Introductory Guide to Options for the Diversion of Biodegradable Municipal Waste from Landfill

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Contents

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Background

Municipal Solid Waste (MSW) is waste collected by or on behalf of the local authority or its agents. It consists of mostly household waste and may include municipal parks and gardens waste, beach cleansing waste, commercial or industrial waste and waste resulting from the clearance of fly-tipped materials. The total quantity of MSW has risen year on year[1], presenting a growing problem for local authorities, particularly as the legislation[2] which limits the amount of biodegradable municipal waste (and therefore residual MSW) that can be sent to landfill becomes more stringent over time.

Over the last 8 years England has increased its recycling rate from 7% to 27%. Despite this considerable improvement, more than 62% of all MSW generated in England is disposed of in landfills[3]. The aim of this guide is to provide an introduction to the options for diverting this remaining MSW from landfill. Some of these options are already established practice in the UK or overseas. Others include technologies which have yet to be commercially tested in the UK for municipal waste management. Further details about the new and established technologies featured in this report are available from the Waste Technology Data Centre available on the Environment Agency website and in separate Technology Briefs in this series.

The most significant challenge facing the management of MSW is how to divert the biodegradable component of MSW (known as Biodegradable Municipal Waste) away from landfills. Legislation and policy measures have been set in place to significantly reduce the amount of this biodegradable waste sent for disposal in landfills. These measures are explained in the following sections.

What is Biodegradable Municipal Waste (BMW)?

Biodegradable Municipal Waste (BMW) is the fraction of MSW that will break down under the action of micro-organisms, either in the presence of oxygen in air (known as aerobic conditions) or in the absence of oxygen such as that within a landfill or digestion plant (known as anaerobic conditions). The types of materials that comprise BMW include food or kitchen wastes, garden wastes, paper, card, wood and some textiles. Figure 1 illustrates the composition of household waste, over half of which consists of garden, kitchen and paper/board, the main biodegradable fractions within MSW.

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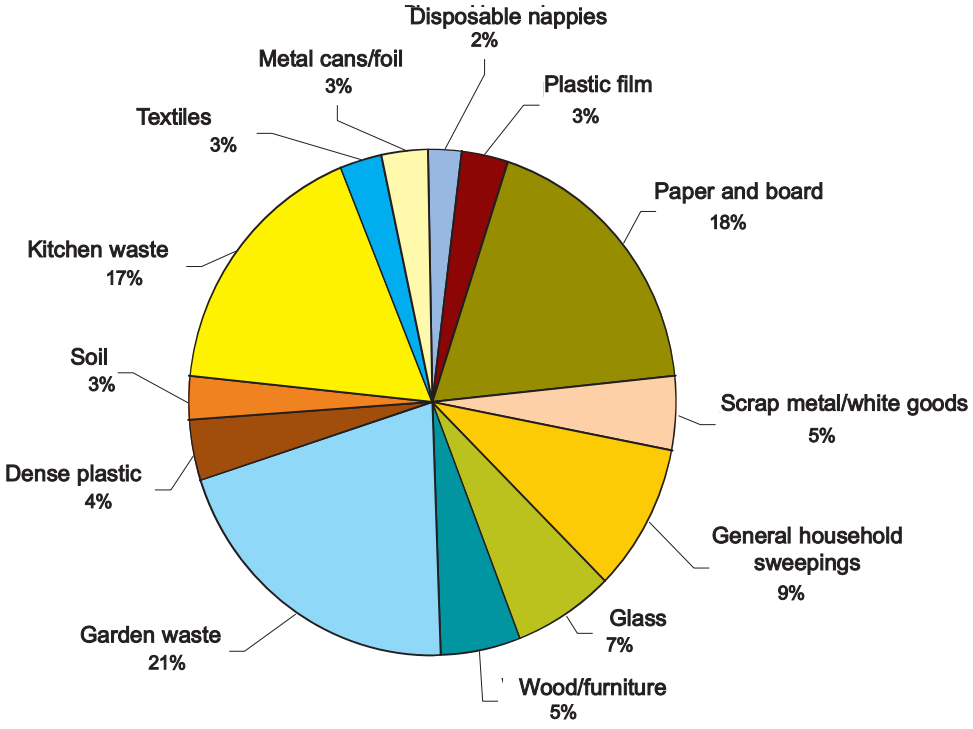
1 This is now showing signs of slowing and in some areas waste arisings are falling, and indeed for 2005/6 there was a 3% fall nationally. However, this may be partly explained by other factors occurring in that particular financial year

2 The Landfill Directive, Waste and Emissions Trading Act 2003 and Landfill Allowances Trading Regulations

3 Results from WasteDataFlow for 2005/6 http://www.defra.gov.uk/environment/statistics/wastats/bulletin.htm

Background

Figure 1: Household waste composition (England, 2000/1)



Source: Dr Julian Parfitt, Waste & Resources Action Programme, Waste Strategy for England 2007

Why seek alternatives to landfill?

The overall goal for Government is to achieve sustainable waste management, to recover value from waste and break the link between economic growth and the environmental impact of waste[4]. Waste is a resource from which recyclable and compostable materials can be extracted and energy-rich fuels can be produced, reducing the amount that requires disposal to landfill. Waste policy in the UK and England sits within wider European policy and legislation framework. The underpinning legislation is the European Union Waste Framework Directive which defines waste as '*any substance or object…which the holder discards or is required to discard*'.

The Government published the new *Waste Strategy for England in May 2007*[5]. The 5 key objectives of the strategy are to:

- decouple waste growth (in all sectors) from economic growth and put more emphasis on waste prevention and reuse
- meet and exceed the Landfill Directive diversion targets for biodegradable municipal waste in 2010,2013 and 2020
- increase diversion from landfill of non-municipal waste and secure better integration of treatment for municipal and non-municipal waste
- secure the investment in infrastructure needed to divert waste from landfill and for the management of hazardous waste

4 Securing the Future, the UK Government Sustainable Development Strategy, March 2005,available at http://www.sustainable-development.gov.uk/publications/uk-strategy/uk-strategy-2005.htm
5 http://www.defra.gov.uk/environment/waste/strategy/strategy07/index.htm

Background

- get the most environmental benefit from that investment, through increased recycling of resources and recovery of energy from residual waste using a mix of technologies

These objectives emphasise the Government's aim of reducing waste and disposing of less waste to landfill. Increasingly, the contribution waste management can make to climate change is being recognised. The disposal of biodegradable waste to landfill results in the production of methane as the waste degrades, a gas 23 time more potent greenhouse gas than carbon dioxide. Recovering materials and energy from waste reduces the potential contribution waste management makes to climate change.

The EC Landfill Directive

The legislation driving the need to divert BMW from landfill is in response to the EU Landfill Directive published in 1999. The rationale for the need to reduce the levels of BMW is based on the overall aim of the Directive, which is to prevent or reduce as far as possible the negative effects of landfill on the environment, in particular the pollution of surface water, groundwater, soil, and air, and on the global environment, including the greenhouse effect. There are increasing concerns over greenhouse gas emissions from landfills contributing to climate change[6]. The decomposition of biodegradable materials within landfill sites results in the production and escape of methane (this emission will be minimised by good gas control and management of the site). Methane is a potent greenhouse gas, emissions of which need to be reduced. It is estimated that methane from landfill accounted for 40% of total UK methane emissions or 3% of total greenhouse gases in 2005 (including methane and carbon dioxide and other gases)[7].

The Landfill Directive is one measure which aims to reduce the volume of methane released from landfills by imposing a reduction in the quantities of BMW disposed of in this way. Within the Landfill Directive the following targets have been set:

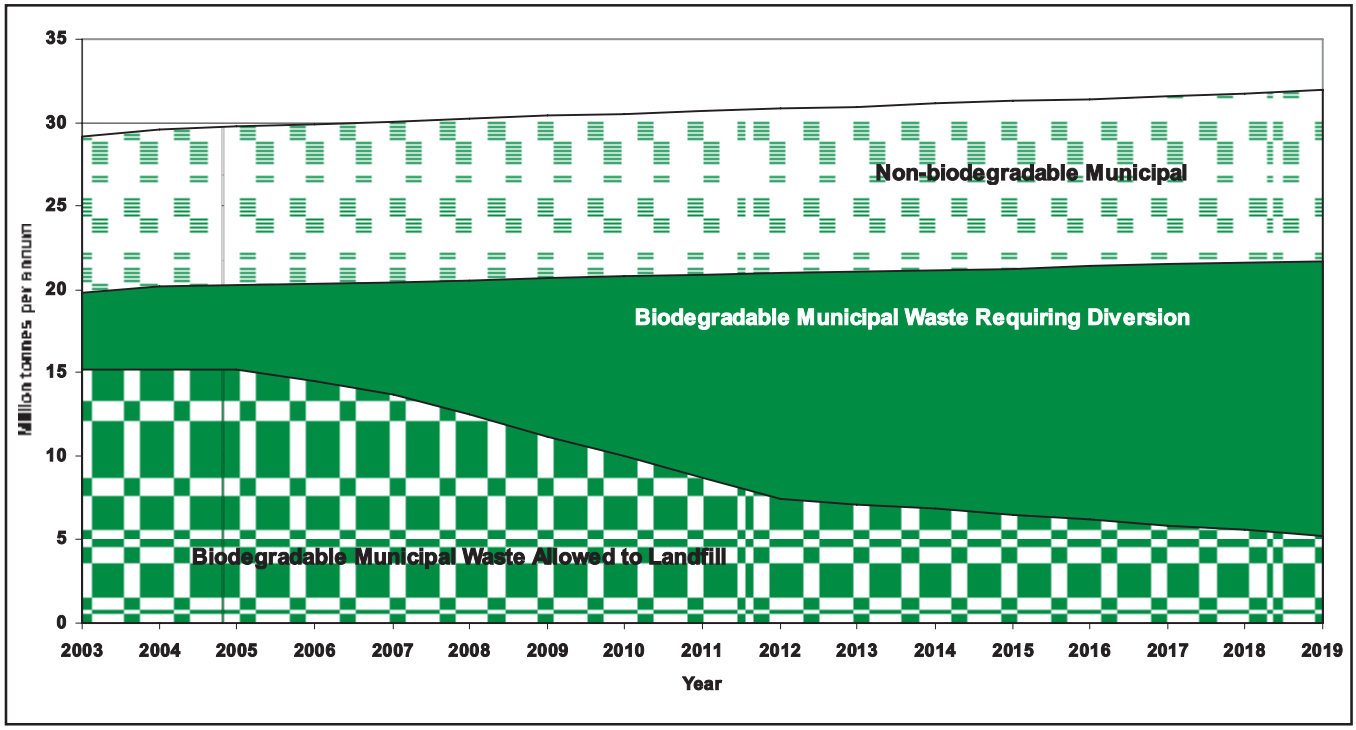
BMW levels allowed to landfill	Target year for UK
75% of 1995 quantities	2009/10
50% of 1995 quantities	2012/13
35% of 1995 quantities	2019/20

These are challenging targets which are made more difficult to achieve because of the UK's historic reliance on landfill as a waste management option, and also because of the increasing quantity of MSW arisings. Failure to meet these targets will result in significant fines for the UK – anticipated to be in the order of £500,000 per day for non-compliance after the target date. These targets have been transposed into English law in the form of the Landfill Regulations 2002, and the Waste & Emissions Trading Act 2003. Data for the last 5 years suggests that MSW growth is around 0.5% per annum. Figure 2 shows the trend of increasing waste arising in England (assuming 0.5% annual growth) and the amount of BMW which will require diversion up until 2020.

6 See Renewable Energy and Waste Management in this Technology Brief series
7 E-Digest Statistics about: Climate Change http://www.defra.gov.uk/environment/statistics/globatmos/gagccukmeas.htm

Background

Figure 2: BMW Diversion & the Landfill Directive Targets



Source: Defra MSW data for England, assuming 0.5 % annual growth of MSW

The Government has introduced the Landfill Allowance Trading Scheme (LATS) as a flexible and cost effective way of enabling England to meet its share of the UK's targets for reducing the landfilling of biodegradable municipal waste under Article 5(2) of the EC Landfill Directive. All Waste Disposal Authorities (WDAs) have been allocated an annual allowance for the amount of BMW they can dispose to landfill up to 2020. The trading scheme offers authorities an alternative approach to targets by providing flexibility of banking, borrowing and trading allowances with each other. The Environment Agency is charged with monitoring WDA compliance with LATS. There is a £150/t penalty for every tonne of BMW landfilled that exceeds the number of allowances a WDA holds for that year. Supplementary penalties may also be imposed on local authorities that contribute to any breach of national landfill directive targets.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

The Landfill Directive

http://europa.eu.int/scadplus/leg/en/lvb/l21208.htm

The Landfill Regulations

http://www.defra.gov.uk/environment/waste/topics/landfill-dir/landfilldir.pdf

LATS

http://www.defra.gov.uk/environment/waste/localauth/lats/index.htm

Background

Waste Policy in England

In addition to the EC Landfill Directive and LATS there are wider environmental, legislative and economic reasons to reduce the quantities of wastes disposed of in landfills, including:

- Increasing priority of Government to deal with the threat of climate change and the role of sustainable waste management in reducing greenhouse gas emissions
- The need to shift the emphasis from waste management to resource management (i.e. to reduce the consumption of materials and energy and to deal with waste as a potential resource of recyclable materials and recoverable fuels) is an important central theme of the sustainable development agenda as described in the EU Thematic Strategy and Waste Strategy for England 2007
- Waste generation is a Government headline indicator for sustainable development and there are additional indicators for disposal to landfill
- The recognition of the potential of waste management treatment processes as contributors to renewable energy and security of energy supply
- The Statutory Best Value Performance Indicators, which promote higher composting and recycling rates for household waste
- Financial incentives to seek alternatives to landfill. The Landfill Tax rose to £24/tonne in April 2007 and is due to rise by £8/year until at least 2010
- The Household Waste Recycling Act 2003 includes a requirement for all households to have kerbside collection of recyclables for at least two materials, where practicable, unless alternative comparable provision is made

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Strategy for England 2007 and supporting annexes

http://www.defra.gov.uk/environment/waste/ strategy/strategy07/index.htm

Guidance on developing municipal waste management strategies

http://www.defra.gov.uk/environment/waste/management/guidance/mwms/pdf/mwms.pdf

Sustainability / Sustainable Development

http://www.sustainable-development.gov.uk/

The Landfill Tax

http://www.hmce.gov.uk/businesses/moretma.shtml

Best Value Performance Indicators

http://www.defra.gov.uk/environment/waste/localauth/perform-manage/index.htm

Strategy and Option Development

There are a wide variety of alternative waste management options and strategies for dealing with MSW to limit the residual amount left for disposal to landfill. This section provides an introduction to these alternative options each of which has its own strengths, weaknesses, risks and benefits. There are many technical and local variations in how waste is managed. Readers seeking further and more detailed information should consult the contacts and recommended websites at the end of each section.

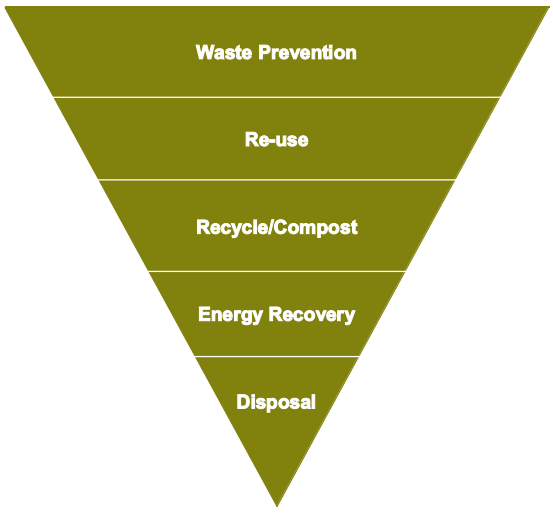
The Hierarchy of Options

One of the guiding principles for European and UK waste management has been the concept of a hierarchy of waste management options, where the most desirable option is not to produce the waste in the first place (waste reduction and prevention) and the least desirable option is to dispose of the waste with no recovery of materials or energy. Between these two extremities there are a wide variety of waste management options that may be used as part of a waste management strategy to recover materials (for example furniture reuse, glass recycling or green waste composting) or generate energy from the wastes (for example through incineration, or fermenting biodegradable wastes to produce usable gases). The role of each of these options is introduced within this guide.

The waste hierarchy (an example of which is shown in Figure 3) is only intended as a guide and should be used in conjunction with life-cycle thinking and with decision making principles as described in the Government's guidance on strategic and spatial planning, specifically:

- Waste and Resources Assessment Tool for the Environment (WRATE), a 'Life Cycle Assessment' (LCA) software tool for comparing different management systems treating Municipal Solid Waste (MSW)
- Guidance on Municipal Waste Management Strategies (DEFRA, July 2005)
- Planning Policy Statement 10: Planning for Sustainable Waste Management (Communities and Local Government, July 2005)
- Companion Guide to Sustainable Waste Management (Communities and Local Government, June 2006)

Figure 3: Waste Hierarchy Diagram



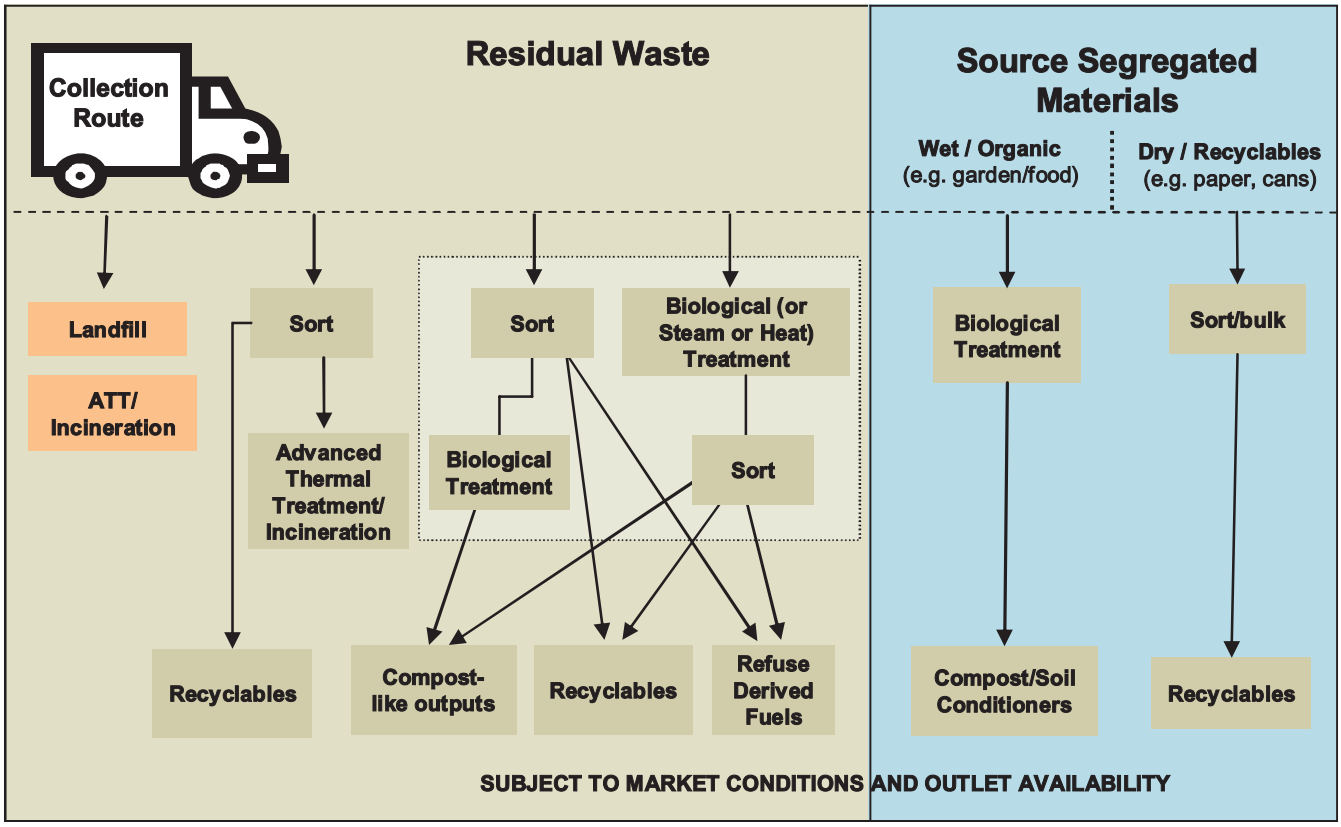
Source: Waste Strategy for England 2007

Strategy and Option Development

Waste recovery and disposal options

After reduction and reuse initiatives have taken place, material and energy recovery is required followed by disposal of any remaining waste. How MSW is managed is linked to the collection systems in place to collect waste and materials from the kerbside. In figure 4, the right side of the diagram illustrates the options that are available to local authorities for collecting materials sorted by the householder for recycling and composting (known as 'source segregated' materials). The left side of the diagram illustrates the options available for managing the remaining, residual MSW.

Figure 4: Options for Recovery & Treatment of Municipal Solid Waste



This diagram excludes residues sent directly to disposal from treatment processes and other rejects from the processes which will typically be sent to landfill. There are almost always rejects for disposal from all recycling, composting and treatment processes. Materials which fail in the marketplace are also likely to be sent for disposal.

The rest of this guide describes the main options available for managing MSW, and the role they have in diverting BMW from landfill.

Strategy and Option Development

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

The Waste Hierarchy

http://www.defra.gov.uk/environment/waste/topics/index.htm

EU Thematic Strategy on Waste

http://www.defra.gov.uk/environment/waste/thematicstrat/index.htm

Guidance on Municipal Waste Management Strategies

http://www.defra.gov.uk/environment/waste/localauth/pdf/guidemunwaste-strategy.pdf

Planning Policy Statement 10

http://www.communities.gov.uk/index.asp?id=1143834

WRATE

http://www.environmentagency.gov.uk/wtd/1396237/

Prevention and Re-use

Prevention

Managing waste places an environmental, social and economic burden on society. Taking steps to prevent waste from being produced in the first place saves natural resources and reduces the burden of waste management. MSW quantities have historically grown by around 1.5% a year, although the average annual rate of growth over the last 5 years has reduced to around 0.5%. There are a number of reasons for this increase, including: the changing demographics of society such as more people living on their own leading to increased waste arisings per person; increased levels of packaging on products and the consumer based 'disposable' society.

Measures which can be used to reduce waste arisings include: changing householder behaviour, for example by promoting the purchase of products with less packaging or encouraging the use of alternatives which reduce the amount of waste entering the waste stream such as providing compost bins to householders with gardens . Initiatives such as developing home composting will tackle directly the organic, biodegradable components of MSW. The promotion of services to reduce unwanted direct mail and the quantity of paper packaging used with in products will also target the biodegradable materials in MSW.

There are a wide variety of initiatives to promote and support waste reduction, delivered by local authorities in the UK. There is also assess to support for waste reduction initiatives either through the promotion of good practice or by providing access to funding, including projects implemented and managed by:

- Waste & Resources Action Programme – working with retailers and their supply chain to encourage waste reduction and recycling; managing a Home Composting Campaign working with local authorities in England and Scotland to encourage householders to purchase compost bins at a subsidised price and providing advice;
- Eco-Schools, a programme of assistance to schools to enable them to analyse their operations and become more sustainable
- Envirowise providing waste minimisation advice to businesses
- Business Resource Efficiency and Waste (BREW) Programme, providing advice and support to business on improving resource efficiency measures, minimising waste production and improving its bottom line

Prevention and Re-use

Re-use

If waste generation cannot be prevented then the next best option is to reuse relevant materials. 'Reuse' means the application of the waste material, product or appliance for the same purpose as was originally intended, by the same or another user. An example of this would be the reuse of furniture collected by a local authority or deposited at a Household Waste Recycling Centre (HWRC). Often waste materials such as discarded electrical goods, furniture, bicycles and similar consumer goods will require repair or some form of safety check to ensure that they are appropriate for reuse by another consumer. The third sector (e.g. community groups) has demonstrated good practice in this area of work. Clothing reuse is most often carried out via charity shops and larger charity organisations such as the Salvation Army. The reuse of furniture, for example, would have a positive impact on the residual waste stream as this would result in less BMW remaining for disposal (wood is considered to be 100% biodegradable and textile / fabrics 50% biodegradable). Households can also reuse materials to avoid or delay them entering the waste stream, for example by reusing glass jars and carrier bags.

Community and charity groups often fulfil their social and environmental aims through the reuse of waste, providing useful items to those most in need in their local area. The Furniture Reuse Network has around 400 member organisations which aim to reduce poverty by helping households in need access furniture, white goods and other household items at affordable prices. Many of these schemes also provide training and employment opportunities for the community.

Where materials are used as a raw material for a new product (i.e. reprocessed in a production or manufacturing process for the original purpose, or for other purposes), this is known as Recycling.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

WRAP

http://www.wrap.org.uk/

National Industrial Symbiosis Programme

http://www.nisp.org.uk

Community Composting Network

http://www.comunitycompost.org

Community Recycling Network

http://www.crn.org.uk

Furniture Reuse Network

http://www.frn.org.uk

Community Repaint Network

http://www.communityrepaint.org.uk

Recycling and Collection Systems

Source Segregated Materials for Recycling

The term 'Recycling' means to reprocess a waste material into a usable item either in the same form as the original product or into a different product. To achieve recycling, the appropriate waste materials (recyclables) must be separated from the mixed waste stream. This separation can be achieved in a number of different ways, for example, householders can take the materials to dedicated facilities (known as bring or 'drop – off' sites) such as bottle or paper banks or to Civic Amenity sites (increasingly known as Household Waste Recycling Centres). Alternatively the materials may be collected directly from households in separate containers (source segregated collections of recyclables) or extracted from, residual MSW by a echanical and possibly manual sorting process. However the collection of recyclables represents just the first stage in the recycling process. These recyclables may need further sorting and bulking before they are transported to reprocessors to be converted into new products or into an appropriate feedstock material for a manufacturing process.

The Government has set statutory recycling and composting targets for local authorities in England to encourage increasing levels of recycling across the country and national recycling levels have improved significantly in response. The Household Waste Recycling Act 2003 requires all waste collection authorities to provide kerbside collections for at least two materials from all households, where practicable, and unless equivalent alternative arrangements are in place, by 2010. Over the last few years considerable investment has gone into recycling schemes with England achieving a recycling rate of 27% in 2005/6. *Waste Strategy for England 2007* sets higher national targets for the recycling and composting of household waste of at least 40% by 2010, 45% by 2015 and 50% by 2020.

Technical advice and support is available to local authorities to help them develop and implement segregated collection systems for recyclables and organic wastes from the WRAP Recycling and Organics Technical Advisory Team (ROTATE). Further support and advice is available through the Local Authority Recycling Advisory Committee (LARAC) which promotes waste reduction and recycling, through networking, information provision, campaigning and advocacy.

The following paragraphs explain the types of collection systems available for collecting materials at source. The way materials are collected will influence requirements for further sorting or bulking prior to sale into the marketplace or biological treatment and will impact on the quality of the materials and the markets into which they can be sold.

Collection systems for dry materials

Bring Sites and HWRC Collection Options

Recyclables deposited at bring sites or Household Waste Recycling Centres (HWRCs) are usually segregated by types of material: for example all paper goes into one bank, all green glass into another, cans into another. As a result of this segregation, there is a minimal requirement for further sorting of these materials before they are reprocessed into new materials or products. In this instance, a local authority may only require a bulking station to 'bulk up' materials for transport and logistical reasons, before sending the materials direct for reprocessing or to a materials broker. For materials such as mixed paper and mixed glass there may be further sorting into different grades at specialist facilities.

Recycling and Collection Systems

Kerbside Collection Options

For recyclables collected from the household, there are a variety of possible collection options which fall into the following alternatives, each of which require different supporting infrastructure to process the collected recyclables:

Single Material Collections

The local authority will supply a single container – or the household is asked to supply a container such as a plastic carrier bag - for the collection of specific materials. This material may be appropriate for bulking and direct sale to a reprocessor without further sorting, or some limited mechanical sorting may be used to refine the material quality. This system was more popular when recycling systems were first introduced and when many local authorities collected only one material, typically paper. However, as recycling schemes have expanded some authorities have chosen to provide a separate collection of a single material where it has not been feasible to add this material to their multi-material collection scheme, for example, glass.

Co-mingled Collections

The term co-mingled means that all recyclable materials targeted by the collection scheme are placed in the same container (box, sack or wheeled bin) by the householder and are collected (co-mingled) in a single compartment vehicle and delivered to a Materials Recovery Facility (MRF) for sorting. Some authorities operate two stream collections whereby households are provided with one or more containers into which specified mixed recyclables are placed for regular collection – either the glass or the paper can be kept separate from the other materials. These materials are collected in two compartment vehicles in order to keep the glass or the paper separate and are delivered to a MRF for sorting In some schemes, households are asked to provide one of their own containers, such as a plastic carrier bag for collection of paper.

This type of collection system requires a specialist facility to sort the recyclables into separate material types and to prepare them for sale to reprocessors. This is known as a Materials Recovery Facility (MRF) or is sometimes referred to as a Materials Recycling Facility.

Kerbside sorting collections

As with co-mingled collections a container is provided to householders for the targeted recyclables which are then sorted into constituent materials at the kerbside (i.e. from the box outside the household) by the operatives of a specialist collection vehicle. This is a more labour intensive process in terms of the collection operation compared with a co-mingled collection scheme. However, generally a MRF is not required and it has benefits in terms of ensuring that a higher quality of material is usually collected.

Recycling and Collection Systems

Mixed Waste Collections

Recyclables may also be extracted from the mixed MSW (normal residual or 'black bag' waste) through separation and treatment processes. These types of systems are described later in this guide and include Mechanical Biological Treatment and Mechanical Heat Treatment. The amount of recyclables extracted from these systems is likely to be limited and of a lower quality (in most instances) than recyclables collected through dedicated source segregated collection systems. However, combined with some form of source segregated collection system, the additional materials recovered from mixed wastes can enhance overall recycling rates.

Collection Systems for organic materials (biowaste)

Bring Sites and HWRC Collection Options

Garden (or green) waste can be deposited by householders at bring sites or HWRCs into designated containers. Good signage is required to reduce contamination from non-biodegradable material, such as plastic bags. The waste is usually composted in open windrows.

Kerbside collection options

The challenges of meeting the statutory recycling and composting targets, as well as the Landfill Directive BMW diversion targets, have led many local authorities to give priority to the biodegradable wastes contained within MSW through separate collections of garden waste, and in some instances, food waste (or kitchen waste). These wastes are typically collected in wheeled bins or sacks and may involve a specialist collection vehicle. Authorities are developing a range of different schemes, some collecting garden waste only, food waste and garden together, and sometimes food waste separately. These wastes are known as 'biowastes'.

WRAP has published the findings of two studies into the management of household biowaste covering the:

- Cost and benefits of different approaches to biowaste collection and management
- Cost and environmental implications of different methods for collecting and treating food waste

The main finding of the work is that there are real benefits to local authorities in terms of cost and capture of biowaste if both the collection and processing costs are considered together. Mixing food waste with garden waste in kerbside collections should be avoided if possible as it adds significant processing costs and may not result in significantly higher biowaste diversion rates if collected on a fortnightly basis. For further information see the reports on the WRAP website[8].

Methods for increasing recycling rates

There are a number of methods local authorities can use to further increase their recycling rates. These include:

- Introducing / expanding kerbside collection schemes to more households
- Collecting more recyclable material streams (such as garden waste and kitchen waste)
- Increasing householder participation/ container set-out rates

[8] http://www.wrap.org.uk/local_authorities/biowaste.html

Recycling and Collection Systems

- Reducing the level of contamination in the materials collected
- Maximising the capture rate: increasing the amount of a particular material that is collected

Markets for Recyclables

It is essential to have secure markets for materials collected for recycling, as material can only be deemed to have been recycled once it is beneficially incorporated into new products. The market for the sale of recyclables can fluctuate considerably, although improved price stability has been experienced in recent years. As more material comes onto the market with improved local authority recycling rates, it is likely that quality issues and the capacity of the market to accept these additional materials will become increasingly important. In 2001, the Government established the Waste & Resources Action Programme (WRAP) to address these market issues and stimulate new markets for recyclates. This programme continues to work in the development of markets.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

WRAP Good Practice Guides

http://www.wrap.org.uk/local_authorities/toolkits_good_practice/index.html

Local Authority Support Unit

http://www.defra.gov.uk/environment/waste/wip/support/index.htm

WRAP ROTATE:

http://www.wrap.org.uk/local_authorities/rotate/index

Waste and Recycling Beacon Case Studies

http://www.beacons.idea.gov.uk/idk/core/page.do?pageId=5148277

RecycleNow Partners Developing Recycling Communications campaigns

http://www.recyclenowpartners.org.uk/

Mechanical Sorting and Processing

Mechanical techniques may be used to sort co-mingled recyclates into separate material streams or may be used to separate mixed MSW into different fractions. Mechanical sorting and processing techniques are used, to some extent, in conjunction with most residual waste treatment technologies. Mechanical methods may be combined with manual sorting in the form of picking lines where materials are hand picked and sorted from a co-mingled materials stream. Manual sorting should only be undertaken on appropriate waste streams and using adequate protective equipment and environmental controls. Mechanical sorting techniques are typically based on conveyor systems for moving the materials around the treatment facility, with various processes to sort materials by size and density.

Sorting of Co-mingled Recyclables

The sorting of co-mingled materials, where materials such as cans, plastic and paper are collected from the kerbside in the same vehicle, is required to sort the recyclables into different material fractions. Sorting separates materials according to their physical properties using equipment such as magnets, screens and trommels. Usually manual sorting is included as well as mechanical sorting if source segregated materials are being sorted. The sorting process takes place in a Materials Recovery Facility (MRF). As a greater range of materials are now collected at the kerbside compared with a few years ago, more advanced equipment is used in some MRFs, capable of separating glass from paper, different types of plastic, or paper from plastic.

WRAP has issued some guidance on MRFs that draws on good practice in MRF design and operations from the USA and Europe and has undertaken some work to better understand the contractual arrangements in place between local authorities and their MRF contractors. A MRF costing tool also is available from WRAP.

Sorting and Processing of Residual MSW

There are a variety of techniques which may be used to separate residual MSW into different fractions and the purpose of this may be:

1. To extract recyclable material;

2. To separate out an organic rich fraction (high in BMW) for biological processing; or

3. To produce a fraction with a high calorific value (good combustion properties) to be used as a fuel.

To render the waste more suitable for separation techniques it must first be prepared. Preparation techniques release the waste from the bags it is contained in and reduces the size of the waste. The type of mechanical preparation process used depends on the desired outputs from the overall treatment process. For example, a bag splitting process may be used if the objective is to maximise the recovery of recyclables, where as a more aggressive hammer mill may

Mechanical Sorting and Processing

be used to significantly reduce the size of the waste for fuel production. A complex mechanical sorting system may be used to divide the residual waste into several fractions. There will always be a reject fraction requiring disposal to landfill from MSW processing operations.

It is important to note that there will be some contamination of the different waste fractions sorted through mechanical means from a residual MSW stream. The degree of contamination can be mitigated by the addition of another treatment process (for example partially composting or 'drying out' of the waste, see Mechanical Biological Treatment), or steam treatment, see Mechanical Heat Treatment) and / or intensive mechanical pre-processing through for example, pulverising the wastes down to a more regular sized stream that is more amenable to some of the mechanical sorting processes.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre

http://www.environment-agency.gov.uk/wtd

Defra Waste Technology Guides

http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Materials Recovery Facility Guidance

http://www.wrap.org.uk/local_authorities/toolkits_good_practice/materials.html

Biological Treatment

All biological waste treatment processes involve the decomposition of biodegradable wastes by living microbes (bacteria and fungi) which use the biodegradable waste materials as a food source for growth and proliferation. There are two main types of conditions in which microbes live and therefore two main classes of biological treatment processes:

- Aerobic digestion (or composting) – in the presence of oxygen
- Anaerobic digestion – in the absence of oxygen

These treatment processes can be used for both source segregated organic waste and for the biodegradable fraction of residual MSW, are described below.

Aerobic Digestion

Aerobic digestion, otherwise known as composting, is a biological process in which biodegradable wastes, such as garden and food wastes are decomposed in the presence of oxygen present in air under the action of micro-organisms such as bacteria and fungi. For composting to occur in an optimum manner, five key factors need to be controlled by the process: temperature, moisture content, oxygen concentration, material porosity and the relative amounts of nutrients such as carbon and nitrogen in the material (the Carbon: Nitrogen ratio). The process results in elevated temperatures of the waste, the production of carbon dioxide (like methane, carbon dioxide is a greenhouse gas, but much less potent than methane) water/leachate and a stabilised residue. The carbon dioxide produced from composting is regarded as 'biogenic'. The amount emitted to the atmosphere is equivalent to that adsorbed during its lifetime when the plant matter is growing.

Aerobic digestion can be undertaken on source segregated waste or the organic, biodegradable fraction of residual MSW. The quality of the stabilised residue should be higher for source segregated material and a wider range of markets are available for the resulting compost, which may be marketed as a growing media, soil conditioner or mulch, depending on quality and the physical character of the material. The residue from composted mixed waste will have fewer end market options due to its lower quality. To distinguish it from compost from 'clean' waste the residue is referred to as a compost-like-output in this guide. For more information on the treatment of residual MSW see the technologies described later in this guide.

The composting process is operated according to the types of materials accepted at the facility. If both garden and food waste are composted together (either source segregated or from mixed MSW), stricter rules apply to both the process conditions and end markets for the compost and compost-like outputs. This is due to the potential risks to animals and human health from the transfer of diseases from meat wastes into the environment. These controls are specified by the Animal By-Products Regulations, which are regulated by Animal Health (formally known as the State Veterinary Service).

WRAP deliver an organics initiative under the Defra Waste Implementation Programme, which provides technical advice and training to those active in the composting sector. It has capital funds to help develop new processing capacity for biodegradable waste and is working to develop applications and markets for waste-derived compost.

Biological Treatment

Compost Techniques and Technologies

Composting processes primarily fall into two categories: windrow composting, for garden derived wastes, and 'In-vessel' composting, which is required to process material containing food waste, which has either been collected with garden waste or for the organic fraction mechanically recovered from mixed MSW.

Windrow composting is an established technique for dealing with collected garden wastes in the UK. The material is shredded and then piled in elongated rows, called windrows, and aerated through either turning of the windrows or by air forced through the material. There are many on-farm composting facilities accepting municipal green waste plus an increasing number of centralised, larger composting facilities. Windrow composting generally takes place outdoors and is the least costly form of aerobic digestion. There are other techniques, such as static pile composting, where air is forced through the waste mass to promote biodegradation. Windrow composting is however by far the most prevalent composting technique used in the UK.

In-vessel composting (IVC) embraces a variety of techniques whereby source segregated biowastes or the organic fraction from mixed MSW are initially composted in an enclosed vessel or tunnel, followed by a period of further composting outdoors. The advantage of these processes is that the vessel is designed to achieve and maintain specified temperatures to facilitate pathogen destruction in accordance with the requirements of the Animal By-Products Regulations. This legislation governs the management of wastes arising from animal sources, including food and catering wastes, to prevent animal by-products from presenting a risk to animal or public health through the transmission of disease. As local authorities strive to divert increased quantities of BMW, it is anticipated that UK experience in IVC will significantly increase in the near future.

Compost Markets

The markets available for compost depend on whether the input material was source segregated or from residual MSW, the quality of the resulting compost and the demand for different products. Outputs from facilities processing source segregated waste is usually screened and graded to produce composts, soil conditioners and mulches and is suitable for use in a number of sectors including:

- Land restoration and soft landscaping
- Domestic use in gardens
- Agriculture and horticulture

The activities of the Waste & Resources Action Programme (WRAP) have resulted in the development by the British Standards Institute of a Publicly Available Specification for composted materials (BSI PAS 100). The

purpose of the specification is to increase consumer confidence in buying compost. Compost producers who are PAS 100 certified produce a 'quality compost', by processing source segregated organic waste. The Composting Association is responsible for providing third party assessment and conformity with PAS 100.

A Quality Protocol for Compost developed by WRAP, the Environment Agency and other key players in the industry sector, sets out the criteria for the production of quality compost from source segregated biowaste like food and garden waste. If compost is produced according to these criteria the compost produced is no longer regarded as a waste and can be spreads to land without the need to register with the Environment Agency for a waste exemption. Compost not produced according to the protocol is still considered to be waste, including any output from non-certified composting sites (e.g. sites which are not PAS 100 certified) and any facility processing the organic, biodegradable fraction from residual MSW.

The output from a composting facility processing the organic fraction from residual MSW is not deemed to be suitable for application to agricultural land. Whilst it is sometimes referred to as a soil conditioner by some technology suppliers, the term compost-like-output distinguishes it from 'quality compost'. It can potentially be used to remediate land but would need to demonstrate ecological improvement and a waste management licence exemption would be required from the Environment Agency. Alternatively it can be disposed to landfill, although is likely to have residual biodegradability which would have to be measured and would count towards the landfill allowance scheme (LATS).

Anaerobic Digestion

Anaerobic Digestion (AD) is a biological process where biodegradable wastes, such as food waste or the mechanically separated organic rich fraction of MSW, are converted into a 'digestate' and biogas. The wastes are decomposed by microbes in the absence of oxygen – different to composting which is an aerobic process, taking place in the presence of oxygen. AD systems are enclosed, engineered vertical or horizontal vessels. The biodegradable material is macerated and water is often added to provide suitable moisture and flow properties. Waste remains in the vessels for 2 -3 weeks and reaches temperatures of up to 60 °C. As the waste degrades, biogas is produced, comprising mainly methane and some carbon dioxide. This is collected in tanks and used on or off site. Biogas can be used in a number of ways but is usually burned to produce electricity; the heat from the process may be utilised on site of by neighbouring users. Excess electricity not required by the plant can be exported for distribution in the grid and excess heat can be used for district or industrial heating.

AD is used in the UK for treating agricultural manures and slurries, as well as sewage, however there is limited experience on its application to municipal biowastes in the UK. The Defra New Technologies Demonstrator Programme has partly funded the development of a demonstrator plant in Shropshire to process predominantly source segregated food waste and garden waste. There is also a commercial scale AD facility in Leicestershire treating the mechanically separated organic fraction of residual MSW. There is considerable interest in this technology as an option to help meet the landfill diversion obligations and to generate renewable electricity.

Biological Treatment

Anaerobic digestion is particularly suited to treating source segregated food waste. It is not particularly suitable for treating garden only collections although co-mingled garden and food waste can be treated (providing there is sufficient food waste in the mix). The research by WRAP, referred to previously, concluded that of the treatment options available for collected food waste, from an environmental perspective AD is likely to fare the best.

The residue from AD (digestate and liquor) can be applied to land subject to obtaining regulatory approval. The latter point is an important one and the quality of the output from the process will dictate its potential application. If digestate is produced from source segregated biowaste it can count as 'composting' under the statutory recycling and composting targets. Facilities accepting food waste will be subject to the controls that are specified by the Animal By-Products Regulations.

Outputs from the Process

Solid, liquid and gas components are typically generated by an AD process. These outputs are described below:

Digestate and liquor

Due to the high moisture content of the wastes entering the process, the outputs from an AD process can have a high moisture content. The digestate is stored in a storage tank before it is mechanically pressed into solid and liquid fractions. The solid fraction can be used directly on land or aerobically treated to produce a compost /compost-like output.

The use of both the digestate and the liquor will depend on the quality of the input material and the management and operation of the process. Digestate products generated from source segregated biowaste can be used in the same way as compost. When the mechanically separated biodegradable

Biological Treatment

fraction of residual MSW is digested it is unsuitable for application to agricultural land. It can potentially be used to remediate land but would need to demonstrate ecological improvement. Alternatively it can be disposed to landfill, although is may have some residual biodegradability which will need to be measured.

Biogas

The biogas (mostly methane and some carbon dioxide) produced during this process can be sold as fuel or combusted to generate electricity, for example, in gas engines. The sale of this electricity will be eligible for Renewables Obligation Certificates (ROCs) which can provide an additional income stream. ROCs provide a financial incentive for the production of electricity from renewable sources. Information on renewables is available from the DTI and trading of ROCs are administered by the Non-Fossil Purchasing Agency.

There is more information on both aerobic digestion and anaerobic digestion within the separate Technology Brief on Advanced Biological Treatment (ABT) in this series, available on the Defra New technologies web pages.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre

http://www.environment-agency.gov.uk/wtd

Defra New Technologies Demonstrator Programme

WRAP, ROTATE and the Organics

programme http://www.wrap.org.uk/

ABT Technology Brief

http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Animal By-Products Regulations

http://www.defra.gov.uk/animalh/ by-prods/legislation.htm

Animal Health

http://www.defra.gov.uk/animalhealth/inspecting-and-licensing/abp/index.htm

The Composting Association

http://www.compost.org.uk/

Renewables Obligation

http://www.dti.gov.uk/energy/sources/renewables/index.html/

Non-Fossil Purchasing Agency

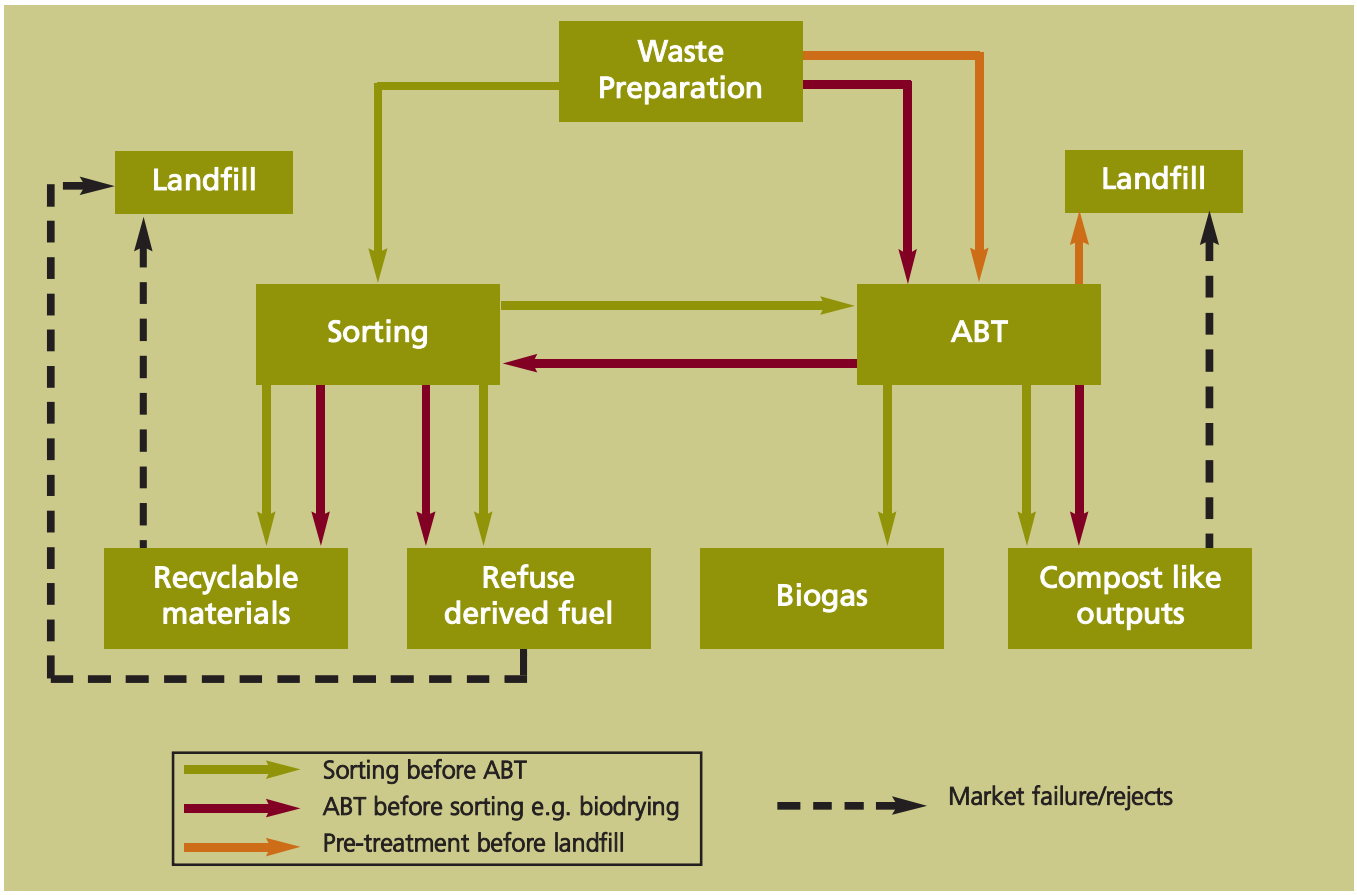
http://www.nfpa.co.uk/

Mechanical Biological Treatment

Mechanical Biological Treatment (MBT) is a generic term for an integration of several processes commonly found in other waste management technologies such as Materials Recovery Facilities (MRFs), sorting and composting or anaerobic digestion plants. MBT facilities always contain both mechanical and biological processes and are used to treat residual MSW. The first MBT plants were developed with the aim of pre-treating waste, reducing the environmental impact of landfilling residual waste. MBT therefore compliments, but does not replace, other waste management technologies such as recycling and composting as part of an integrated waste management system.

MBT plants may be configured in a variety of ways to achieve the required recycling, recovery and BMW diversion performance. In its simplest form, MBT provides a drying and mass reduction operation for residual waste prior to landfill, however this approach is unlikely to achieve significant BMW diversion performance unless further biological treatment is undertaken. Other MBT systems are designed to treat and separate residual MSW into useable fractions of materials and/or a waste fuel for energy recovery. Figure 5 below illustrates the potential options for MBT. Following waste preparation, the waste is either sorted first or undergoes biological treatment first. ABT is short for Advanced Biological Treatment and includes both aerobic and anaerobic techniques.

Figure 5: Mechanical Biological Treatment options



Mechanical Biological Treatment

Mechanical Treatment

Prior to mechanical sorting, waste preparation is required to release the contents of the bags and reduce the size of the waste materials. Techniques used include bag splitting, hammer mills and ball mills.

The mixed waste is sorted by a series of mechanical separation techniques into different fractions. The number of fractions and their composition will be influenced by the markets and outlets available, and the overall performance objective of the facility. The most common fractions obtain are:

- Recyclables – such as metals and sometimes glass/stones to use as an aggregate substitution
- A biodegradable fraction – containing the majority of food waste, garden waste and fines material
- A high calorific, combustible fraction – rich in plastic and paper and card
- A reject fraction – material which is unsuitable for further treatment, perhaps because it is oversize or is a household product such as an electrical item

Treatment options and outputs

Biological treatment can either take place on the whole of the waste or on the separated biodegradable fraction. If all of the residual MSW is biologically treated, a process known as biodrying is often used. This is a form of in-vessel composting and dries the waste, reducing the moisture content making it easier to separate the waste into different fractions. The process usually only takes a maximum of 2 weeks and does not significantly reduce the biodegradability of the waste and the waste is only partially stabilised. The majority of this material is often intended to produce Refuse Derived Fuel (RDF). Alternatively, the waste can be treated for a longer period of time to reduce its biodegradability and disposed to landfill.

When the waste is sorted first, the mechanically separated biodegradable fraction is either composted or undergoes anaerobic digestion. These processes take longer and the objective is to reduce the volume of the waste and to reduce its biodegradability significantly. The material can be regarded as a compost-like output, which can be applied to land under certain circumstances if it meets the regulatory requirements. Currently this outlet is limited since the Environment Agency considers it to be unsuitable for agricultural land[9]. It could be used to remediate poor quality land by contributing to topsoil manufacture, as long as an ecological benefit can be demonstrated. Alternatively the material can be disposed to landfill. The Environment Agency has developed guidance for operators on how to measure the reduction in biodegradability that has taken place through biological treatment. This information could help an authority achieve allowance allocations under the landfill Allowance Trading Scheme (LATS), however the testing regime is not a statutory requirement currently.

9 http://www.environment-agency.gov.uk/commondata/acrobat/mbt_output_guidance_1149762.pdf

Mechanical Biological Treatment

The Government has identified 6 potential outlets for RDF:

1. Industrial intensive users, for power, heat or both (combined heat and power, CHP)

2. Cement kilns

3. Purpose build incinerators with power output or CHP

4. Co-firing with coal at power stations

5. Co-firing with biomass fuels

6. Advanced thermal treatment technologies such as gasification and pyrolysis

The main current example of co-combustion in the UK is the burning of RDF in cement kilns although other markets are developing. Waste contractors are developing relationships with the cement industry and others to try and meet their specifications and provide a useful industrial fuel and waste recovery operation.

MBT plants are well established in mainland Europe and are becoming operational in the UK. Many Local Authorities are considering MBT as a technology choice for treating residual waste and planning permission has been granted for several facilities treating a considerable tonnage of MSW. There is more information on MBT within the separate Technology Brief in this series, available on the Defra New technologies web pages.

Mechanical Heat Treatment

Mechanical Heat Treatment is a relatively new term used to describe configurations of mechanical and thermal, including steam, based technologies. The generic purpose of these processes is to separate a mixed waste stream into several component parts, to give 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.

The most common system being promoted for the treatment of MSW using MHT is based around a thermal autoclave. Autoclaving has been used for many years to sterilise hospital and surgical equipment using the action of steam and pressure. This technology is also in common use for the sanitisation treatment of some clinical wastes, and for certain rendering processes for animal wastes, prior to sending to landfill. However its application to MSW is a recent innovation and there is limited commercial experience on this feedstock material.

A second type of MHT system is a non-pressurised heat treatment process, where waste is heated in a rotating kiln prior to mechanical separation.

Most processes carry out a basic initial screening to remove any large items from the waste stream unsuitable for further processing in the system; for example, large metal objects, rubble or particularly bulky or difficult items such as carpets. Several processes then shred the waste to homogenise the particle size. The waste is then loaded into the heat treatment vessel. The steam process 'cooks' the waste to:

- Breakdown biodegradable materials, including paper and card, into a fibre or floc
- Clean glass bottles and cans and disintegrate the glue;
- Plastics are softened and labels are removed. Certain types of plastics are deformed by the heat, but remain in a recognisable state, whereas other plastics soften completely forming hard balls of dense plastic.

The cleaning action of the steam is said to make materials more suitable for recycling, although the limited commercial track record of these technologies for MSW processing should be a consideration when discussing markets or outlets for the outputs. The fibre (sometimes called floc) is promoted to be suitable for recycling into construction products, use as RDF or can be biologically treated to reduce its BMW content prior to landfill. Although there are many options for managing the outputs from MHT they are all dependent on availability of sustained markets and outlets.

There is limited experience in the application of MHT to MSW treatment. There are no commercial UK facilities currently (this may change over the next year) although there are some smaller scale demonstrator facilities. Most commercial experience is derived from a facility in the USA. There is more information on MHT within the separate Technology Brief in this series, available on the Defra New technologies web pages.

Thermal Treatment

Incineration

Incineration involves the combustion of unprepared residual MSW or RDF. All incinerators in the UK recover energy from waste in the form of electricity and/or heat. To allow the combustion to take place a sufficient quantity of oxygen is required to fully oxidise the fuel. Incineration plant combustion temperatures are in excess of 850°C and the waste is mostly converted into carbon dioxide and water. Any non-combustible materials (e.g. metals, glass, stones) remain as a solid, known as Incinerator Bottom Ash (IBA) that always contains a small amount of residual carbon.

Waste is combusted under controlled conditions, to reduce its volume and hazardous properties, and to generate electricity and / or heat. There are currently 19 plants in the UK and England disposed of 2.8 million tonnes of MSW through incineration in 2005/6.

Recovery of energy from residual waste, including by incineration, is compatible with a high recycling strategy. The key to striking the right balance lies in early consultation between stakeholders when local waste strategies are being developed, and in suitably flexible facilities and contracts – i.e. that do not 'lock in' fixed amounts of waste. In mainland Europe, Denmark and the Netherlands divert the most waste from landfill, achieving the highest recycling rates and recovering energy from residual waste.

All waste incineration plant must comply with the Waste Incineration Directive. This Directive sets the most stringent emissions controls for any thermal processes regulated in the EU. The requirements of the Directive have been translated into the UK through The Waste Incineration (England and Wales) Regulations 2002[10] which came into force on 28 December 2002. The Directive imposes strict measures on the operating temperature and control measures for emissions. As a result all facilities have extensive air pollution control equipment to clean exhaust gases and are required to effectively manage the solid residues arising from a facility.

There are two principal solid residues from thermal treatment systems: the bottom ash, which is the solid remainder of the waste feedstock after processing (Incinerator Bottom Ash, IBA) and the treatment residues from the air pollution control process (Air Pollution Control, APC residues). The residues from stack emission control process are classified as hazardous waste and will require specialist treatment whilst the bottom ash may be recycled into appropriate construction applications or disposed of to landfill. Most facilities also recover metals for recycling from the IBA.

Moving Grate Plants

Modern incineration plant tend to use moving grate technology. This means the waste is slowly propelled through the furnace by a mechanically moved grate. Waste continuously enters at one end of the furnace and the ash is continuously discharged at the other. As the waste moves through the furnace (or combustion chamber) it undergoes complete combustion. The technology needs to be managed to ensure the necessary conditions for optimum combustion of the waste. The typical unit capacities of an incinerator plant range from 45 – 200,000 tonnes per annum. Site capacities may be up to 600,000 tonnes per annum (if more than one unit is used on a particular site).

[10]The Waste Incineration (England and Wales) Regulations 2002 (SI 2002 No, 2980). http://www.opsi.gov.uk/si/si2002/20022980.htm

Thermal Treatment

Fluidised Bed Technology

The combustion of MSW using a fluidised bed (FB) technique involves pre-sorting of residual MSW materials to remove heavy and inert objects, such as metals, prior to processing in the furnace. The waste is then mechanically processed to reduce the particle size. The combustion is normally a single stage process and consists of a lined chamber with a granular bubbling bed of an inert material such as coarse sand / silica or similar bed medium. This bed is 'fluidised' by air (which may be diluted with recycled flue gas) being blown vertically through the material at a high flow rate. Wastes are moved through the furnace by the action of this fluidised bed of particles. The UK has much less experience of managing MSW through this technology, although it is widely applied to sewage sludge. A new fluidised bed plant has recently been commissioned in Allington, Kent.

Other Kilns

Oscillating Kilns move waste through the furnace by a 'rocking' or oscillating action, shuffling waste through an inclined combustion zone. There is only one commercial scale facility in the UK using an oscillating kiln design, the 56,000 tpa facility at Grimsby. This plant uses technology more prevalent in France, which is appropriate for smaller scale facilities (25-60,000 tonnes per annum), in this instance incorporating combined heat and power (CHP). Smaller scale plant may be integrated into a more local solution for smaller communities. There is more information on Incineration within the separate Technology Brief in this series, available on the Defra New technologies web pages.

Advanced Thermal Treatment

There are a wide variety of Advanced Thermal Treatment (ATT) systems incorporating alternative heat based technologies for the treatment of residual MSW or prepared RDF. Both incineration and ATT liberate energy from waste and remove its biodegradability. These technologies differ in how the energy is liberated for recovery. Incineration combusts waste in an excess of air to directly release energy, whereas ATT systems treat waste in the absence of oxygen in a limited quantity of air to produce a syngas, which is used to generate energy. The most common ATT systems marketed for MSW fall under one of two groups. Pyrolysis or Gasification based processes, although both can be used sequentially, as part of the same ATT plant.

Pyrolysis

Pyrolysis, often incorporating gasification, is a medium temperature thermal process where organic derived materials in the waste are broken down under the action of heat and in the absence of oxygen. Pyrolysis is similar to the process which produces charcoal. Only carbon based materials can be pyrolysed. Where MSW is to be used it is normally pre-sorted to remove the majority of the non-organics and may be mechanically processed to homogenise the feedstock. A prepared Refuse Derived Fuel (RDF) from another appropriate process may also be used. The Pyrolysis process heats the waste, typically between 300-850°C, and breaks down plastics, paper and other organic derived materials to produce a gas (known as syngas). This gas may be condensed to produce a Pyrolysis Oil. The Pyrolysis Oil or the gas may be used as a fuel to generate electricity or in an engine. Flue

Thermal Treatment

gas clean up measures would be required for Pyrolysis facilities. A solid (Pyrolysis char) is also produced which may require specialist disposal or additional processing, for example in a Gasification process.

Gasification

Gasification operates at a higher temperature range than Pyrolysis, typically above 650°C. Air or oxygen is used to partially combust the waste to achieve higher temperatures. Gasification is equivalent to the process which produced 'town gas' from coal. Additionally for Gasification, water is added to the Gasifier, either as steam or as water included in the feedstock (in this case MSW or a fraction thereof). The high temperature causes, the water 'cracks' to produce hydrogen and oxygen. The oxygen reacts further with the carbon in the feedstock (waste) material. The differentiation between Pyrolysis and Gasification is the high concentration of hydrogen in the gas produced by the process. As with Pyrolysis the gas produced (Syngas) can be combusted to generate electricity (as described above). A solid residue (ash or slag) is also produced which usually requires disposal if no markets for recycling are available. Flue gas clean up measures would be required for emissions from Gasification facilities.

These ATT technologies are unproven for MSW on a commercial scale in the UK, and overseas experience is patchy. The Defra New Technologies Demonstrator Programme contains examples of ATT projects which will assist in demonstrating (or not) their suitability for residual MSW or RDF. There is potential for these systems to be components in an integrated municipal waste management strategy. Facilities may also be appropriate for processing specific 'problem' waste streams or to link in with other pre-processing MSW facilities such as MBT, as they are more suitable for pre-processed, homogenous waste streams (i.e RDF). Their typical small scale (30 – 60,000 tonnes per annum) in contrast to many incineration facilities may make it easier to find suitable locations. The energy production aspects of the processes, with electricity generated from the biomass fraction of waste being eligible for Renewable Obligation Certificates is another positive characteristics of these facilities. There is more information on ATT within the separate Technology Brief in this series, available on the Defra New technologies web pages.

Further information and support on BMW diversion

Waste Technology Data Centre (WTDC)

Run by the Environment Agency, this website is the focus for providing technical data on the new and existing waste management technology options. The site is impartial and aims to provide authoritative and comparable information on waste management technologies. It contains Case Studies on different technology suppliers including aerobic/anaerobic processes, MBT, MHT, ATT and incineration.

WTDC

http://www.environment-agency.gov.uk/wtd

Waste and Resources Assessment Tool for the Environment (WRATE)

WRATE is a 'Life Cycle Assessment' (LCA) software tool for comparing different management systems treating Municipal Solid Waste (MSW). There are other LCA tools; however, none offer the same scope of waste technologies that are provided by WRATE or have the level of sophistication of technical development. The software follows the "Gate to Grave" modelling approach. The system boundary is initiated when materials are discarded into a waste management system (the Gate) to its point of recycling, recovery or final disposal (the Grave).

WRATE has converted the site process data collected by the Waste Technologies Data Centre (WTDC) into 40 life cycle assessments. It includes the processes' environmental costs and benefits of resources used, transport and the operational impacts of materials, and energy treated downstream from WTDC processes. It includes the ecoinvent v1.2 database that is used to estimate the life cycle costs for the materials and energy that are used or recovered by processes. A licence and training is required in order to use WRATE

WRATE

http://www.environment-agency.gov.uk/wtd/1396237/?version=1&lang=_e

Defra New Technologies Publications

This document is one of a series of Waste Technology Briefs produced by Enviros Consulting Ltd for Defra under the Supporter Programme. Technology Briefs in the series include:

- Introductory Guide to Waste Management Options
- Advanced Biological Treatment
- Mechanical Biological Treatment
- Mechanical Heat Treatment
- Advanced Thermal Treatment
- Incineration
- Managing Outputs from Waste Technologies
- Renewable Energy and Waste Technologies

The documents are available electronically on the Defra website.

Defra

http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Defra New Technologies Demonstrator Programme

With a budget of £30 million the programme provides nine demonstration projects covering four different waste treatment technologies. The programme aims to prove

Further information and support on BMW diversion

the economic, social and environmental viability (or not) of each selected technology. Visitor centres are provided at each site for key decision makers from local authorities and the waste sector to learn more about the particular strengths and weaknesses of these technologies. There will also be a series of impartial reports, presentations and advice from experts working on behalf of Defra. For further information on the demonstrator projects contact wastetech@enviros.com.

Defra

http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Waste & Resources Action Programme (WRAP)

WRAP delivers a number of programmes, funded by Defra, to support and find solutions to resource management issues including:

- An organics market development programme, including support and investment to the composting sector to develop sustainable and reliable markets for increasing tonnages of organic material. This includes capital investment support for the development of composting and anaerobic digestion facilities, business development advice, continued work on compost standards, research and development and specific initiatives with the landscaping and horticultural industries.

- ROTATE - a free advisory service for local authorities providing technical advice and training for local authorities looking to implement and improve collection systems for recyclable materials and organic wastes.

- The national Recycle Now advertising campaign to raise consumer awareness of recycling issues and to get them to act, and a programme of support for locally - managed communications campaigns to increase participation in new or expanded recycling schemes

- A range of issue specific waste minimisation initiatives including home composting, food waste reduction campaign and work with retailers and key brands.

WRAP

http://www.wrap.org.uk

Recycle Now

http://www.recyclenow.com/

Recycle Now Partners

http://www.recyclenowpartners.org.uk/

Glossary

Aerobic	In the presence of oxygen.
Aerobic Digestion/Composting	Biological decomposition of organic materials by micro-organisms under controlled, aerobic, conditions to a relatively stable humus-like material called compost.
Anaerobic	In the absence of oxygen.
Anaerobic Digestion	A process where biodegradable material is encouraged to break down in the absence of oxygen. Material is placed in to an enclosed vessel and in controlled conditions the waste breaks down typically into a digestate, liquor and biogas.
Animal By-Products Regulation	Legislation governing the processing of wastes derived from animal sources.
Biodegradable	Capable of being degraded by plants and animals.
Biogas	Gas resulting from the fermentation of waste in the absence of air (methane/carbon dioxide).
Biodegradable Municipal Waste (BMW)	The component of Municipal Solid Waste capable of being degraded by plants and animals. Biodegradable Municipal Waste includes paper and card, food and garden waste, wood, and a proportion of other wastes, such as textiles.
Bottom Ash	The ash that arises from a combustion process in a furnace.
Bring Sites	Bring Sites are facilities provided at supermarkets and other facilities visited by householders, in which recyclable waste may be deposited.
Char/Slag	Material remaining following partial or complete combustion, or other thermal treatment process such as Pyrolysis and Gasification.
Civic Amenity (CA) Site	A facility where the public can dispose of household waste. Civic Amenity sites often have recycling points.
Co-combustion	Combustion of wastes as a fuel in an industrial or other (non waste management) process.
Co-mingled	Targeted recyclable materials are placed in the same container and collected co-mingled in a single compartment vehicle for sorting at a Materials Recovery Facility.
Digestate	Solid and / or liquid product resulting from Anaerobic Digestion.
Feedstock	Raw material required for a process.
Fermentation	A chemical reaction in which an organic molecule splits into simpler substances.
Flock	A small loosely aggregated mass of flocculent material.
Fluidised Bed Combustion	A combustion technology system in which a sand bed (or similar inert material) is fluidised by air jets, heated to temperatures high enough to support combustion, combustible wastes are then added.
Fly Ash	The fine dust that is removed from the flue gas in the flue gas cleaning process of thermal treatment operations.
Gasification	Gasification is the process whereby carbon based wastes are heated in the presence of air or steam to produce fuel-rich gases. The technology is based on the reforming process used to produce town gas from coal.

Glossary

Greenhouse Gas	A term given to those gas compounds in the atmosphere that reflect heat back toward earth rather than letting it escape freely into space. Several gases are involved, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), ozone, water vapour and some of the chlorofluorocarbons.
Green Waste	Vegetation and plant matter from household gardens, local authority parks and gardens and commercial landscaped gardens.
Incineration	The controlled thermal treatment of waste by burning, either to reduce its volume or toxicity. Incineration recovers energy from waste by utilising the calorific value of the waste to produce heat and / or power.
Inert	Innocuous, undamaging, non-toxic. Something that is not detrimental to health or the environment.
In-vessel Composting	The aerobic decomposition of shredded and mixed organic waste within and enclosed container, where the control systems for material degradation are fully automated. Moisture, temperature, and odour can be regulated, and a stable compost can be produced much more quickly than outdoor windrow composting.
Kerbside Collection	Any regular collection of recyclables or waste from premises, including collections from commercial and industrial premises as well as households.
Liquor	Concentrated liquid, produced as a result of the decomposition of organic waste. If from a landfill site, it is referred to as leachate.
Materials Recycling Facility/ Material Recovery Facility (MRF)	Dedicated facility for the sorting of co-mingled recyclable materials into separate material streams.
Mechanical Biological Treatment MBT	A generic term for mechanical sorting / separation technologies used in conjunction with biological treatment processes, such as composting.
Minimisation	See Reduction
Moving Grate System	A generic term for mechanical sorting / separation technologies used in conjunction with biological treatment processes, such as composting.
Mulches/ Soil Conditioners	Any substance spread or allowed to remain on the soil surface to conserve soil moisture and shield soil particles from the erosive forces of raindrops and runoff. May be used to add texture / structural properties to soil.
Municipal Solid Waste (MSW)	Household waste and any other wastes collected by the Waste Collection Authority, or its agents, such as municipal parks and gardens waste, beach cleansing waste, commercial or industrial waste, and waste resulting from the clearance of fly-tipped materials.
Pyrolysis	During Pyrolysis organic waste is heated in the absence of air to produce a mixture of gaseous and liquid fuels and a solid, inert residue (mainly carbon).
Recyclate/Recyclable materials	Post-use materials that can be recycled for the original purpose, or for different purposes.
Recycling	Involves the processing of wastes, into either the same product or a different one. Many non-hazardous wastes such as paper, glass, cardboard, plastics and scrap metals can be recycled. Hazardous wastes such as solvents, can also be recycled by specialist companies.
Refuse Derived Fuel (RDF)	A fuel produced from combustible waste that can be stored and transported, or used directly on site to produce heat and/or power.

Glossary

Reduction	Reduction can be accomplished within manufacturing processes involving the review of production processes to optimise utilisation of raw (and secondary) materials and recirculation processes. It can be cost-effective, both in terms of lower disposal costs, reduced demand for raw materials and energy costs. It can be carried out by householders through actions such as home composting, reusing products and buying goods with reduced packaging.
Regional Self Sufficiency Principle	Dealing with wastes within the region or country where they arise.
Renewables Obligation	Introduced in 2002 by the Department of Trade and Industry, this system creates a market in tradable renewable energy certificates, for which each supplier of electricity must demonstrate compliance with increasing Government targets for renewable energy generation.
Reuse	Can be practised by the commercial sector with the use of products designed to be used a number of times, such as reusable packaging. Householders can purchase products that use refillable containers, or re-use plastic bags. The processes contribute to sustainable development and can save raw materials, energy and transport costs.
Source-segregated	Usually applies to household waste collection systems where recyclable and/or organic fractions of the waste stream are separated by the householder and are often collected separately.
Statutory Best Value Performance Indicators	Local Authorities submit performance data to Government in the form of annual performance indicators (PIs). The Recycling/ Composting PIs have a statutory target attached to it which Authorities are required to meet.
Sustainable Development	Development which is sustainable is that which can meet the needs of the present without compromising the ability of future generations to meet their own needs.
Waste Collection Authority WCA	District Council (in two tier areas) or Metropolitan/ Unitary Authority with responsibility for waste collection from each household in its area. WCAs also have a duty to prepare and publicise waste recycling plans and strategies.
Waste Disposal Authority WDA	County Council (in two tier areas) or Metropolitan/ Unitary Authority with responsibility for safe disposal of all waste arisings in a particular geographical area. The Environmental Protection Act 1990 required all local authorities to transfer their waste disposal facilities to either a partly owned, arms length Local Authority Waste Disposal Company LAWDC or directly into the private sector to carry out their waste disposal responsibilities exclusively by means of letting contracts.
Waste Hierarchy	This concept suggests that the most effective environmental option may often be to reduce the amount of waste generated (reduction); where further reduction is not practicable, products and materials can sometimes be uses again, either for the same or a different purpose (reuse); failing that value should be recovered through waste (through recycling, composting or energy recovery from waste); only if none of the above offer an appropriate solution should waste be disposed of.
Windrow Composting	The aerobic decomposition of appropriate shredded biodegradable waste using open linear heaps known as 'windrows', which are approximately three meters high and four to six meters across. The process involves mechanical turning of the waste until the desired temperature and residence times are achieved to enable effective degradation. This results in a bulk-reduced, stabilised residue known as compost. Windrow composting can take place outdoors or within buildings and the process takes around three months.