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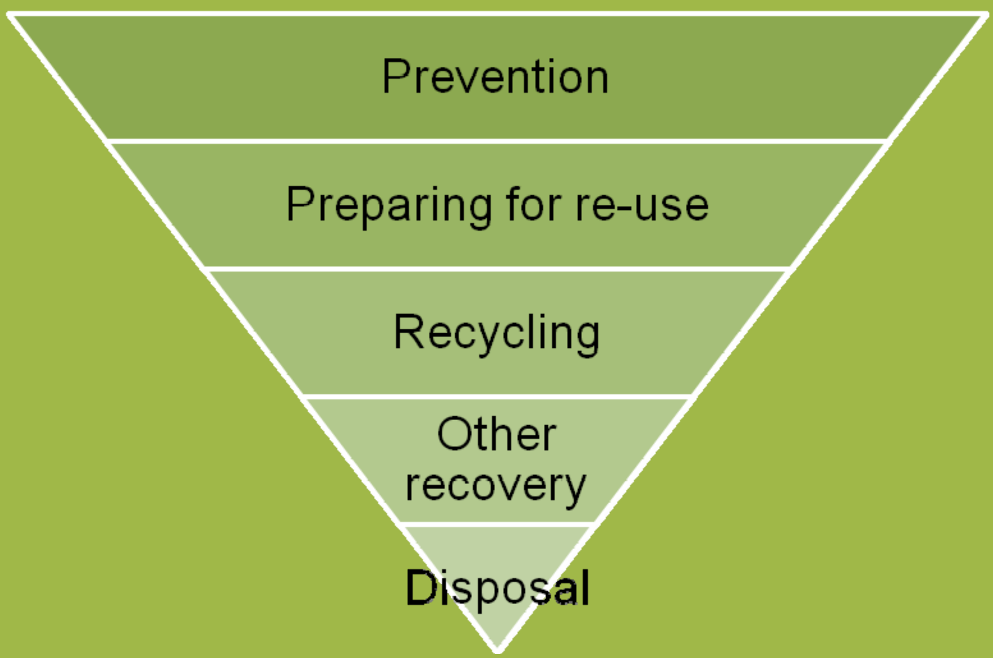
Applying the Waste Hierarchy: evidence summary



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Environment Agency
WRAP England
Working together for a world without waste
defra
Department for Environment Food and Rural Affairs

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Introduction

1. What is this document for?

This document summarises the ***current scientific research*** on the environmental impacts of various waste management options for a range of materials and products.

It explains how the various options for dealing with waste have been ranked in order of environmental preference within the waste hierarchy. For a few materials, it also explains deviations from the hierarchy.

2. Who should read it?

Anyone interested in finding out the reasoning behind the priority order of the waste hierarchy. This document is designed for non-specialists.

3. What does it cover?

This document deals with research on the *environmental impacts* of various waste management options for a range of materials and products. It does **not** cover economic impacts, which will vary - among other things - according to the size of an organisation, the range of materials it handles and its location.

This document covers the most common types of waste arising, but it is not designed to be a comprehensive list. All the research we have used is referenced in the text and at the end.

It does not cover *hazardous waste*. The application of the hierarchy to hazardous waste will be set out in separate guidance that will follow the Strategy for Hazardous Waste Management in England.

Both that guidance and this evidence summary only apply to England. Other nations are publishing their own guidance.

4. The Waste Hierarchy

Article 4 of the revised Waste Framework Directive[1] sets out 5 steps in dealing with waste. *Figure 1* below sets these out and provides examples of what they mean.

Like all Member States, the UK needs to apply this hierarchy as a priority order in waste prevention and management legislation and policy.

Figure 1: The waste hierarchy as set out at Article 4 of the revised Waste Framework Directive

Stages	Include
Prevention	Avoidance, reduction and re-use; using less hazardous materials (1)
Preparing for re-use	Checking, cleaning, refurbishing, repairing whole items or spare parts
Recycling	turning waste into a new substance or product. Includes composting if it meets quality protocols
Other recovery	anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste. Some backfilling operations
Disposal	Landfill and incineration without energy recovery (2)

Notes:

(1) *Avoidance* includes buying fewer items, reducing process waste or using less material per unit in design and manufacture. *Reduction* covers keeping products for longer, designing them so they last longer. *Re-use* includes selling and buying used items, donating them for free, exchanging them etc.

(2) The revised Waste Framework Directive sets an energy efficiency threshold above which municipal waste incinerators can be classified as recovery facilities, and below which they continue to be classified as disposal facilities. Where energy recovery in municipal waste incinerators is discussed in this document, it is assumed that the option considered is above this threshold.[2]

[1] Directive 2008/98/EC
[2] Annex II of the revised Waste Framework Directive

Departing from the waste hierarchy

Article 4(2) of the Directive allows Member States to depart from the hierarchy for specific waste streams in order to deliver the best environmental outcome. However, this has to be justified by life-cycle thinking on the overall impact of generating and managing these waste streams.

For three materials, Life Cycle Assessment evidence suggests that **waste management options which are not in keeping with the waste hierarchy are better for the environment**:

- for **food** waste, wet or dry anaerobic digestion is better than other recycling and recovery options – see section 9 for more details
- For **garden waste,** dry anaerobic digestion is better than other recycling and recovery options. See section 10 for more details
- for **lower grade wood** energy recovery options appear more suitable than recycling – see section 19 for more details

Other considerations - namely the general environmental protection principles of precaution and sustainability, technical feasibility and economic viability, protection of resources as well as the overall environmental, human health, economic and social impacts – can also be taken into account[3]. These other factors are better considered on a case-by-case basis and are not covered here.

[3] in accordance with Articles 1 and 13 of the revised Waste Framework Directive.

Methodology

5. Life-cycle thinking

Life Cycle Assessment (LCA) is used to quantify the environmental impacts associated with a specific product, supply chain and waste management option. This allows comparisons to be made between the environmental impacts of different products or options.

Life-cycle thinking incorporates the basic approach of LCA without requiring a detailed assessment of each product or process. Whilst it is informed by the requirements set out in standards on LCA (e.g. ISO 14040),, it uses a range of referenced data sources to identify trends in findings and conclusions which are generally applicable in a range of circumstances, and are considered to be representative.

This summary and the waste hierarchy guidance which it supports are based on life-cycle thinking. This document uses current LCA research to come to key conclusions, and will be updated as new robust evidence comes to light.

6. Environmental impact indicators

We have selected four environmental impact indicators against which to compare waste management options:

Climate change	Climate change, or global warming, refers to the increase in the average temperature of the Earth's surface. This is caused by emissions of greenhouse gases including carbon dioxide, nitrous oxide and methane. Direct emissions from waste management contribute to all of these, and when emissions from the whole life of materials and products are included, the contribution of waste management, including prevention, becomes significant. Climate Change is an issue of global concern. In the UK, the Climate Change Act 2008 sets out an objective to reduce carbon dioxide emissions 80% by 2050 against a 1990 baseline.
Air quality (incl acidification, ozone creation, toxicity (human and aquatic)	Acidification has direct and indirect damaging effects, such as nutrients being washed out of soils, increased solubility of metals into soils, and damage to stone buildings. Photochemical Ozone Creation Potential (also known as summer smog) is implicated in impacts such as crop damage and increased incidence of asthma, for emissions of substances to air. Waste management options can affect acidification through

	emissions from energy use, and emissions of nitrogen oxides and hydrocarbons lead to summer smog.
Water quality (incl eutrophication)	Eutrophication is the addition of excessive amounts of organic or inorganic fertiliser to land or water. Excessive growth (and death) of plants and algae can lead to decreased oxygen levels in water, creating conditions which cannot support diverse life. Eutrophication may be caused for example by leachate or effluent from waste disposal systems.
Resource depletion	Resource depletion is the decreasing availability of natural resources. These may be renewable (e.g. wood) or non-renewable (metals). As economies around the world grow, demand and competition for finite resources – including raw materials and fuel - also increases. Many of these resources could potentially be reduced to unacceptable levels[4]. This will have a range of environmental and economic impacts. Alternative options within the waste hierarchy have the ability to reduce our demand for resources and extend the life of resources.

It is worth noting that the impact of transport of waste material (including collection from the kerbside) has been taken into account in our assessment. Generally, emissions from transport of recyclable materials are a very small fraction of the total impacts, and they are dwarfed by the benefits of recycling. There are some exceptions to this, in particular aggregates, where due to low emissions associated with production and disposal, transportation becomes more significant.[5]

The way different EU countries apply the waste hierarchy may differ because of their energy mix (the CO_2 emissions associated with a kWh of electricity vary across Europe, depending on the mix of fuels used and the efficiency of production); extent of landfill gas capture, and nature of the avoided materials.

[4] Turner, R. K., Morse-Jones, S., and Fisher, B. (2007): *Perspectives on the 'Environmental Limits' Concept: A report to the Department for Environment, Food and Rural Affairs,* Defra, London.
[5] http://aggregain.wrap.org.uk/

7. Annual review: submitting new evidence

Inevitably, this document uses a snapshot of current research. Over time, technologies may change; so will the background energy mix. Both will influence the relative environmental impacts of waste management options.

To take account of such changes, this document will be reviewed on an annual basis and updated as appropriate.

You may have delivered, have commissioned, or be aware of **peer-reviewed evidence** (e.g. life cycle analysis, academic publications and other scientific studies) on any of the environmental impacts looked at in this document.

If this evidence has not been considered yet, please send a copy to:

> *Waste Hierarchy Evidence Review*
> c/o Waste Resources, Sustainable Consumption Evidence Programme
> Defra,
> Ergon House, c/o 17 Smith Square, London, SW1P 3JR

Or email it to *wasteresearch@defra.gsi.gov.uk* (with *'Waste Hierarchy Evidence Review'* in the subject line, please).

For your peer-reviewed evidence to be considered in the 2012 annual review, it must reach Defra no later than **30 June 2012**. It will be considered by scientists from Defra, DECC, WRAP and the Environment Agency.

8. How this document fits with other tools

This summary gives an order of environmental preference for waste management options, but in general it does not *quantify* their environmental impacts. Some figures are provided which are representative of impacts at a UK level, but actual impacts will vary according to the markets to which recyclates are sent, the efficiency of energy recovery facilities used, etc. The overall hierarchy of options is unlikely to be affected by such variations.

The Environment Agency has developed ***WRATE***[6], a piece of software which allows organisations to calculate the environmental impacts of their systems, including waste management impacts. Businesses and public bodies can use WRATE or alternative LCA software to help them make decisions on how to apply the waste hierarchy in practice in their circumstances.

The Environment Agency is also developing a set of tools known as ***Resource Efficiency Appraisal Development*** (READ), which businesses and organisations will be able to use to benchmark how well they manage resources and to identify the biggest opportunities to improve. A simple online assessment tool is available via *http://www.environment-agency.gov.uk/business/topics/performance/121909.aspx*

[6] *http://www.environment-agency.gov.uk/research/commercial/102922.aspx*

The evidence for individual material or product streams

9. Food

Of the estimated 18-20 million tonnes of food waste created in the UK each year, around 8.3 million tonnes comes from households. [7] The majority of this is still sent to landfill, where it breaks down and releases methane. A further 5 million tonnes is lost in the supply chain, and more still through the catering sector (restaurants etc).

Prevention

A considerable amount of food waste (up to 80% for households and schools, for example) can be avoided.[8] Wasting food wastes the resources which have gone into growing, processing and transporting that food. On average, preventing 1 tonne of food waste avoids over 4 tonnes CO_2 equivalent[9]. Preventing food waste saves far more than any of the options for managing this waste. Businesses and households can prevent food waste by changing the amount of food they buy and how they store and process it. Schemes such as Fareshare which redistribute unwanted food also help prevention.

Recycling and other recovery options

Options for the treatment of food waste include, in order of environmental benefit (greatest benefit at the top):

- anaerobic digestion
- composting
- incineration with energy recovery.

Please note that food waste must be treated in accordance with the relevant legislation (see the individual sections below for more details).

We do not currently have comparative information on the environmental benefits of other options e.g. landspreading or rendering (see below). Landspreading of food waste is subject to the controls regulated by the Environment Agency, and to the requirements of Environmental Permits or exemptions (see *http://www.defra.gov.uk/environment/quality/permitting/*).

Anaerobic digestion

In anaerobic digestion, food waste is microbiologically broken down in enclosed containers in the near absence of oxygen. The outputs produced are *digestate*, which can be used instead of fossil fuel-intensive fertilisers, and *biogas*, which can be used to generate vehicle fuel, heat, electricity, combined heat and power, or refined and directly injected into the gas grid[10]. Each of these has a different degree of environmental benefit, and may be more or less feasible

[7] WRAP (2009): Household Food and Drink Waste in the UK report.
[8] Ibid. 'Avoidable' and 'potentially avoidable' food waste which includes potato peels, bread crusts etc, i.e. things that could be eaten but people choose not to.
[9] WRAP (2008): *The Food We Waste* report.
[10] As part of the Defra AD Demonstration Programme, work on technology which would enable gas to be injected into the grid is being progressed.

depending on plant location.[11] For guidance on the use of digestate, please refer to the Quality protocol for Digestate.[12].

The combination of both outputs means that anaerobic digestion is environmentally preferable to composting.[13] **This departs from the normal order of the waste hierarchy.**

Composting

The relative merits of composting, and energy recovery options other than anaerobic digestion, depend on the compost being used in place of fertiliser or peat. Composting and energy recovery are broadly similar in terms of greenhouse gas emissions. Energy recovery can avoid more air pollution since burning food waste avoids the use of fossil fuels, but compost applied to land as part of good nutrient management planning can help reduce waste pollution when used in place of artificial fertilisers[14]. Only one data source has been identified which considers resource depletion[15], which assumed that fertiliser supply was unlimited, an issue on which opinion has since changed[16]. Insufficient data is available on this issue to assess the relative merits of composting and energy recovery.

'In-vessel' composting (IVC) allows collected food waste to be composted on a large scale. It can produce composts meeting quality standards[17] which can be used as an alternative to inorganic fertilisers and peat-based products.

Many types of food waste collected by local authorities and private contractors are not suitable for *windrow composting.* Only where food premises process strictly vegetables only, or have for example a dedicated vegetable processing line with a strict HACCP agreed with the local authority to guarantee complete separation from all products - *http://www.defra.gov.uk/food-farm/byproducts/*.

In addition to commercial composting, composting on a small to medium scale may be carried out by voluntary/community/environmental organisations and social enterprises, who collect and compost food and garden waste from local houses and businesses. [18]

Businesses can compost on site – but even if they don't move food waste to or from the site, they must comply with relevant legislation[19]. In most cases where food waste is being composted or anaerobically digested on a site other than

[11] For more information, see the biogas portal: *www.biogas-info.co.uk*
[12] *http://www.environment-agency.gov.uk/business/topics/waste/114395.aspx*
[13] RW Beck (2004) Anaerobic Digestion Feasibility Study; Iowa Department of Natural Resources *http://www.iowadnr.gov/waste/policy/files/bluestem.pdf*
WRAP (2010) Environmental Benefits of Recycling – 2010 udpate
http://www.wrap.org.uk/wrap_corporate/publications/benefitsrecycling.html
[14] *WRAP (2010):* Environmental Benefits of Recycling – 2010 update
[15] Finnveden (2000) *Life cycle assessment of energy from solid waste*; Sweden
[16] Cordell, D., White, S., Drangert, J.-O., and Neset, T.S.S., (2009): Preferred future phosphorus scenarios: A framework for meeting long-term phosphorus needs for global food demand. 2009, *International Conference on Nutrient Recovery from Wastewater Streams*, Vancouver, 10-13th May, 2009. Published by IWA Publishing, London, UK
[17] BSI PAS 100:2011 http://www.organics-recycling.org.uk
[18] The Community Composting Network has more information (*www.communitycompost.org)*.
[19] See *http://www.defra.gov.uk/environment/quality/permitting/*

the premises of origin, the operation will also need to comply with relevant Animal By-Products legislation[20].

Home composting can also be an effective means of dealing with food waste. It has the potential to offer high environmental benefits[21]. Amateur gardeners accounted for 69% of peat use in the UK in 2007[22]. Compost from home composting can provide a potential alternative to peat-based composts. Home composting can potentially divert up to 150kg of waste per household per year from local authority collection [23]. Local authorities should therefore consider promoting home composting alongside any collection schemes. This does not mean that composting comes above other options in the waste hierarchy, but it should complement them.

Not all domestic food waste is suitable for home composting, eg cooked food or foodstuffs of animal origin, which may attract vermin. For guidance on these please see DirectGov[24] and Recycle Now[25]. Other systems, including anaerobic digestion, in-vessel composting, and Greencone, are able to handle wider ranges of foods.

Other energy recovery options

Food waste is combustible, but its high moisture content means that it is best suited to anaerobic digestion. As a renewable material, it replaces the combustion of fossil fuels when energy is recovered, and so even in incineration facilities which only recover electricity, it offers some environmental benefit. Available research suggests that composting remains preferable to combustion with energy recovery[26].

Segregated and non segregated food waste may also be a suitable feedstock for the production of renewable transport biofuels, renewable heat power and/or renewable chemicals through advanced biofuels and biorefinery technologies. There is some evidence[27] that these can provide greenhouse gas savings relative to other technologies and reduce demand for resources, but further evidence is needed to compare other environmental impacts. This is being gathered.

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[20] see *http://archive.defra.gov.uk/foodfarm/byproducts/wastefood/composting/index.htm*
[21] *WRAP (2007): Biowaste Cost Benefit Analysis Report* and *Appendices*
WRAP (2009): Update to Biowaste Cost Benefit Analysis Report
[22] DEFRA (2008): *Monitoring of peat and alternative products for growing media and soil improvers in the UK 2007*
[23] *WRAP (2009) Home Composting Diversion: District Level Analysis*
[24] *http://www.direct.gov.uk/en/environmentandgreenerliving/wasteandrecycling/dg_064369*
[25] *http://www.recyclenow.com/home_composting/*
[26] WRAP (2010): *Environmental Benefits of Recycling*
[27] Eunomia Research and Consulting (March 2010) INEOS Bio Advanced Biofuels process at Sand Seals Planthttp://www.ineosbio.com/media/files/INEOS%20Bio%20Life-cycle%20Assessment.pdf

Rendering

Rendering is a treatment process through which food waste and other animal by-products are heated at high temperature, sometimes under pressure, to remove moisture and until the fat (tallow) can be separated from the protein material. The tallow can be used to produce tyres and paint; small amounts may also be used as animal feed fertilisers, or as a fuel. The protein element can be dried to produce meat and bone meal which can be used, subject to animal by-product controls[28], as a protein source in pet food manufacture and as a fuel.

There is currently no research into the relative environmental merits of rendering compared to other processes. Some work is underway at Harper Adams University College.[29]

Landspreading of catering food waste is another recovery option. We do not at present have evidence of its environmental benefits relative to other waste management methods.

Disposal

Food should be diverted from landfill wherever possible. Food waste degrades to the greenhouse gas methane over a short space of time in landfill. Even where are methane is captured for flaring or energy recovery, the overall lifecycle impact is still negative. [30]

[28] http://www.defra.gov.uk/foodfarm/byproducts/legislation.htm
[29] Ramirez, A. (undated) Development and application of a life cycle assessment toolkit for the rendering industry *http://www.harper-adams.ac.uk/postgraduate/research/research.cfm?ID=36*
[30] WRAP (2010): Environmental Benefits of Recycling

10. Green (garden) waste

There is no clear picture of how much garden waste currently arises, or how much is being collected. We may start to have more information, from household waste at least, as local authorities are now able to enter information on collections of green garden waste and mixed garden and food waste into WasteDataFlow.

There is no specific information on the benefits of **preventing** garden waste.

Preparation for reuse is not a feasible option for garden waste.

Recycling and other recovery options

Separate collection of food and garden waste provides businesses and local authorities with the widest choice for dealing with the collected material.

Garden waste collected together with food has to be treated to the same standards as food waste. See http://archive.defra.gov.uk/foodfarm/byproducts/wastefood/composting/index.htm for more details.

Anaerobic digestion (AD)

Unlike food waste, garden waste requires a 'dry' anaerobic digestion system to break down effectively (because of the presence of wood, it takes longer to degrade). There are currently very few of these types of plant in operation in the UK.

In anaerobic digestion, garden waste is microbiologically broken down in enclosed containers in the near absence of oxygen. The outputs produced are digestate, which may be used as an alternative to fertilisers or for land remediation. For restriction on the use of digestate, please refer to the Quality Protocol for digestate.[31].

Anaerobic digestion also generates a gas, which used as gas for injection into the grid, or to generate vehicle fuel, electricity, combined heat and power. Each of these has a different environmental benefit, and may be more or less feasible depending on plant location. [32]

***The combination of both outputs means that dry anaerobic digestion is environmentally preferable to composting*. This departs from the normal order of the waste hierarchy.**

Composting

Composting can be carried out at home or on a larger scale. Commercial and community operations may be windrow (garden waste only) or in-vessel (food and garden waste).

[31] http://www.environment-agency.gov.uk/business/topics/waste/114395.aspx
[32] For more information, see the biogas portal: www.biogas-info.co.uk

Where use of compost reduces the use of peat, it offers significant environmental benefits.

The relative positions of composting green waste and energy recovery options (other than anaerobic digestion) against the environmental criteria selected are not clear; more evidence is needed. Recent research has found that composting green waste offers greenhouse gas savings which are on a par with energy recovery[33]. Energy recovery can avoid more air pollution, since burning food waste avoids using fossil fuels. However, composting avoids more water pollution where use of artificial fertilisers are avoided. [34] There are also some benefits of applying composts to soils which are more difficult to quantify, such as improving soil structure. No data sources have been identified which consider resource depletion.

Research into home composting shows that free garden waste collections lead to an increase in waste collected (including Household Waste Recycling Centres) [35]. Promotion of home composting can divert 150kg of waste (mainly garden waste) from local authority collection per household per year[36]. Local authorities should therefore consider promotion of home composting alongside any collection schemes. Composting complements other options in the waste hierarchy.

Other Energy Recovery Options

As a renewable material, garden waste replaces the combustion of fossil fuels when used to generate energy, and so even in incineration facilities which only recover electricity it offers some environmental benefit.[37]

Segregated and non segregated green waste may also be a suitable feedstock for the production of renewable transport biofuels, renewable heat power and/or renewable chemicals through advanced biofuels and biorefinery technologies. There is some evidence[38] that these can provide greenhouse gas savings relative to other technologies and reduce demand for resources, but further evidence is needed to compare other environmental impacts.

Landspreading of shredded garden waste is another recovery option. We do not at present have evidence of its environmental benefits relative to other waste management methods.

Disposal

Garden waste should be diverted from landfill wherever possible as it emits methane (a greenhouse gas) when it degrades. Even where some of this is captured for flaring or energy recovery, the overall impact is still negative. [39]

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[33] Kranert, M., Gottschall, R., Bruns, C. & Hafner, G. (2010). Energy or compost from green waste? A CO2-based assessment. *Waste Management*. 30: 697-701
WRAP (2010) *Environmental Benefits of Recycling – 2010 update*
[34] *WRAP (2010):* Environmental Benefits of Recycling – 2010 update
[35] *WRAP (2007)* Biowaste Cost Benefit Analysis Report and *Appendices*
WRAP (2009) Update to Biowaste Cost Benefit Analysis Report
[36] WRAP (2009): *Home Composting Diversion: District Level Analysis*
[37] *WRAP (2010):* Environmental Benefits of Recycling – 2010 update
[38] Eunomia Research and Consulting (2010): *INEOS Bio Advanced Biofuels process at Sand Seals Plant.* www.ineosbio.com/media/files/INEOS%20Bio%20Life-cycle%20Assessment.pdf
[39] *ibid.*

11. Glass

In 2008 over 2.6 million tonnes of glass packaging was used in the UK, 61% of which was recycled[40]. The vast majority of that made in the UK is clear, and the rest is split roughly evenly between amber and green glass. In the hospitality sector (hotels, pubs etc.) waste may comprise 10-30% glass[41].

Other types of waste glass include architectural glass (e.g. from windows), automotive glass (e.g. windscreens) and glass in electrical equipment. Glass in electrical equipment (e.g. Cathode Ray Tubes) is covered in Section 18 below.

British Glass figures suggest that in 2006, 1.1 million tonnes of flat glass were produced in the UK. It is estimated that up to 500,000 tonnes of flat glass waste is produced from buildings each year within the UK. Of this, just under half is currently recycled, from the manufacturing industries as well as from the construction and demolition industry.[42]

Prevention

Minimisation of the amount of glass used for a given function, and reuse both have significant benefits due to the avoidance of raw materials and energy for manufacturing new glass.[43] Preventing the use of 1 tonne of virgin glass could avoid over 800kg CO2 eq greenhouse gas emissions.[44]

This is true for re-use even when impacts across the whole system (eg collection and washing of containers) are taken into account.

Recycling

Glass can be recycled an infinite number of times. There are two main options for recycling glass.

The first is closed loop recycling through remelt, whereby glass ('cullet') collected for recycling is used in new glass products, replacing virgin glass. This avoids the use of significant amounts of raw materials and energy, including in transport. Remelt may take place in the UK or abroad (mostly in Spain, Italy and Portugal). Export does reduce the environmental benefits of recycling, but it does not negate them. [45]

The second option is open loop recycling, for example through use as aggregates, where the glass is blended with other aggregates in various applications (e.g. road surfaces). The environmental benefits of using glass in

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[40] National Packaging Waste Database https://npwd.environment-agency.gov.uk/filedownload.ashx?fileid=4aea5fa0-9048-439a-9675-7251935ed544
[41] http://www.instituteofhospitality.org/info_services/recycling, Fact File No. 4, *Reducing Waste*
[42] For an introduction to the to the main types of glass and how they can be recycled, please see www.wrap.org.uk/manufacturing/info_by_material/glass/types_of_glass.html
[43] *WRAP (2010) LCA Of Example Milk Packaging Systems: Retail*
[44] Enviros (2003) *Life Cycle Carbon Dioxide Emissions. A Life Cycle Analysis Report*. Prepared for British Glass by Enviros Consulting Ltd. British Glass, Sheffield
[45] WRAP (2007) *Assessment of the International Trading Markets for Recycled Container Glass and their Environmental Implications*; WRAP, Banbury

this manner are negligible, because of the relatively low impact of the material aggregate being replaced. [46]

Energy recovery and Disposal

For glass, these options sit alongside each other at the bottom of the hierarchy. No energy can be recovered from waste glass. Some value may be recovered if the incinerator bottom ash can be used, for example in construction, but in environmental terms the benefits are negligible.

Where it is present in mixed waste destined for energy recovery, it should be removed, either by encouraging greater recycling by businesses and householders, or by sorting before the energy recovery process.

As an inert material, glass does not degrade in landfill. However, it is lost to the resource economy and takes up landfill space. Therefore every effort should be made to separate it for recycling.

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[46] Enviros (2003) *Life Cycle Carbon Dioxide Emissions. A Life Cycle Analysis Report*. Prepared for British Glass by Enviros Consulting Ltd. British Glass, Sheffield

12. Metals

Industry estimates that 15 million tonnes of metal waste arise in the UK per annum, of which over 13 million tonnes are recovered and recycled[47].

Most waste metal arising from households is in the form of packaging (cans for food, pet food and beverages), white goods (washing machines, refrigerators, cookers, etc) and brown goods (televisions and video players etc). Waste metal from such sources accounted for 4.3% of municipal waste in England in 2006/2007, or 1.2 million tonnes.[48] In 2008, 34.6% of aluminium packaging and 61.7% of steel packaging were recovered or recycled.[49]

The metal fraction of waste electrical and electronic equipment is covered in Section 18.

Prevention

Ways of preventing metal waste include lean production and product lightweighting. Metals require significant quantities of energy and raw materials in their extraction and manufacture. This varies enormously for different types of metal. For aluminium, avoiding 1 tonne of virgin metal could avoid over 10 tonnes of CO_2 eq greenhouse gas emissions.[50]

Re-use opportunities depend on the type of product in question. Primary metal packaging offers little or no scope for re-use, whereas secondary and tertiary packaging (cages, drums, stillages) offer many opportunities. The second-hand market for vehicles is well established. Reuse of white and brown goods is addressed in Section 18 below.

Preparation for re-use

Re-using metals avoids the environmental impacts associated with their production (see 'prevention' above).

Opportunities for re-use of *waste* metals depend on what the metal is to be used for or is part of. There are opportunities for refurbishment of metal waste from household WEEE (covered in Section 18) and to end-of life vehicles. Opportunities are available for in the C&I sector, where reconditioning of drums, containers, machinery etc is widespread.

Recycling

The environmental benefits of recycling metals are unequivocal across a range of environmental indicators, including greenhouse gas emissions and resource depletion.

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[47] http://www.recyclemetals.org/about_metal_recycling

[48] Municipal Waste Composition Report March 2009 - http://randd.defra.gov.uk/Document.aspx?Document=WR0119_8662_FRP.pdf

[49] National Packaging Waste Database https://npwd.environment-agency.gov.uk/filedownload.ashx?fileid=4aea5fa0-9048-439a-9675-7251935ed544

[50] European Aluminium Association (2008): *Environmental Profile Report for the European Aluminium Industry*

Research has found recycling of aluminium to have a lesser environmental impact compared to incineration and landfill, delivering greenhouse gas (GHG) emission savings of 9 tCO_2e per tonne aluminium recycled. [51]

The GHG emissions savings for recycling of steel are somewhat more modest at 0.94 kg CO_2e/kg steel compared with incineration, and 1.33 kg CO_2e/kg steel compared with landfilling, but are nevertheless pronounced.[52]

The British Metals Recycling Association provides a directory of metal recyclers[53].

Businesses and local authorities can collect more primary packaging metals by increasing on-the-go recycling infrastructure[54] and promoting recycling at work. Alupro, the industry recycling association for aluminium, and Corus, one of Europe's steel producers, both offer advice to about such initiatives (see *http://www.defra.gov.uk/environment/waste/localauth/recycleonthego/index.htm* *www.alupro.org.uk* and *www.cspr.co.uk*).

Energy recovery

No energy can be recovered from waste metals. If they pass through the energy recovery process they can subsequently be extracted from the ash for recycling. However, every effort should be made to remove them from the recovery fraction, either by encouraging greater recycling by businesses and householders, or by sorting before the recovery process.

Disposal

Metals may rust in landfill and break down, or may remain in situ. As there is no opportunity to recover value, landfill remains at the bottom of the waste hierarchy.

[51] European Aluminium Association (2008): *Environmental Profile Report for the European Aluminium Industry*
[52] WRAP (2006): *Environmental benefits of recycling*
[53] *http://www.recyclemetals.org/*
[54] http://www.defra.gov.uk/environment/waste/localauth/recycleonthego/index.htm

13. Paper and card

In 2008, the UK used 13.2 million tonnes of paper and card products[55]. 8.8 million tonnes of paper and card were collected for recycling. Almost 40% of this was collected from the municipal waste stream, with the remainder coming from commercial and industrial (C&I) sources.

Prevention

Preventing paper waste, by reducing the use of paper in the first place or re-using paper, has significant environmental benefits in terms of greenhouse gas emissions, resource use and energy consumption[56].

Preparing for reuse

We are not aware of any such activities for paper and card.

Recycling

The majority of published studies indicate that recycling is preferable to other waste management options with respect to greenhouse gas emissions, resource depletion, acidification, ozone creation, and water savings [57].

Recycling paper and card is much more environmentally beneficial than allowing it to biodegrade in landfill. The available data suggest that recycling is preferable even when the recovered paper or card is transported to China to be recycled[58]. The benefits of recycling paper and card vary with grade; the higher the quality, the greater the benefit of recycling. The different grades of recovered paper and card are defined in EN 643 European List of Standard Grades of Recovered Paper and Board. Local authorities and waste management companies should ensure their collection schemes meet the quality requirements of their chosen markets[59].

Many recycling plants in the UK use sludge from the recycling process (fibres which are too short to recycle) to generate energy via Combined Heat and Power (CHP), which in turn is used to power the recycling process[60].

Paper and cardboard may also be composted. There is some Australian research covering the impacts of composting paper and card, but neither it nor other studies have included comparisons to other waste management options.[61] We are aware that paper and cardboard without glossy finishes can be used in AD systems to provide a properly balanced carbon/nitrogen ratio for digestion

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[55] WRAP (2010): Realising the value of recovered paper: An update
[56] WRAP (2006): Environmental Benefits of Recycling
[57] WRAP (2006): Environmental Benefits of Recycling and 2010 update
[58] WRAP (2008): CO_2 impacts of transporting the UK's recovered paper and plastic bottles to China
[59] See BSI PAS 105: Recovered paper sourcing and quality for UK end markets, http://www.wrap.org.uk/manufacturing/specifications.html
[60] Dunster, A. (2007): Paper sludge and paper sludge ash in Portland cement manufacture, DEFRA
[61] ROU (2007) *Life Cycle Inventory and Life Cycle Assessment for Window Composting Systems* ROU, University of New South Wales; Australia

but do not have evidence on the relative environmental merits of anaerobic digestion of paper to be able to advise where this fits within the hierarchy.

Research consistently shows that more energy is saved by recycling paper and card (and thus avoiding the use of virgin fibres) than by using waste paper products to replace fossil fuels in energy production. Typically twice as much energy is saved as would otherwise be produced[62].

Energy Recovery

Paper and cardboard used to generate energy are classed as renewable fuels. They offset the use of fossil fuels, so it provides some environmental benefits in terms of avoided resource use, and reduced contribution to acidification relative to landfill.

Where paper is contaminated (e.g. with grease from food) it is less suited to recycling and more suited to energy recovery.

Disposal

Paper and card should be diverted from landfill wherever possible. As they degrade in landfill, they can emit methane. Even where some or most of these emissions are captured for flaring or energy recovery, the overall impact is still negative. [63]

[62] *WRAP (2006) Environmental Benefits of Recycling*
[63] WRAP (2010) *Environmental Benefits of Recycling* - 2010 update

14. Plastics

The UK uses over 5 million tonnes of plastic each year. The major markets are for use in packaging, construction and automotive products, but plastic is also used in furniture, electrical items and agricultural films.[64]

Plastics may be derived from fossil-based oil or from plant materials ('biopolymers'). Biopolymers can have the same characteristics as conventional polymers or can be made in such a way that they biodegrade at the end of their life. Bioplastics are estimated to still account for less than 5% of plastics used in packaging.

'Oxo-degradable' plastics are made of fossil fuel, and contain additives which allow them to degrade faster than conventional plastics. They are not suitable for composting and may not be suitable for conventional recycling.[65]

Prevention

Prevention has significant environmental benefits as it avoids the use of raw materials and energy in manufacturing new plastics.

Preparing for re-use

Plastic drums for bulk packaging can be re-conditioned. We are not aware of other reconditioning activities for plastics. Preparing for re-use has significant environmental benefits as it avoids the use of raw materials and energy in manufacturing new plastics.

Recycling

Plastics collected for recycling are sent to a variety of markets. There is a growing domestic market for products made using recycled plastic, including closed loop applications such as bottles. Plastics are also sent abroad for recycling; the environmental benefits of this vastly outweigh the transport impacts.

Recycling of plastics avoids a significant amount of raw materials and energy use, reducing greenhouse gas emissions and contribution to acidification, even when transport is taken into account. The exact impacts depend on the material being replaced and the relative life of the alternative product.[66]

Plastic bottles are the most commonly collected type of plastic at present, with savings of 1-2 tonnes CO_2 equivalent per tonne recycled depending on the polymer[67]. In 2008, WRAP trialled a variety of technologies for sorting and recycling mixed plastic packaging. These trials showed that these activities can be environmentally beneficial.[68]

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[64] *WRAP (2007) Market Situation Report – Realising the value of recovered plastics*
[65] Defra (2010): Assessing the Environmental Impacts of Oxo-degradable Plastics Across Their Life Cycle, http://randd.defra.gov.uk/Document.aspx?Document=EV0422_8858_FRP.pdf
[66] *WRAP (2006) Environmental Benefits of Recycling*
WRAP (2010) Environmental Benefits of Recycling
[67] *WRAP (2010):* LCA of Example Packaging Systems for Milk
[68] *WRAP (2008):* Domestic Mixed Plastics Packaging Waste Management Options
WRAP (2008) LCA of Management Options For Mixed Waste Plastics

Some plastics made from bio-based materials may also be suitable for recycling[69], although the quantity on the market is not understood to be high enough to allow economic recycling at present.

Where plastics are recycled into alternate products replacing other material (open loop recycling) our understanding is that this can reduce the environmental benefits.

Energy Recovery

Plastics have a high calorific value relative to other wastes; they can generate a large amount of energy when combusted, gasified or pyrolysed. However, when plastics are made from fossil fuels (i.e. oil), the greenhouse gas emissions from recovering energy are far higher than any other waste management technique for plastics. Both recycling and energy recovery help conserve resources, but energy recovery is likely to conserve less resources than recycling, and so appears less beneficial. [70] It could reduce contributions to eutrophication relative to recycling. This is because recycling involves a washing process, utilising detergents to remove unwanted materials, such as food waste. However, most studies find in favour of recycling. [71]

Some alternative technologies, such as pyrolysis or incineration with combined heat and power, show potential to save more energy in the future, but currently have higher greenhouse gas emissions than other techniques. [72]

Some bio-based plastics may be suitable for anaerobic digestion, but this will depend on the specific characteristics of the polymer. When sent to energy recovery, bio-based plastics substitute for fossil fuels, leading to environmental benefits over landfill.

Disposal

Conventional plastics will degrade very slowly, if at all, in landfill conditions. However, they are lost to the resource economy and take up landfill space. In terms of greenhouse gas emissions, sending plastics to landfill is preferable to conventional energy recovery, but is less preferable in terms of of all other environmental indicators commonly considered in Life Cycle Assessment[73]. Overall, landfill remains the bottom of the waste hierarchy.

Plastics which are designed to degrade may or may not breakdown in landfill depending on their properties and the landfill conditions. There is a lack of research into this at present, but if the materials do decompose they are likely to lead to emissions of methane. A proportion of this is captured for energy recovery but much also escapes into the atmosphere.

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[69] WRAP (2010) Environmental Benefits of Recycling – 2010 update
[70] *WRAP (2010):* LCA of Example Packaging Systems for Milk
[70] *WRAP (2008):* Domestic Mixed Plastics Packaging Waste Management Options
[71] *WRAP (2010) Environmental Benefits of Recycling – 2010 update*
[72] *WRAP (2008) LCA of Management Options For Mixed Waste Plastics*
[73] WRAP (2010) Environmental Benefits of Recycling – 2010 update

15. Residual 'black bag' waste

In 2008/09, nearly 22 million tonnes of residual municipal waste were sent to landfill or incineration in the UK[74]. The environmental consequences of this depend on the composition of the waste. The more organic matter is removed for example, the less methane is released from landfill sites. Over time, the changing composition of residual waste may mean that practical management options need to change.

Prevention

Residual waste can be prevented through:

- all the prevention measures for the other waste streams in this document
- and ensuring that as much waste as possible is sorted, prepared for re-use, recycled or recovered, instead of being put in the bin.

Preparation for reuse

Straight reuse and cleaning or repair activities are not feasible options for mixed residual waste.

Recycling

It is possible to extract glass, plastics and metals for recycling from residual waste in material recycling facilities (so-called 'dirty MRFs') and some other treatment processes. In theory, this would allow some of the environmental benefits of recycling those materials to be achieved. However, we do not have evidence of the extent to which the energy needed to sort and wash those materials might offset these environmental benefits.

Energy Recovery

'Energy from Waste' (EfW) covers a variety of processes and technologies. Some of them are described in the flowchart in **Annex A** to this document.

There are three common routes for producing energy for residual waste:

i) Processing of the residual waste using intermediate technologies such as mechanical and biological treatment or autoclave to produce solid recovered fuel (SRF);
ii) Direct combustion;
iii) Gasification or pyrolysis

The 2009 UK Renewable Energy Strategy ("RES") identified waste biomass as an under-used resource which could provide a significant contribution to renewable energy targets and reduce the total amount of waste that is landfilled in the UK.[75]

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[74] http://www.statswales.wales.gov.uk/ReportFolders/reportFolders.aspx; http://www.defra.gov.uk/evidence/statistics/environment/wastats/bulletin09.htm; http://www.doeni.gov.uk;

[75] http://scotland.gov.uk/Publications/2008/08/19084547/0 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx (page 108)

Generating heat only, or heat and electricity together through Combined Heat and Power (CHP) are ways of making our energy production more efficient.[76] The best CHP systems can increase the overall efficiency of an EfW plant from 20-25% to around 60-70%. In CHP plants, the residual heat in the exhaust steam from the generation of electricity is captured and used instead of being discarded. This results in a highly efficient use of fuel and a significantly reduced level of CO_2 emissions when compared to the separate generation of electricity and heat in power stations and heat-only boilers. It can be used whenever electricity is generated through combustion of a fuel, including all types of biomass and biogas electricity generation. CHP should be implemented wherever possible.[77]

i) Processing residual waste using intermediate technologies

A number technologies are commercially proven:

- Direct thermal treatment of waste (eg autoclave);
- Mechanical pre-treatment of waste followed by thermal treatment;
- Mechanical pre-treatment of waste followed by biological treatment and landfill of residue (i.e. biostabilisation); and
- Mechanical pre-treatment of waste followed by biological and thermal treatment

Residual waste could be passed through further treatment, such as ***Mechanical Heat Treatment (MHT) or Mechanical Biological Treatment (MBT)***. Some recyclables, such as metals and glass, could be separated out at this stage.

- ***MBT*** is a residual waste treatment process that involves both mechanical and biological treatment processes. The first MBT plants were developed with the aim of reducing the environmental impact of landfilling residual waste. MBT therefore complements, but does not replace, other waste management technologies such as recycling and composting as part of an integrated waste management system.

  Recyclables derived from the various MBT processes are typically of a lower quality than those derived from a separate household recyclate collection system and therefore have a lower value.

- The objective of ***MHT*** is to separate a mixed waste stream into several component parts using mechanical and thermal (including steam) based technologies. This provides further options for recycling, recovery and in some instances biological treatment. The processes also sanitise the waste, by destroying bacteria present, and reduce its moisture content. *Autoclaving* is a form of MHT.

[76] http://chp.decc.gov.uk/cms/what-is-chp/
[77] For more information, see the CHP Information Note from the Waste Infrastructure Delivery Programme (http://www.defra.gov.uk/environment/waste/residual/widp/documents/chp-information-note090127.pdf)

Glass and metals derived from some MHT processes have the potential to be significantly cleaner than those from MBT processes due to the action of steam cleaning, which can remove glues and labels. Other recyclables such as plastics may also be extracted from some systems. However, most plastic materials are deformed by the heat of the MHT process, some to a greater extent than others, potentially making them more difficult to recycle in some instances.

Both MBT and MHT produce outputs often described as Compost Like Outputs (CLO), and they can produce Solid Recovered Fuel (SRF)[78]. For information on their use please see the Environment Agency Position Statement[79].

Depending on its characteristics, SRF can be used in industrial combined heat and power production, cement kilns, purpose-built waste combustion plants, co-firing with other fuels (e.g. coal in power stations), and treatment in advanced thermal technologies, such as pyrolysis and gasification. SRF is classified as a waste and therefore any facility using the fuel will be subject to the requirements of the Waste Incineration Directive[80].

SRF can then be sent to a fuel user. Industrial and commercial users may prefer SRF to untreated residual waste either as a consequence of how untreated waste is perceived or because of practical, technical issues related to a refined fuel's energy efficiency and compatibility with storage and transportation conditions on industrial sites

ii) Direct combustion

Direct combustion (incineration) is a well-established technology used to generate electricity.

iii) gasification or pyrolysis

Gasification is the heating of organic materials, including mixed waste or biomass, at high temperatures (above 700°C) with a reduced amount of *oxygen* and/or *steam*.

Pyrolysis is a similar high temperature decomposition process, but is carried out in the absence of oxygen. This process requires an external heat source to maintain the temperature required.

The *outputs* from both gasification and pyrolysis comprise a solid residue and a synthetic gas (syngas). The solid residue is a combination of non-combustible materials and carbon. The combustible part can then be burned to produce electricity. The gas can be burned independently in a boiler, engine or gas turbine to produce electricity. Pyrolysis also yields a char which could be used to replace coal in certain applications. Some pyrolysis processes produce gasses that can be condensed into a liquid fuel.

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[78] Also referred to as Refuse-Derived Fuel (RDF)
[79] *http://www.environment-agency.gov.uk/static/documents/Leisure/mbt_2010727.pdf*
[80] Directive *2000/76/EC* of the European Parliament and of the Council of 4 December 2000 on the incineration of waste

There are other technologies such as plasma arc gasification, but the majority of these are still in their development stage for dealing with mixed waste.

Where MBT (and by analogy, MHT) outputs are used as fuel (not replacing coal) or landfilled, the evidence contrasting MBT and direct energy recovery suggests that unless the rate of energy recovery is low, MBT comes below combustion in the waste hierarchy[81]. Where MBT outputs are used to generate SRF to replace coal (e.g. in co-combustion or cement kilns) this could be more advantageous[82]. Currently, evidence on the relative merits is limited. Eunomia (2006) and Papageorgiou et al (2009) suggest that MBT is preferable to combustion[83] whereas Environment Agency Wales (2008) suggests that MBT is less preferable than energy recovery at this stage[84][85]. The use of Combined Heat and Power (CHP) technologies can improve the efficiency of each of these treatment routes and may change this ranking, depending on the combinations being compared.

Residual waste may also be a suitable feedstock for the production of renewable transport biofuels, renewable heat, power and/or renewable chemicals through advanced biofuels and biorefinery technologies. There is some evidence[86] that these can provide greenhouse gas savings relative to other technologies and reduce demand for resources, but further evidence is needed to compare other environmental impacts. This is being gathered.

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[81] BIWA (2003) *Klimarelevanz der Abfallwirtschaft im Freistaat Sachsen. Gutachten im Auftrag des Sächsischen Landesamtes für Umwelt und Geologie*, BIWA Consult, Freiberg (Sachsen).
IFEU (2007) *Ökobilanz thermischer Entsorgungssysteme für brennbare Abfälle in Nordrhein-Westfalen* Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen, Düsseldorf.
Rommel, W. Pitschke, T. Hottenroth, S. Roth, U. (2005) Okoeffizienzvergleich von Entsorgungsstrukturen *Chemie Ingenieur Technik* JAHR 77; NUMB 8, pages 1159
Pitschke, I., Kreibe, S., Cantner, J., Tronecker, D. (2007*) Ökoeffiziente Verwertung von Bioabfällen und Grüngut in Bayern* Ask EU
[82] IKr (2006) *Ökologische und ener- getische Bilanzierung des Vorhabens MKK*, IKr, Bremen
[83] Eunomia (2006): A Changing Climate for Energy from Waste? Friends of the Earth, London.
Papageorgiou, A., Barton, J.R. and Karagiannidis (2009): Assessment of the greenhouse effect impact of technologies used for energy recovery from municipal waste: A case for England, *Journal of environmental management* *Volume 90, Issue 10*, Pages 2999-3012
[84] Environment Agency Wales (2008): *A Life Cycle Assessment and Sustainability Assessment of the alternative strategic waste management Options*, Environment Agency Wales, Cardiff http://www.walesregionalwasteplans.gov.uk/north/consultation_draft_review_doc.html
[85] Eunomia (2006) A Changing Climate for Energy from Waste? Friends of the Earth, London
[86] Eunomia Research and Consulting (2010): *INEOS Bio Advanced Biofuels process at Sand Seals Plant.* www.ineosbio.com/media/files/INEOS%20Bio%20Life-cycle%20Assessment.pdf

Disposal

Landfill is currently the most common means of dealing with residual waste in the UK, and this continues to be the most unsustainable waste management option.

Biodegradable elements of residual waste give rise to methane emissions, a proportion of which are captured for flaring or energy recovery. Government policy continues to promote measures to better manage methane capture at landfill sites and make better use of the gas in providing renewable heat and electricity. In parallel, the Landfill Directive sets targets to reduce the quantity of biodegradable municipal waste sent to landfill, which in turn should lead to a reduction in methane emissions. However, the overall impact of landfill will continue to be negative as there is a range of additional environmental impacts, and not all methane emissions are captured'

16. Textiles

The Defra Sustainable Clothing Roadmap estimates that the UK generates 2 million tonnes of textile waste (including clothing, carpets and footwear) every year, of which about half is clothing. Of the total, 1 million tonnes goes to landfill from the household waste stream, and 0.5m tonnes are collected for re-use or recycling in the UK and overseas.[87]

Prevention

Prevention includes direct reuse of clothing without the need for repair.

Businesses, local authorities and individuals can reduce textile waste by increasing the lifetimes of textiles. 50% of clothes, uniforms, textiles and rugs disposed of by businesses are usable without repair. A third of clothing disposed of by households is usable without repair.[88]

A study of Salvation Army textile reuse and recycling operations established that the reuse (collection, sorting, baling and distribution) of 1 tonne of polyester or cotton garments uses between 1.8 and 2.6% of the energy required for the manufacture of these goods from virgin materials[89].

Defra is investigating the potential for delivering environmental benefits through longer product lifetimes, and will shortly be publishing evidence on this. WRAP is due to publish further research in 2011 which informs the debate on when it is appropriate to repair or reuse certain items rather than replace them.

Preparing for re-use

For textiles, the logistics and environmental impact of re-use (i.e. selling, exchange or donation of textiles that have not become waste), and activities preparing for re-use (collection, sorting, cleaning and re-sale) are very similar.

Taking into account the whole system, including the manufacture of new synthetic and natural fibres, the benefits of both reuse (prevention) and preparing for re-use include significant savings in water use, energy use, raw materials and greenhouse gas emissions. For example, it takes 7,000-29,000 litres of water to produce 1kg of cotton fibres. This is the same as the average UK resident uses in 46-192 days[90]. Diversion of water for growing cotton can have dramatic consequences, as seen in the Aral Sea disaster.

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[87] Oakdene Hollins (2009): *Maximising Reuse and Recycling of UK Clothing and Textiles*, report prepared for Defra

[88] Cooper, T. (2004) Inadequate life? Evidence of consumer attitudes to product obsolescence, *Journal of Consumer Policy*, 27, 421-449

[89] ERM. (2002): *Streamlined Life Cycle Assessment of Textile Recycling*. Report completed for the Salvation Army Trading Company Ltd

[90] http://www.defra.gov.uk/sustainable/government/progress/regional/summaries/16.htm

Where an item requires repair, the limited evidence suggests that this is preferable to recycling.[91] The findings of research into carpet tile reuse, were recently published.[92]

Recycling

Most of the collected textiles which are not reused are recycled into lower value products (e.g. mattresses, wipes, carpet underlay, automotive components or niche clothing). The assessment of whether an item is suitable for reuse or recycling is normally made by a company or charity sorting textiles. Closed loop recycling of clothing has been tried[93], but is not widespread at present.

The environmental benefit of recycling is not as great as for reuse, which avoids all elements of production, but it is still appreciable. On average savings for 1 tonne of material sent for sorting for reuse or recycling are anticipated to be over 3 tonnes CO_2 equivalent.

Carpets are made from natural and synthetic fibres, which still have a value once the carpet is no longer wanted; they can be used in a wide range of applications from sports surfaces to insulation. The industry-government Action Plan[94] aims to lay out measures to reduce landfilling of carpet waste. It considers the technical and financial aspects of recycling. Composting is also an option for biodegradable fibres, but at present we do not have evidence on the relative merits of this.

Other recovery

The environmental impacts of sending textiles to energy recovery vary with the type of fibre they are made of (natural fibres or synthetic (mostly oil-based) fibres).

Both types of fibre will combust and can be used to generate energy. Natural fibres used to generate energy replace fossil fuels. Even in incineration facilities which only recover electricity, this offers some environmental benefits. Synthetic fibres used in place of a fossil fuel do not give the same benefit. All the studies identified assume that there is a mix of both types in the waste stream.[95]

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[91] EDIPTEX. (2007). Environmental assessment of textiles. Danish Ministry of the Environment, Environmental Protection Agency
Allwood, J., Laursen, S.E., Malvido de Rodriguez, C. & Bocken, N. (2006). *Well Dressed? The present and future sustainability of clothing and textiles in the United Kingdom*. University of Cambridge Institute for Manufacturing

[92] http://www.constructionproducts.org.uk/publications/dbfiles/07%20Flooring%20full%20version%20lo-res%2010.pdf

[93] For an example, see http://www.teijin.co.jp/english/news/2009/ebd091118.html

[94] Flooring A Resource Efficiency Action Plan September 2010 http://www.constructionproducts.org.uk/publications/dbfiles/07%20Flooring%20full%20version%20lo-res%2010.pdf

[95] WRAP (2010) *Environmental Benefits of Recycling*; and Allwood, J., et al (2006) *Well dressed? The present and future sustainability of clothing and textiles in the United Kingdom*, University of Cambridge.

The energy generated by combusting textiles is not as high as the energy saved through reuse or recycling. Projections to 2031 consider that this will continue to be the case. [96]

Disposal

Textiles made of natural fibres biodegrade in landfill, producing methane emissions. Even where some of these are captured for flaring or energy recovery, the overall impact is still negative. [97] Landfilling textiles should be avoided.

[96] ERM (2006) *Carbon Balances and Energy Impacts of the Management of UK Wastes* WR0602, Defra.
[97] *WRAP (2010) Update:* Environmental Benefits of Recycling

17. Tyres

In the UK, about 0.5 million tonnes of tyres are disposed of every year. Most of these tyres are removed from vehicles at garages or tyre retailers and replaced; around a quarter are removed from end of life vehicles. Since 2006, the Landfill Directive has prohibited the disposal of tyres in landfill.

Industry data suggests that in 2008, about one quarter of UK waste tyres were re-used; half was recycled and most of the rest was used for energy recovery.[98]

Prevention

Manufacturing tyres uses energy and raw materials like oil and natural rubber, and can produce harmful chemicals. Reducing the number of tyres that need to be produced therefore has benefits for the environment.

If the life of tyres can be extended, then less waste tyres will be produced. Reusing tyres for their original purpose means that new tyres do not have to be manufactured. This means that the use of virgin material and the energy in manufacture are avoided, leading to environmental benefits.

Preparing for re-use

Retreading is another way of re-using most of the materials in a tyre: the old tread is removed and a new tread applied to the tyre. It is a remanufacturing process and offers high environmental benefits in terms of reduced greenhouse gas emissions, contribution to acidification, eutrophication and resource depletion.[99]

Recovery options

Recovery options for tyres include, in descending order of environmental benefit:

- Recovery through the use in road surfaces
- Energy recovery through cement kilns and pyrolysis
- Other methods of recovery
- Energy recovery through gasification, incinerators and microwave treatment

Use in road surfaces

Breaking the tyres down into crumb and using this in place of virgin rubber or bitumen (e.g. in flooring and surfaces) has positive environmental benefits[100]. More information about current and potential applications for tyre-derived materials can be found at www.wrap.org.uk/tyres.

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98 http://www.etrma.org/pdf/2009_11_09__ETRMA_PR_ELTs_recovery_rate_in_2008.pdf

99 Centre for Remanufacturing and Reuse (2009): *The carbon footprint of retreaded versus new light commercial vehicle tyres*

100 EA (2004) *Life Cycle Assessment of the Management Options for Waste Tyres*
Villanueva, A., Hedal, N., Carlsen, R. (2008) *Comparative life cycle assessment of two options for waste tyre treatment: recycling in asphalt and incineration in cement kilns* IFEU Heidelberg

Energy recovery through cement kilns and pyrolysis

Several options exist for the recovery of energy from waste tyres.

The most environmentally beneficial method is to burn them in *cement kilns*, where they replace coal[101].

Pyrolysis (breaking down materials at a high temperature in the absence of oxygen) can also have environmental benefits, producing steel, carbon and oil, and in some cases heat and power as well[102]. Pyrolysis produces less energy than cement kilns, but it produces raw materials. At present, the technology is less beneficial than a cement kiln, but more beneficial than other energy recovery, e.g. incineration with energy from waste or gasification (see below).

Other methods of recovery

Other, less beneficial methods of recovery include using waste tyres in place of natural resources for use in sea defences or drainage fill. This is because these applications avoid the use of natural resources with low environmental impacts (e.g. gravel).

Energy recovery through gasification, incinerators and microwave treatment

At present, incineration with energy recovery and gasification do not recover as much energy as alternative options, nor avoid the use of raw materials. Microwave treatment can also recover steel, carbon and oil, but the energy required in this process means that it is not an environmentally beneficial option.[103]

Landfill is prohibited for tyres.

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[101] EA (2004) Life Cycle Assessment of the Management Options for Waste Tyres
[102] ibid
[103] ibid

18. Weee

EA figures for 2009 show that 1.54 million tonnes of electronic and electrical equipment (EEE) was purchased by householders and businesses. Of this, about 80% was purchased by households.[104]

By far the largest component of WEEE is metals. Plastics, metals-plastics mixtures, and glass from screens are the next largest groups.

The hazardous components that can arise in some WEEE require specific waste treatment. For example cathode ray tubes in TVs and monitors and flat panel displays require specialist treatment. These hazardous components should be removed from the WEEE and treated separately. The remainder can go then down the normal recycling route.

Prevention

For some items (mobile phones, drills, cameras, some small kitchen and personal care products), research published by WRAP in late 2010 shows that the impact of production is far greater than their consumption of energy in use.[105]

Defra is investigating the potential for delivering environmental benefits through longer product lifetimes, and will shortly be publishing evidence on this. WRAP is due to publish further research in 2011 which informs the debate on when it is appropriate to repair or reuse certain items rather than replace them.

Preparing for re-use

There is a thriving market for reconditioned large appliances and IT equipment, and again repair and refurbishment avoid the environmental impacts of manufacturing new goods.

Recycling

Even when the environmental impacts of collection and reprocessing are considered, WEEE recycling is clearly better for the environment than incineration or landfill.[106]

This is because the benefits of recycling the metallic and uncontaminated plastic fractions of WEEE outweigh the impacts of the recycling process, in terms of greenhouse gas emissions and resource depletion. Recent demonstration work has shown a 50-75% reduction in emissions from using recycled WEEE plastics rather than virgin plastics.[107]

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[104] http://www.environment-agency.gov.uk/business/topics/waste/111016.aspx
[105] WRAP (2010) Environmental assessment of consumer electronic products
[106] R. Hischier, P. Wäger, J. Gauglhofer (2005): *Does WEEE recycling make sense from an environmental perspective? The environmental impacts of the Swiss take-back and recycling systems for waste electrical and electronic equipment.*
Jaco Huisman and Ab L. N. Stevels (2006): *Eco-Efficiency of Take-Back and Recycling, a Comprehensive Approach.*
Y. Barba-Gutierrez , B. Adenso-Diaz, M. Hoppa (2008): *An analysis of some environmental consequences of European electrical and electronic waste regulation*
[107] WRAP (2009): *Separation of mixed WEEE plastics final report*

In addition, it is estimated that only 1% of 'speciality' metals (or "rare and precious metals" used in electronics are currently recycled. Research by the United Nations Environment Programme suggests that chip makers use more than 60 of these metals, with demand for indium for example expected to double to by 2020. Recycling these metals is between 2 and 10 times more energy efficient than smelting the metals from virgin ores (which are also to be found in very few places on Earth).[108]

Other forms of recovery

Once the metal fraction, printed circuit boards, high-quality plastic fractions etc have been taken out for recycling, incineration with energy recovery is preferable for the residual combustible waste, also it allows the extraction of precious metals from circuit boards

Any hazard associated with the material will require consideration before sending this material for further recovery. The hazardous components of WEEE call for specific waste treatment, and are not covered in this guidance. They will be covered in the guidance which will follow the Strategy for Hazardous Waste Management in England.

Disposal

Landfill is the waste management method of last resort for WEEE, and should be avoided.

19. Wood

WRAP estimate that 4.7 million tonnes of wood waste were generated in the UK in 2008-9.[109] However, this could be an underestimate due to a lack of reliable data from the construction sector, and is likely to be lower than previous years because of the economic downturn. The vast majority of arisings came from construction and demolition activities, with packaging another significant source.

The ***sustainability of timber*** is important when considering environmental impacts. The benefits of preventing wood waste, preparing wood waste for re-use, recycling it or recovering energy from it are all the greater if unsustainably sourced wood is being replaced or avoided.

This is because where forests are managed sustainably; the amount of CO_2 absorbed over the life of a tree should be in balance with the amount of CO_2 emitted at the end of the life of the tree and its products. In contrast, where wood is sourced from forests which are being clear-felled, additional CO_2 is emitted to the atmosphere due to the change in land use.

Prevention

Businesses and individuals can help prevent wood waste by reusing wooden items (e.g. furniture, multi-use pallets, structural timber and identifying ways to reduce the initial timber demand (e.g. light weighting). Prevention avoids the impacts associated with the production and distribution of these timber products throughout their lifetime.

Preparing for reuse

Extending the life of wooden products through the preparation for re-use offers environmental benefits. The nature and size of these benefits depends on the source of the virgin wood which would otherwise need to be used and on the amount of refurbishment required. The potential benefits include reduced biotic resource depletion and savings in raw materials and avoidance of greenhouse gas emissions. [110]

Recycling and energy recovery

Scientific research on the relative environmental merits of waste management operations for wood is limited, with only 3 Life Cycle Assessments and 5 LCA-like reports identified (two of which were published in the UK). Defra has an ongoing research project entitled ‘An Assessment of the Environmental Impact of Management Options for Waste Wood’ which seeks to assess the environmental impacts of possible management options for waste wood across the lifecycle of the processes and end products, and the practicalities of such options in the light of current arrangements and available processing facilities. This project is due to complete at the end of April 2011. The project is due to be published shortly.

[109] *WRAP (2009) Wood Waste Market In The UK*
[110] WRAP (2010) Update - Environmental Benefits of Recycling

Most of the evidence suggests that recycling is preferable to energy recovery in terms of climate change, whereas energy recovery is preferable regarding resource depletion, since fossil fuel usage is avoided. This depends on the grade of wood being treated, however, and the evidence on other air pollution impacts is mixed. For recycling, the results are influenced by the end markets the wood is used in. For energy recovery, the results are influenced by the efficiency of energy recovery and the type of energy recovered. [111]

Recycling and recovery options for wood waste depend very much on the type of waste wood, and how well sorted it is. Wood waste encompasses saw dust, pallets, pre-consumer waste such as off-cuts, doors, beams and planks, furniture, etc.

- Clean wood waste can be recycled into a variety of end products, including panelboard, mulch or animal bedding.
- Contamination with paint, preservatives or other chemicals and materials (e.g. nails) reduces the range of feasible recycling applications. In some cases treated wood is classified as hazardous waste, and has to be managed accordingly. Lower grade waste wood can only be used in a Waste Incineration Directive (WID) compliant facility.

To maximise both the quantities of wood recycled and the benefits of doing so, wood should be ***graded according to the end markets it is suitable for*** where possible. The Wood Recyclers' Association have developed a grading structure for UK derived, non-virgin wood for recycling into products, feedstocks and fuels; see **Annex B** for guidance on this. WRAP and the EA are currently working on developing a quality protocol for wood.

Use of wood in energy recovery has the potential to reduce depletion of non-renewable resources and reduce greenhouse gas emissions from energy production. It could also prevent the import of virgin timber for energy recovery.

Disposal

In landfill, wood breaks down to release methane emissions over a period of years. The rate at which it degrades depends on the type of wood, landfill conditions (e.g. how wet the landfill is), preservatives etc. Over 100 years, emissions from 1 tonne of wood can vary from near zero to 5 tonnes CO_2 equivalent. [112] Landfilling of waste wood should be the last resort.

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[111] WRAP (2010) Environmental Benefits of Recycling – 2010 update. The wood chapter contains references to the separate studies mentioned, as does the Bibliography below.

[112] F.A. Ximenes, W.D. Gardner and A.L. Cowie (2008) The decomposition of wood products in landfills in Sydney, Australia, *Waste Management* Vol 28 (2008) pp 2344–2354
Morton A. Barlaz (2006) Forest products decomposition in municipal solid waste landfills *Waste Management, Vol 26, 2006, pp 321-333*
Micales J.A.; Skog K.E. (1997) The Decomposition of Forest Products in Landfills, *International Biodeterioration and Biodegradation*, Vol 39 (1997) , pp. 145-158

Bibliography

Allwood, J., et al (2006): Well dressed? The present and future sustainability of clothing and textiles in the United Kingdom, University of Cambridge. *http://www.ifm.eng.cam.ac.uk/sustainability/projects/mass/UK_textiles.pdf*

Barba-Gutierrez Y , Adenso-Diaz B., Hoppa M. (2008): An analysis of some environmental consequences of European electrical and electronic waste regulation, Resources, Conservation and Recycling No.52, 481–495

BIWA (2003) *Klimarelevanz der Abfallwirtschaft im Freistaat Sachsen. Gutachten im Auftrag des Sächsischen Landesamtes für Umwelt und Geologie*, BIWA Consult, Freiberg (Sachsen). http://www.biwa-consult.de/

Centre for Remanufacturing and Reuse (2009): The carbon footprint of retreaded versus new light commercial vehicle tyres

Defra (2007): Paper sludge and paper sludge ash in Portland cement manufacture, - WR0115
http://www.smartwaste.co.uk/filelibrary/Portland_cement_paper_sludge.pdf

Defra (2007): Waste Strategy for England
http://defraweb/environment/waste/strategy/strategy07/documents/waste07-strategy.pdf

Defra (2008): Waste Wood as a Biomass fuel: Market information report
http://www.defra.gov.uk/environment/waste/topics/documents/wastewood-biomass.pdf

Defra (2008) Monitoring of peat and alternative products for growing media and soil improvers in the UK 2007
http://www.defra.gov.uk/evidence/science/publications/documents/peatAlternatives2007.pdf

Defra (2009): Project REDUCE Monitoring and Evaluation - Developing Tools to Measure Waste Prevention - WR0105
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14655#RelatedDocuments

Defra, Sustainable Development data, Domestic water consumption
http://www.defra.gov.uk/sustainable/government/progress/regional/summaries/16.htm

Defra (2009): Municipal Waste Composition Report March 2009 – WR0119
http://randd.defra.gov.uk/Document.aspx?Document=WR0119_8662_FRP.pdf

Environment Agency (2004): Life Cycle Assessment of the Management Options for Waste Tyres, R & D Technical Report P1-437/TR, ISBN I 844 32289 0.

Enviros (2003): Glass Recycling - Life Cycle Carbon Dioxide Emissions
http://www.britglass.org.uk/Files/Enviros_LCA.pdf

ERM (2006) Carbon Balances and Energy Impacts of the Management of UK Wastes WR0602, Defra.
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14644

ERM (2002): Streamlined Life Cycle Assessment of Textile Recycling. Report completed for the Salvation Army Trading Company Ltd

Eunomia (2006) *A Changing Climate for Energy from Waste?* Friends of the Earth, London

European Aluminium Association (2008): Environmental Profile Report for the European Aluminium Industry
http://www.eaa.net/upl/4/en/doc/EAA_Environmental_profile_report_May08.pdf

Gentil, E Boldrin, A, & Potter, A (2008): Carbon Footprinting of Second-life Materials Using Life Cycle Thinking South-East Regional Assembly
http://www.southeast-ra.gov.uk/documents/sustainability/waste/ewm_lca_carbon_footprinting.pdf

Hischier R., Wäger P., Gauglhofer J. (2005): Does WEEE recycling make sense from an environmental perspective? The environmental impacts of the Swiss take-back and recycling systems for waste electrical and electronic equipment (WEEE), Environmental Impact Assessment Review, pp 525– 539.

IFEU (2007) *Ökobilanz thermischer Entsorgungssysteme für brennbare Abfälle in Nordrhein-Westfalen* Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen, Düsseldorf

IKr (2006) *Ökologische und ener- getische Bilanzierung des Vorhabens MKK*, IKr, Bremen

Jaco Huisman and Ab L. N. Stevels (2006): Eco-Efficiency of Take-Back and Recycling, a Comprehensive Approach, IEEE Transactions On Electronics Packaging Manufacturing, VOL. 29, NO. 2, p.83

NNFCC (2008): Life Cycle Assessment of Biopolymers for Single-use Carrier Bags
http://www.nnfcc.co.uk/metadot/index.pl?id=7989;isa=DBRow;op=show;dbview_id=2457

NNFCC (2009): Evaluation of Opportunities for Converting Indigenous UK Wastes to Fuels and Energy (AEAT) - 09-012
http://www.nnfcc.co.uk/metadot/index.pl?id=9840;isa=DBRow;op=show;dbview_id=2457

NNFCC (2009): Project Advanced thermochemical biofuels road map and challenge – 09- 014
http://www.nnfcc.co.uk/metadot/index.pl?id=10046;isa=DBRow;op=show;dbview_id=2457

NNFCC (2010) Renewable Polymers Fact Sheet: Bioplastics -
http://www.nnfcc.co.uk/metadot/index.pl?id=10324;isa=DBRow;op=show;dbview_id=2539

NNFCC (2010): A Detailed Economic Assessment of Anaerobic Digestion Technology and its Suitability to UK Farming and Waste Systems 2nd Edition (Andersons) - 10-010
http://www.nnfcc.co.uk/metadot/index.pl?id=7198;isa=DBRow;op=show;dbview_id=2539

Oakdene Hollins (2009): Maximising Reuse and Recycling of UK Clothing and Textiles, report prepared for Defra - EV0421
http://randd.defra.gov.uk/Document.aspx?Document=EV0421_8745_FRP.pdf

Pitschke, I., Kreibe, S., Cantner, J., Tronecker, D. (2007) *Ökoeffiziente Verwertung von Bioabfällen und Grüngut in Bayern*, http://www.ask-eu.de/default.asp?Menue=20&ArtikelPPV=16489&Keyword=Bioabfälle%20und%20Grüngut

Rivela, Moreira, Munoz, Rieradevall, Feijoo (2006): Life cycle assessment of wood wastes: A case study of ephemeral architecture Science of the Total Environment vol. 357; pp. 1-11

Rommel, W. Pitschke, T. Hottenroth, S. Roth, U. (2005) Okoeffizienzvergleich von Entsorgungsstrukturen *Chemie Ingenieur Technik* JAHR 77; NUMB 8, pages 1159

Schluep, M et al (2009): Recycling – from E-Waste To Resources, United Nations Environment Programme, http://www.unep.org/PDF/PressReleases/E-Waste_publication_screen_FINALVERSION-sml.pdf

US EPA. (2006). Solid waste management and greenhouse gases, A Life-Cycle Assessment of Emissions and Sinks.

Villenueva (2008): Comparative life cycle assessment of two options for waste tyre treatment

Wackernagel and Rees (1996): Our ecological footprint, New Society Publications.

WRAP (2004): Can You Recycle Your Flat Glass?
http://www.wrap.org.uk/downloads/FlatGlassWaste2.ad3d6cb1.484.pdf

WRAP (2006): Environmental Benefits of Recycling
http://www.wrap.org.uk/downloads/Recycling_LCA_Report_Sept_2006_-_Final.f2d27fb8.2838.pdf

WRAP (2006): UK Plastics Waste – A review of supplies for recycling, global market demand, future trends and associated risks
http://www.wrap.org.uk/downloads/UK_Plastics_Waste.f3b660a5.5543.pdf

WRAP (2006): Develop a process to separate brominated flame retardants from WEEE polymers
http://www.wrap.org.uk/recycling_industry/publications/develop_a_process_to.html

WRAP (2007): Managing Biowastes from Households in the UK: Applying Lifecycle Thinking in the Framework of Cost-benefit Analysis: Report and Appendices
http://www.wrap.org.uk/downloads/Biowaste_CBA_Final_Report_May_2007.52ef4a13.3824.pdf and
http://www.wrap.org.uk/downloads/Biowaste_CBA_Report_Appendices_May_2007.e9759323.3823.pdf

WRAP (2007): Market Situation Report – Autumn 2007 Realising the value of recovered plastics
http://www.wrap.org.uk/downloads/PlasticsMktRep.d5178089.4755.pdf

WRAP (2008): An Assessment of WRAP's Tyre Programme and a Forecast of the UK's Used Tyre Market up to 2015
www.wrap.org.uk/downloads/TYR_031_Final_Report_MC_JK.ddd228c6.6137.pdf

WRAP (2008) LCA of Management Options For Mixed Waste Plastics - MDP 017
http://www.wrap.org.uk/downloads/LCA_of_Management_Options_for_Mixed_Waste_Plastics.35e43217.5497.pdf

WRAP (2008): CO_2 impacts of transporting the UK's recovered paper and plastic bottles to China
http://www.wrap.org.uk/downloads/CO2_Impact_of_Export_Report_v8_1Aug08.e906681f.5760.pdf

WRAP (2008): Domestic Mixed Plastics Packaging Waste Management Options – MDP017
http://www.wrap.org.uk/downloads/Mixed_Plastic_Final_Report.4d017aca.5496.pdf

WRAP (2008): The Food We Waste report - RBC405-0010
http://www.wrap.org.uk/downloads/The_Food_We_Waste_v2__2_.197af068.5635.pdf

WRAP (2009) Home Composting Diversion: District Level Analysis
http://www.wrap.org.uk/downloads/Home_Composting_Diversion_District_Level_Analysis.4d405bd8.7747.pdf

WRAP (2009): Food Waste Collection: Update to WRAP Biowaste Cost Benefit Study
http://www.wrap.org.uk/downloads/Update_to_Biowaste_CBA_Report.5f724af5.6164.pdf

WRAP (2009): Life Cycle Assessment of Closed Loop MDF recycling: Microrelease Trial

WRAP (2009): Waste Prevention Toolkit
http://www.wrap.org.uk/local_authorities/research_guidance/waste_prevention/index.html

WRAP (2009) Wood Waste Market in the UK – MKN022
http://www.wrap.org.uk/downloads/Wood_waste_market_in_the_UK.f3b45ab9.7547.pdf

WRAP (2009): Separation of mixed WEEE plastics final report -MDD018 and MDD023,
http://www.wrap.org.uk/recycling_industry/publications/separation_of_mixed.html

WRAP (2010) Environmental Benefits of Recycling 2010 update – SAP097
http://www.wrap.org.uk/downloads/Environmental_benefits_of_recycling_2010_update.53016551.8816.pdf

WRAP (2010): LCA of Example Packaging Systems for Milk
http://www.wrap.org.uk/retail/case_studies_research/example_systems.html

WRAP (2010): Realising the value of recovered paper: An update
http://www.wrap.org.uk/downloads/WRAP_Paper_market_situation_report_Feb2010.b3a0647f.8440.pdf

WRAP / Institute of Hospitality: Fact file on recycling No.4, *Reducing waste*
http://www.instituteofhospitality.org/info_services/recycling

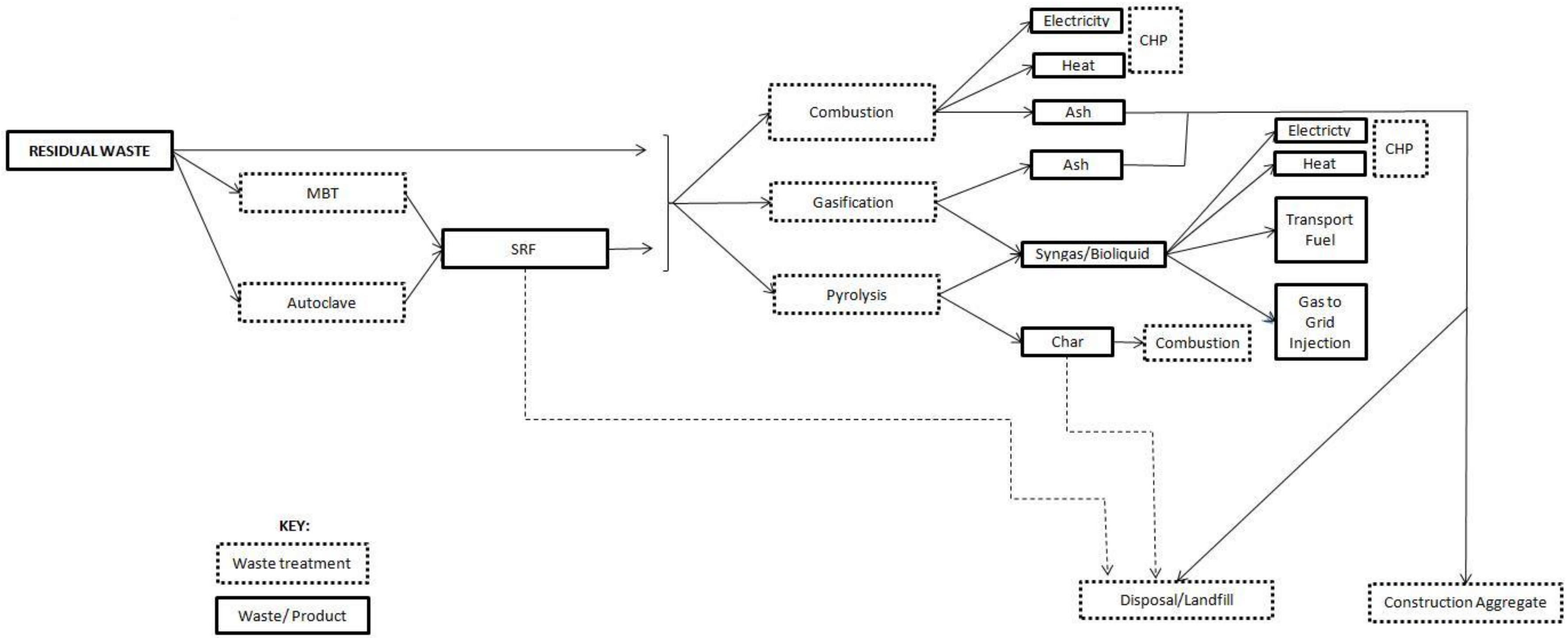
WRAP Market Situation Reports
http://www.wrap.org.uk/recycling_industry/market_information/market_situation_reports/index.html

Other sources of information

The UK Renewable Energy Strategy 2009
http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx

UK Low Carbon Transition Plan 2009
http://www.decc.gov.uk/en/content/cms/publications/lc_trans_plan/lc_trans_plan.aspx

Annex A: Energy from Waste for residual waste: the options



Annex B: Wood Recyclers' Association Grading Structure

The Wood Recyclers' Association[113] has developed the following grading structure for non-virgin wood for recycling into products, feedstocks and fuels. Please note that it is not a set of specifications, nor a standard, nor is it intended to be included in contract documentation, all of which require more detail.

Grade of wood	Typical markets	Typical sources of raw material for recycling.	Typical materials	Typical non–wood content prior to processing	Notes
Grade A. **"Clean" Recycled Wood**	A feedstock for the manufacture of professional and consumer products such as animal bedding and horticultural mulches. May also be used as fuel for renewable energy generation in non WID* installations, and for the manufacture of pellets and briquettes.	Distribution. Retailing. Packaging. Secondary manufacture e.g. joinery. Pallet reclamation.	Solid softwood and hardwood. Packaging waste, scrap pallets, packing cases, and cable drums. Process off-cuts from manufacture of untreated products.	Nails and metal fixings. Minor amounts of paint, and surface coatings.	Some visible particles of coatings and light plastics will remain. Excludes grades below. Is a waste for W.M.Regs* requirements. Does not require a WID installation**
Grade B. **Industrial Feedstock Grade**	A feedstock for Industrial wood processing operations such as the manufacture of panel products, including chipboard and medium density fibreboard (MDF)	As Grade A, plus construction and demolition operations and Transfer Stations.	May contain up to 60% Grade A material as above, plus building and demolition materials and domestic furniture made from solid wood.	Nails and metal fixings. Some paints, plastics, glass, grit, coatings, binders and glues. Limits on treated or coated	The Grade A content is not only costly and difficult to separate, it is essential to maintain the quality of feedstock for chipboard manufacture, and for PRN revenues. Some feedstock specifications contain a 5 – 10% limit on former panel products such as

113 www.woodrecyclers.org/

				materials as defined by WID.	chipboard, MDF, and plywood. Excludes Grade D. Is a waste for W.M.Regs* requirements. Does require a WID installation, unless granted an exemption**
<u>Grade C.</u> **<u>Fuel Grade.</u>**	Biomass fuel for use in the generation of electricity and/or heat in WID** compliant installations	All above plus Municipal Collections, Recycling Centres Transfer Stations And Civic Amenity Recycling sites	All of the above plus fencing products, flat pack furniture made from board products and DIY materials High content of panel products such as chipboard, MDF, plywood, OSB and fibreboard.	Nails and metal fixings. Paints coatings and glues, paper, plastics and rubber, glass, grit. Coated and treated timber (non CCA or creosote).	Suitable only For WID installations**. Material coated and treated with preservatives as defined by WID may be included. Excludes Grade D Is a waste for W.M.Regs* requirements.
<u>Grade D</u> **<u>Hazardous Waste</u>**	Requires disposal at special facilities	All of the above plus fencing, trackwork and transmission pole contractors.	Fencing Transmission Poles Railway sleepers Cooling towers	Copper / Chrome / Arsenic preservation Treatments Creosote	Is a waste for W.M.Regs* requirements. Does require a special WID installation.

*Waste Management Regulations – this grade requires a waste management licence (or exemption) until final use, and is subject to waste transfer regulations. The definition as to whether a material is a waste or not is under review (September 2009).

** A Waste Incineration Directive-compliant installation is required to allow this grade to be used as biomass.

There will be some coated or treated wood in all grades, as it is impossible to identify or exclude every particle of such material