production burdens associated with a cotton T-shirt. This was based on best available data, but there are many possible variables in the supply chain and so data quality is considered 'medium'.
ARD of T-shirt displacement	0.04	kg Sb-eq per 250g T-shirt	Medium		
MJF of T-shirt displacement	70	MJ-eq per 250g T-shirt	Medium		

				assessment method.	
GWP of jumper displacement	27.9	kg CO_2e per 500g jumper	Low	Assumed displacement of 50% poly-cotton jumper and 50% woollen jumper. Modelled based on the following sources. **Raw materials:** - 550g wool per 500g jumper (assuming 10% wastage rate) Packaging – 20g PE film per jumper - 280g woven cotton and 280g polyester fabric per 500g jumper Packaging -10g PE film per T-shirt (assumptions as per Defra lifetimes study)	Data quality considered to be 'low' as there are considerable uncertainties around the materials being displaced and production methods used. In particular, there is uncertainty in the wool production dataset, as different approaches can be taken to allocating sheep rearing emissions to wool and other products. Different approaches taken, or different economic values for the various co-products from production, can make a significant difference to greenhouse gas emissions estimates. Detailed energy data for wool processing were also not available, and so were assumed to be equivalent to those for a T-shirt.
ARD of jumper displacement	0.1	kg Sb-eq per 250g jumper	Low		
MJF of jumper displacement	172	MJ-eq per 250g jumper	Low	Inventories from Ecoinvent database, specifically: Wool, sheep, at farm/US SNI; Yarn production, cotton fibres/GLO SNI; Weaving, cotton/GLO SNI; Textile, woven cotton, at plant/GLO; Fleece, polyethylene, at plant/RER SNI (as proxy for man made fibres); Polyethylene, LDPE, granulate, at plant/RER SNI Extrusion, plastic film/RER SNI. **Manufacturing:** - 8.8 kWh per kg textile processing T-shirt (assumed the same as for T-shirts, taken from Steinberger *et al*). Life cycle inventories for SE ASIA Electricity 2007 Medium Voltage Import (poly-cotton); UK Electricity 2010 Medium Voltage Import (wool) **Transport:** - transportation modelled assuming wool production in the UK; cotton production in the US and manufacture in China. Ecoinvent transport datasets applied. Modelled in Sima Pro 7.2.4 using the ReCiPe (v 1.04) impact assessment method.	

Table A2 Financial cost data sources, quality and assumptions

Name	Datapoint	Unit	Data Quality Score	Source	Justification
Cost of landfill	70	£/tonne	High	2009/2010 gate fees report. Median value excluding Landfill Tax and haulage	Up-to-date source, so data quality considered high
Cost of recycling	-230	£/tonne	Medium	http://www.letsrecycle.com/prices/textiles/. The value used for all recycling in this assessment is equivalent to the price of textile bank-collected materials.	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	2009/2010 gate fees report. Median value excluding haulage	Up-to-date source, but potentially variable, so data quality considered medium
Cost of bulky waste collection	400	£/tonne	Medium	Assumed as for preparation for reuse: cost of doorstep collection	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	40	£/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	14	£/tonne	Medium	Personal communication with Tony Clark, General Manager Oxfam Wastesavers	Specific data from sound source, but likely to be variable, so considered to be medium data quality.
Site maintenance	20.9	£/tonne	Medium	WRAP data, based on data from new Furniture Reuse Site in Barnet.	Based on business plan so projection rather than actual. Taken year 2 operating costs as site established at this point.
Labour costs of preparation for reuse – employed	7.88	£/hour	Medium	Charity Retail Association Salary Survey 2010	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 £20k 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
Utility costs of preparation for reuse	2.73	£/tonne	High	Oxfam Wastesaver have a total utility cost of £30,000 per annum on a facility receiving approximately 11,000 tonnes of clothing per annum. This is a cost of £2.73 per tonne, applied to all clothing.	Reasoned datapoint, although based on assumptions
Cost of customer drop off	150	£/tonne	Low	Oxfam Wastesaver – this cost is for 'collection and consolidation' of stock from Oxfam charity shops.	Some uncertainty around this value.
Cost of doorstep collection	400	£/tonne	High	Oxfam Wastesaver – costs arise from distribution and collection of doorstep bags. High cost is due to a low return rate (~2%).	Relatively good agreement between different sources
Cost of dedicated reuse banks	300	£/tonne	Medium	Oxfam Wastesaver – cost of ownership and collection of bank	Some uncertainty around this value.
Cost of Other collection	30	£/tonne	Low	Oxfam Wastesaver – 'trunking charge' from pickup of donations	Some uncertainty around this value.
Revenue generated from sale – preparation for reuse	-900	£/tonne	Medium	Oakdene Hollins, Recycling of Low Grade Clothing Waste. Table 9. Clothing for reuse, Africa, 2005.	Generic value for all textiles, and relatively old for cost data
Displaced new purchase (T-shirt) – avoided cost	-11	£/unit	Low	Euromonitor (2009) – Table 10 Forecast Sales of Clothing by Subsector: Volume 2008–2013. 2011 value for men's tops taken, as conservative value	Good data source, but not specific to T-shirts
Displaced new purchase (jumper) – avoided cost	-15	£/unit	Low	Euromonitor (2009) – Table 10 Forecast Sales of Clothing by Subsector: Volume 2008–-2013. 2011 value for men's jumpers.	Good data source, but likely to be very variable
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	-4300 for jumpers, -6420 for T-shirts	£/tonne	Medium	Oakdene Hollins report Recycling of low grade clothing waste, 2006. Good quality used clothing can sell for between £6000 and £9000 per tonne. The most conservative estimate is used here – but not specific to T-shirts	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	84	%	Medium	Composition of labour at Oxfam Wastesavers is used	Single source so data quality reduced
Labour composition – volunteer labour	4	%	Medium	Composition of labour at Oxfam Wastesavers is used	Single source so data quality reduced
Labour composition -welfare to work	12	%	Medium	Composition of labour at Oxfam Wastesavers is used	Single source so data quality reduced
Labour composition – learning difficulties	0	%	Medium	Composition of labour at Oxfam Wastesavers is used	Single source so data quality reduced
Preparation for reuse – initial checking	0.008	FTE/tonne	Low	Calculated using WRAP assumptions regarding hours/tonne (13 hours,	Assumption

employment intensity				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.	
Preparation for reuse – preparation employment intensity	0.004	FTE/tonne	Low	Based on personal communication with textile recycler – 1 person per tonne per day. In the assessment, this is assumed to represent sorting overseas.	Assumption
UK employment intensity of displaced products	0.0525	FTE/tonne	Low	The UK clothing and textile industry employs 105,000 people (ONS, 2008), with an output of 697,000 tonnes. However, total UK consumption is 2 million tonnes. Therefore, per tonne consumed, 0.053 FTEs (170,000/2,000,000) are employed (which equates to 5.25 employees per 100 tonnes consumed).	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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