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Introductory Guide

Options for the Diversion of Biodegradable Municipal Waste from Landfill

defra

Waste Implementation Programme
New Technologies

Contents

Prepared by Enviros Consulting Limited on behalf of Defra as part of the New Technologies Supporter Programme. For further copies/pdf versions, please contact the New Technologies helpline on 0870 240 9894 e. wastetech@enviros.com

We acknowledge support from the Department for Environment, Food & Rural Affairs, the Environment Agency, the Waste and Resources Action Programme, Be Environmental Ltd and Stuart McLanaghan of Associates in Industrial Ecology.

Background

Municipal Solid Waste (MSW) is waste collected by or on behalf of the local authority. It comprises mostly household waste and it may include some commercial and industrial wastes. The quantity of Municipal Solid Waste is currently increasing year on year, and is a growing problem for local authorities particularly as new legislation which limits the amount of mixed MSW that can be sent to landfill comes into effect.

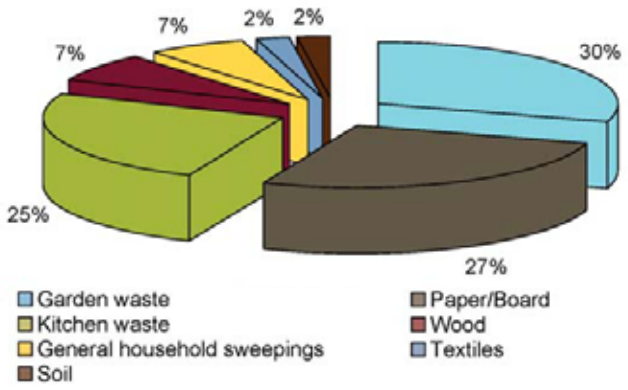
At present more than 75% of all MSW generated in England is disposed of in landfills. The aim of this guide is to introduce alternative options for the management of MSW which do not rely solely on landfill. Some of these options are already established practice in the UK or overseas. Others are yet to be commercially tested in the UK for municipal waste management. Further details about the new technologies featured in this report are available from the Waste Technology Data Centre.

The most significant challenge facing the management of Municipal Solid Waste is how to divert the biodegradable component of MSW (known as BMW) away from landfills. Measures have been set in place (see below) to reduce the amount of this biodegradable material allowed to be sent for disposal in landfills.

What is BMW?

Biodegradable Municipal Waste (BMW) is the fraction that will break down, either in the presence of air or under anaerobic conditions (such as that within a landfill, where oxygen is absent). The types of materials that comprise this Biodegradable Municipal Waste include: kitchen wastes, green or garden wastes, paper, card, cork, and even some textiles. Figure 1 illustrates the materials that comprise BMW.

Figure 1 Biodegradable Municipal Waste



Source: Waste Not, Want Not 2002

Why seek alternatives to landfill?

The EC Landfill Directive

The legislation driving the need to divert BMW from landfill is in response to the European Commission (EC) Landfill Directive published in 1999. The rationale for the need to reduce the levels of biodegradable materials going to landfill is based on concerns over greenhouse gas emissions and the threat of global warming. The decomposition of biodegradable materials within landfill sites results in the production and escape of methane. Methane is a potent greenhouse gas, emissions of which have to be reduced. The Landfill Directive is one measure designed to reduce the quantities of methane produced from landfills by targeting a reduction in the quantities of BMW disposed of in this way. Within the Landfill Directive the following targets[1] have been set:

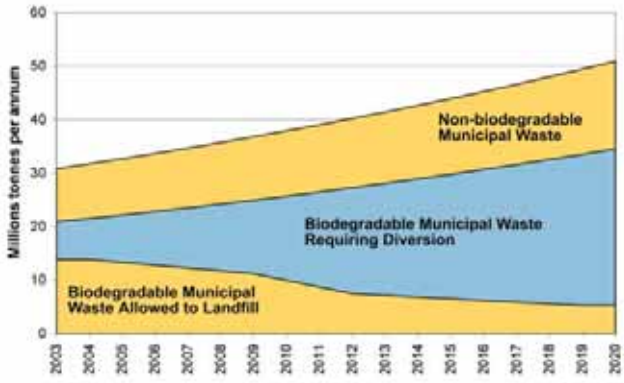
BMW levels allowed to landfill	Target year for UK
75% of 1995 quantities	2010
50% of 1995 quantities	2013
35% of 1995 quantities	2020

[1] The target years highlighted includes the 4 year derogation open to the UK as a Member State landfilling more than 80% of its MSW in 1995.

Background

These are challenging targets which are made more difficult to achieve because of the UK's reliance upon landfill as a waste management option and also because of the increasing quantity of Municipal Solid Waste arisings. Failure to meet these targets will result in significant fines for the UK - anticipated to be up to £500,000 per day. These targets have been transposed into English law in the form of the Landfill Regulations 2002, and the Waste & Emissions Trading Act 2003. Figure 2 shows the trend of increasing waste arising (assuming 3% annual growth) and the amount of BMW which will require diversion up until 2020.

Figure 2 BMW Diversion & the Landfill Directive Targets



Source: Defra data, assuming 3% annual growth of MSW

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

Waste Technology Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Waste Policy in England

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

- The need to shift the emphasis from **waste** management to **resource** management (i.e. to deal with the materials as a potential resource of recyclable materials and recoverable fuels rather than a waste stream for disposal) is an important trend representing a central theme of the sustainable development agenda.

- Waste generation is a Government headline indicator for sustainable development and there are additional indicators for disposal to landfill.

- The Statutory Best Value Performance indicators, which promote composting and recycling for household waste.

- There are also financial incentives to seek alternatives to landfill. The Landfill Tax is due to rise at annual £3 / tonne increments from the current level of £15 / tonne (2004/5) up to £35 / tonne in 2011/12.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Policy & Strategy in England see Waste Strategy 2000 Parts 1&2

http://www.defra.gov.uk/environment/waste/strategy/cm4693/pdf/wastvol1.pdf

http://www.defra.gov.uk/environment/waste/strategy/cm4693/pdf/wastv2_1.pdf

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/business/othertaxes/landfill-tax.htm

Best Value Performance Indicators
http://www.bvpi.gov.uk/pages/Index.asp

Introduction to Municipal Solid Waste Management Options

There are a wide variety of alternative waste management options and strategies for dealing with Municipal Solid Waste 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 and weaknesses. There are typically a number of variations which fall under each of the headings within this section and readers seeking further and more detailed information should consult the contacts and recommended web-sites 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 prevention) and the least desirable option is to dispose of the waste with no recovery of materials or energy. Between these two extremes there are a wide variety of waste treatment 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). It is these waste treatment options that are considered 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 other decision making principles such as the Best Practicable Environmental Option (BPEO), the Proximity Principle, the Regional Self Sufficiency Principle and the Precautionary Principle.

Figure 3 Waste Hierarchy Diagram

Source: Waste Strategy 2000

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

The Waste Hierarchy
http://www.defra.gov.uk/environment/waste/strategy/cm4693/12.htm

The Waste Framework Directive (1975)
http://europa.eu.int/eurlex/en/lif/reg/en_register_15103030.html

The principles of BPEO, Proximity Principle and Regional Self-Sufficiency
http://www.defra.gov.uk/environment/waste/strategy/cm4693/10.htm

Reduction and Reuse

Reduction

The need to minimise the quantity of materials that enter the waste stream is emphasised by the increasing quantity of Municipal Solid Waste arising year on year, typically by around 3% a year. There are a number of reasons for this increase, including: the changing demographics of society (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 the amount of waste arisings include: changing householder behaviour, (for example by promoting the purchase of products with less packaging or encouraging the reuse of products such as glass jars); or providing compost bins or digesters to householders with gardens to remove the green wastes or kitchen wastes from the waste stream. Initiatives such as developing home composting will tackle directly one of the Biodegradable Municipal Waste streams and by persuading householders to buy products with less packaging, paper and card will also be reduced from the waste stream.

There are a wide variety of initiatives to support waste reduction, either through the promotion of best practice or providing access to funding, including projects developed by the Government under the Waste Implementation Programme (WIP) and other campaigns such as Encams, Envirowise, local authority funding programmes and the Waste and Resources Action Programme (WRAP).

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

The Government Waste Strategy
http://www.defra.gov.uk/environment/waste/strategy/

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

Envirowise
http://www.envirowise.gov.uk/

Waste awareness campaigns, Encams
http://www.encams.org/home/home.asp
& WRAP http://www.wrap.org.uk/

Local Authority Funding
http://www.defra.gov.uk/environment/waste/localauth/wastefund/

Reuse

If waste generation cannot be prevented and materials are therefore discarded by the householder or other municipal waste source, then the next best option is to **reuse** relevant materials. 'Reuse' means the application of the waste material, goods or appliance for the same purpose as was originally intended, by the same or another user. An example would be the reuse of furniture collected by a local authority or deposited at a Civic Amenity (CA) site. 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 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).

Where materials are used as a raw material for a new product, this is known as Recycling (see page 6).

The Government has promoted schemes for the reuse / repair of materials through funding schemes and, for example, through the work of the Waste & Resources Action Programme (WRAP) raising awareness of the need to reduce, reuse and recycle waste from the household.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

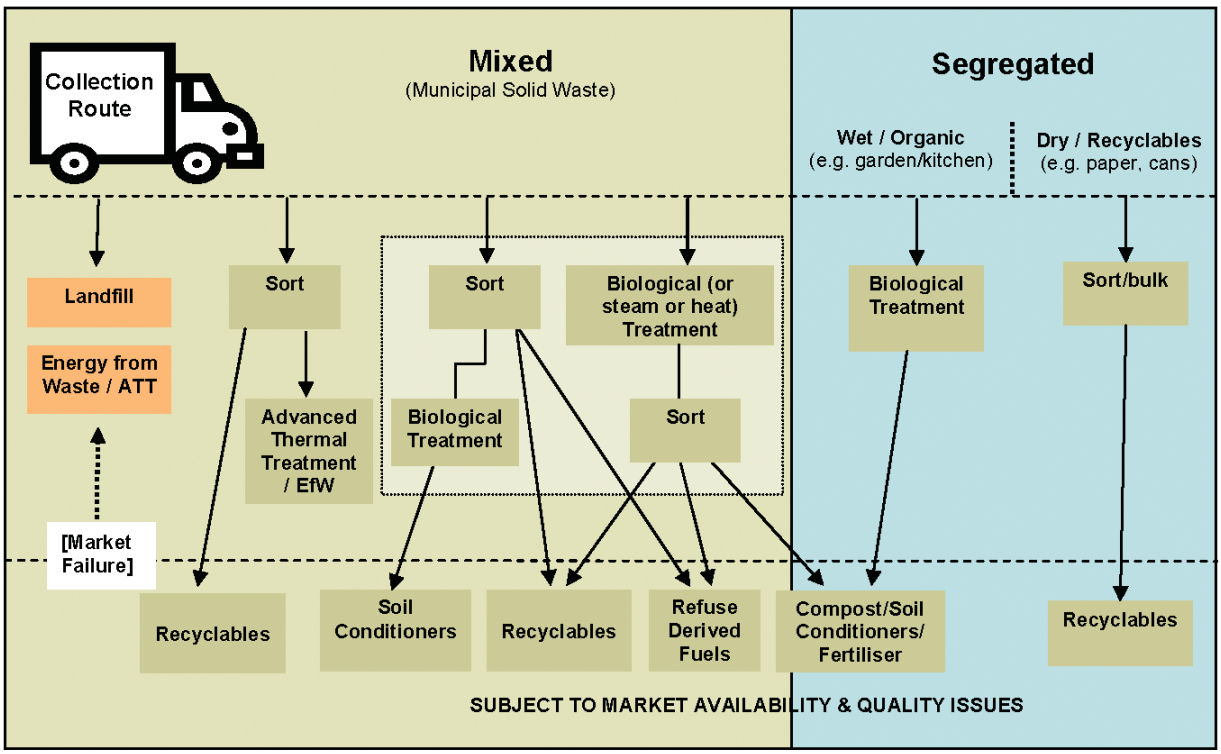
The Government Waste Strategy
http://www.defra.gov.uk/environment/waste/strategy/cm4693/12.htm#2

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

How can I manage the rest?

The management of the materials remaining in the waste stream after reuse and reduction initiatives have taken place, is the subject of the rest of this section, and is one of the key priorities of the Government's Waste Implementation Programme (WIP). How MSW is managed will link to the system in place to collect waste and materials from the kerbside. Figure 4 illustrates the waste management options that are available to local authorities dependent on whether there is a mixed (e.g. one waste container) or segregated (more than one waste/recyclables container) collection system in place.

Figure 4 Options for Recovery & Disposal of Municipal Solid Waste



NB: This figure excludes residues sent directly to disposal from the treatment processes and other rejects from the processes, which will typically be sent to landfill. Materials which fail in the marketplace are also likely to be sent for disposal.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

WIP and the waste technology options
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

The Government Waste Strategy (Waste Strategy 2000)
http://www.defra.gov.uk/environment/waste/strategy/cm4693/index.htm

New technologies - contact the Local Authority New Technologies Supporter Helpline
0870 240 9894 wastetech@enviros.com

The Government Strategy Unit report on waste management
http://www.number-10.gov.uk/su/waste/report/01.html

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 (recyclate) must first 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 sites). Alternatively the materials may be collected directly from the households (see below). However collection represents just the first stage in the recycling process.

The Government has set statutory recycling and composting targets for local authorities in England to encourage increasing levels of recycling across the country. 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, by 2010.

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 Waste Implementation Programme's Local Authority Support Unit and from WRAP's Recycling and Organics Technical Advisory Team (ROTATE).

Sorting of Recyclables

The level of sorting and separation required for recyclables will depend upon the collection system employed. The following paragraphs explain the type of sorting facilities needed to process the collected recyclate (prior to reprocessing and sale into the marketplace) for different types of collection system.

Bring Sites /Civic Amenity (CA) Site Collection Options

Recyclables deposited at bring sites or CA sites are usually segregated into different types of material for example all paper goes into one bank, all green glass into another, plastics into another. Therefore there is a minimal sorting requirement 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 making logistics more economic before sending the materials off for reprocessing by a specialist facility or materials broker.

Kerbside Collection Options

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

Single Material Recyclate Collections

The local authority will supply a single container for the collection of each recyclate material. A typical example of this is a paper collection. This material may be appropriate for bulking and direct sale to a reprocessor without further sorting, or limited mechanical sorting may be used to refine the material quality.

Co-mingled Recyclate Collections

The term ‘co-mingled’ means that more than one type of recyclate material is placed by the householder within the same receptacle (for example paper in the same container as cans). Households are provided with one or more containers (or asked to provide one of their own in some circumstances) in which specified mixed recyclables are placed for regular collection.

This type of collection system requires a specialist facility to sort the recyclables into separate material types for reprocessing. This is known as a Materials Recycling Facility or Materials Recovery Facility (MRF - see Mechanical Sorting / Processing).

Kerbside Sort Collections

As with co-mingled collections, a container is provided for co-mingled recyclables which are then sorted into constituent materials at the kerbside (i.e. outside the household) by the operatives of a specialist collection vehicle. This is a more labour intensive process in terms of the collection operation. However it has benefits in terms of ensuring the quality of the recyclate collected and there is not usually a requirement for further sorting of the materials.

Mixed Waste Collections

Recyclables may also be extracted from mixed waste (normal refuse or 'black sack' waste) through dedicated separation and treatment processes. These systems are described later in this guide and include Mechanical - Biological Treatment, mechanical sorting and other novel systems such as Autoclaving (see page 17). The amount of recyclables extracted from these mechanically based systems is likely to be significantly less and of a lower quality (in most instances) than recyclables collected through dedicated 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.

Markets for Recyclables

It is essential to have secure markets for materials generated through a recycling strategy as a material can only be deemed to have been recycled once it is beneficially used in a given market. The market for the sale of recyclables can fluctuate considerably. As more material comes onto the market it is likely that quality issues and the capacity of the market to accept these additional materials will become increasingly important to sustaining the local waste strategy. In 2001, the Government established the Waste and Resources Action Programme (WRAP) to address these market issues and stimulate new markets for recyclates. This programme continues to work in the development of new and stable markets for recycled materials.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

The Government Waste Strategy
http://www.defra.gov.uk/environment/waste/strategy/cm4693/index.htm

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

Local Authority Funding
http://www.defra.gov.uk/environment/waste/localauth/funding/

WRAP and ROTATE
http://www.wrap.org.uk/

The Household Waste Recycling Act 2003
http://www.defra.gov.uk/environment/waste/legislation/recyclebill/index.htm

Mechanical Sorting and Processing

Mechanical sorting and processing techniques are used, to some extent, in conjunction with most of the waste treatment technologies described within this guide. Mechanical techniques may be used to process mixed MSW or segregated, co-mingled recyclates as described below. Mechanical methods may be combined with manual sorting in the form of picking stations where materials are hand picked and sorted from a waste stream. There are potential health implications of such operations and manual sorting should only be undertaken on appropriate waste streams and using adequate protective equipment. Mechanical sorting and processing techniques used for waste are typically based on conveyor systems for moving the waste around the treatment facility.

Sorting and Processing Mixed MSW

There are a variety of techniques which may be used to separate mixed waste streams into different fractions. 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) which may be used as a fuel.

A complex mechanical sorting system may be used to split a mixed MSW stream into all three of these fractions. However, there will usually be a reject fraction for disposal from mixed waste processing operations.

It is important to note that there is likely to be contamination of the different waste fractions sorted through mechanical means from a mixed municipal waste stream. The degree of contamination can be mitigated by the addition of another treatment process (for example partially drying the waste, see Mechanical Biological 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.

Sorting and Processing Co-mingled Recyclables

The sorting of co-mingled materials, for example where cans and paper are collected in the same container from the household kerbside, will require a different type of mechanical processing facility to mixed waste. Typically there is an element of manual sorting within these operations. The purpose of this operation is to sort the recyclables, into different material fractions, for example separating all the paper into one fraction, card into another, steel cans into another and aluminium cans into another fraction. This type of facility is known as a Materials Recycling Facility or MRF. More advanced technologies used in some MRFs are now capable of separating different types of plastic or paper from plastic.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

New technologies - contact the Local Authority New Technologies Supporter Helpline
0870 240 9894 wastetech@enviros.com

Composting

Composting is a biological process in which biodegradable wastes, such as garden and kitchen wastes are decomposed in the presence of air by the action of micro-organisms (for example 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 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 - see 'Why seek alternatives to Landfill'), water and a stabilised residue. The nature and quality of the residue will depend on the input material, the composting process itself (including screening of materials to refine the product) and the market into which the residue is due to be sent. The residue may be a compost, soil conditioner or mulch.

A number of different composting processes can be used to decompose garden waste into a usable product. Some of these processes may also treat kitchen wastes. However, due to the potential risks to animal/human health from the transfer of diseases from meat wastes into the environment there are stricter controls over the processing of kitchen type wastes and only certain approved treatments may be used for this purpose. These controls are specified by the Animal By-Products legislation, which is regulated by the State Veterinary Service.

The Government has provided support to local authorities seeking to develop biodegradable waste collection systems under local authority funding programmes and currently provides advice and training through the ROTATE (Recycling & Organics Technical Advisory Team) initiative. There is also a dedicated Organics initiative under the Waste Implementation Programme which includes training and a capital fund to help develop new processing capacity for biodegradable waste.

Methods of Collecting Wastes Suitable for Composting

Green/Kitchen Waste Collections

The challenges of meeting the statutory recycling and composting targets, as well as the wider Landfill Directive obligations, have led many local authorities to target the biodegradable wastes contained within municipal waste through separate collections of garden (or green) waste and in some instances, kitchen (food scrapings) waste. These wastes are typically collected in wheeled bins or sacks and may involve a specialist collection vehicle.

Collection from Civic Amenity Sites

Green waste deposited by householders at Civic Amenity (CA) sites can readily be collected for composting.

Mixed Waste Collections

Composting processes may be used for mixed waste (normal refuse, or 'black sack' waste) in combination with a mechanical materials recovery and/or fuel preparation process, or as a stabilisation process prior to landfill. For details of this type of composting application see Mechanical Biological Treatment and other technologies described in this guide.

Compost Technologies

Composting processes for municipal waste management primarily fall into two categories: windrow composting, for green, or garden derived wastes and more contained 'In-vessel' composting, some examples of which can (subject to regulatory approval) process both garden and kitchen/ catering derived organic wastes.

Windrow composting is an established technology for dealing with green wastes, where the material is shredded and then piled in elongated rows (windrows) and aerated through either turning of the windrows or by air forced through the material. Windrow composting may take place in buildings or externally. 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 and these operations are likely to increase over the coming years.

Biological Treatment

In-vessel composting (IVC) embraces a variety of techniques whereby the kitchen and garden wastes may be composted together in an enclosed vessel or tunnel. The advantage of these processes is that they are more controlled and can be designed to achieve and maintain specified temperatures to facilitate bacteria destruction (in accordance with the requirements of the Animal By-Products Regulation which governs the management of wastes arising from animal sources, including food and catering wastes). It is this enhanced level of control that makes approved IVC systems appropriate for processing kitchen type municipal wastes in addition to green wastes. Not all IVC systems will be capable of processing kitchen wastes. Each process type would require approval from the Regulator (the State Veterinary Service). There is limited experience of In-vessel composting in the UK to date but due to Animal By-Products legislation and the need to meet both landfill diversion and statutory recycling and composting targets it is likely that this will be a growing area of biodegradable waste treatment.

Compost Markets

The composts, mulches or soil conditioners that are produced by the various composting operations clearly require markets. There are a variety of applications for existing compost materials - depending on market availability and product quality - from horticultural to agricultural usage, or for landfill restoration or engineering purposes.

A British Standards Institution Publicly Available Standard (BSI PAS 100) has been developed for compost quality derived from source segregated biodegradable waste in order to help standardise the market for compost materials. The Waste and Resources Action Programme (WRAP) has undertaken a range of initiatives to encourage the use of composts and soil conditioners from source segregated biodegradable wastes.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

The Government Waste Strategy
http://www.defra.gov.uk/environment/waste/strategy/cm4693/index.htm

Waste Technology Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Local Authority Funding
http://www.defra.gov.uk/environment/waste/localauth/funding/

WRAP, ROTATE and the Organics programme
http://www.wrap.org.uk/

New biological technologies - contact the Local Authority New Technologies Supporter Helpline
0870 240 9894
wastetech@enviros.com

Animal By-Products legislation
http://www.defra.gov.uk/animalh/byprods/FormerFoodstuffs/guidance_dispffs.pdf

State Veterinary Service
http://www.defra.gov.uk/corporate/contacts/ahdo.htm#svs

Anaerobic Digestion

Anaerobic Digestion (AD) is a biological process where biodegradable wastes, such as garden and kitchen waste, are converted into a 'digestate' (containing biosolids and a liquid) and biogas. The wastes are decomposed by bacteria in the absence of air, this is a key differentiation from Composting processes. In AD systems, biodegradable material is placed into an enclosed vessel and under controlled conditions and processed at elevated temperatures. The decomposition of the biodegradable material leads to the release of a methane rich biogas which can be collected and burnt as a fuel to produce electricity.

At the time of going to press there are no full scale Anaerobic Digestion plants operating commercially in the UK for Biodegradable Municipal Wastes. However there is considerable interest in the technology to help meet the landfill diversion obligations and the first full scale AD plant in England is due to commence operations in 2004.

Anaerobic Digestion will only decompose biodegradable material. Some systems in operation in Europe digest an organically rich waste fraction mechanically sorted from mixed MSW, as part of a treatment process. The digestate produced from Anaerobic Digestion processes is likely to count as 'composting' under the statutory recycling and composting targets.

The Government has provided support to local authorities seeking to develop organics collection systems under previous rounds of funding and through advice from ROTATE (Recycling & Organics Technical Advisory Team). There is also a dedicated Organics initiative under the Waste Implementation Programme (WIP) which includes training and a capital fund to help develop new processing capacity for Biodegradable Municipal Waste. This Guide is funded under the New Technologies programme, which provides impartial advice, information and training to local authorities considering new technologies for MSW management, of which Anaerobic Digestion is an example.

Collection Methods for Anaerobic Digestion Operations

The modes of collection for BMW for Anaerobic Digestion processing are the same as those for composting operations (see page 9). It is envisage that most AD processes will be able to comply with the requirements of the Animal By Products Regulations, subject to approval from the State Veterinary Service and appropriate configuration of the process.

Outputs from the Process

A solid, liquid and gas component are typically generated by an Anaerobic Digestion process. These outputs are described below:

Digestate Product

Following the anaerobic digestion process the digestate containing biosolids and liquid can be used as a biofertilizer subject to market availability and suitable quality. Alternatively, the biosolids can be dewatered from the digestate and treated aerobically. The resultant compost like material can be used as soil conditioner. The use of both the digestate and dewatered biosolids will depend on the quality of the input material (source segregated organic material will generally produce a 'cleaner' product than material from a mixed waste stream) and the management/ operation of the process. The availability of the markets will influence the required level of processing of the digestate material.

The liquor or filtrate resulting from any dewatering stage is rich in organic compounds and can be re-circulated through the process, used as a fertiliser, treated or disposed to sewer dependent on the nature of the process and the characteristics of the liquor.

Biological Treatment

Biogas

The Biogas (mostly carbon dioxide and methane) produced during this process and can be sold as fuel or combusted for example, in gas engines to generate electricity. The sale of this electricity will be eligible for Renewables Obligation Certificates (ROCs). ROCs provide a financial incentive for the production of electricity from renewable sources.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

New Biological Technologies - contact the Local Authority New Technologies Supporter Helpline
0870 240 9894
wastetech@enviros.com

WRAP Organics Programme
www.wrap.org.uk

Local Authority Funding
http://www.defra.gov.uk/environment/waste/localauth/funding/

Animal By-Products legislation
http://www.defra.gov.uk/animalh/by-prods/FormerFoodstuffs/guidance_dispffs.pdf

State Veterinary Service
http://www.defra.gov.uk/corporate/contacts/ahdo.htm#svs

Renewables Obligation
http://www.dti.gov.uk/energy/renewables/

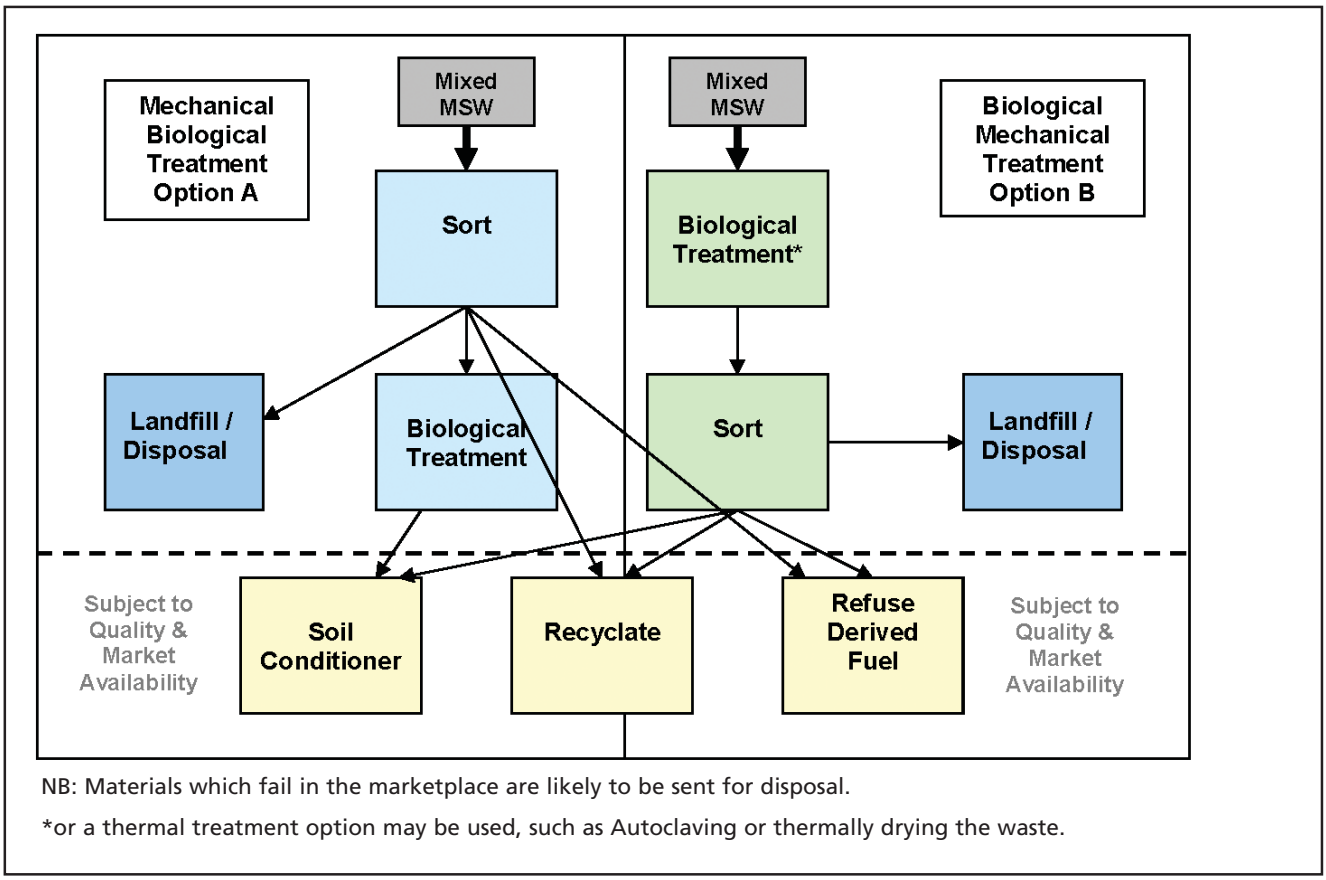
Mechanical Biological Treatment

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 plants. In its simplest form MBT provides a drying and bulk reduction operation for mixed waste prior to landfill. The drying stage makes the subsequent separation of recyclate materials easier

In more complex waste management systems the biodegradable fraction can subsequently be treated in anaerobic digestion and/or composting plants, and the highly calorific fraction made into a refuse derived fuel for energy recovery.

MBT plant are designed to handle raw Municipal Solid Waste. Figure 5 shows the two principal MBT type operations.

Figure 5 Mechanical Biological Treatment options



NB: Materials which fail in the marketplace are likely to be sent for disposal.

*or a thermal treatment option may be used, such as Autoclaving or thermally drying the waste.

Option A - Mechanical-Biological Treatment: mixed waste is firstly sorted through a series of mechanical treatment operations into recyclable materials (for example metals and glass), Refuse Derived Fuel (RDF) and an organic rich fraction (green waste, kitchen waste, some card or other materials). RDF typically comprises materials with good combustion properties, such as paper, plastics, card, textiles and other miscellaneous materials. The organic fraction is biologically treated to reduce the volume and stabilise it so it can be used as a soil conditioner. There will also be a reject fraction which will require landfill disposal.

Mechanical Biological Treatment

Option B - Biological-Mechanical Treatment: mixed unsorted waste is homogenised by a biological treatment process (such as partially composting and drying out of the waste). It is then screened and sorted using mechanical processes into recyclable, RDF and/or soil conditioner streams. There will be a reject fraction which will require landfill disposal.

Where markets exist Refuse Derived Fuel may be sent for processing in either a dedicated facility, such as an incinerator/ Energy from Waste plant or an Advanced Thermal Treatment process (see pages 15-16) or may be used as a fuel in an existing industrial process. Where the RDF is used together with another fuel (usually coal) in an industrial application, this is known as co-combustion. The main example of co-combustion in the UK, in this context, is the burning of RDF in cement kilns.

At present MBT has not been operated commercially in the UK although planning permission has been granted for a considerable tonnage of MBT capacity, with full scale plants due for commissioning over the next two years.

As with any process if MBT is designed to produce a composting/ soil conditioning product, it will be subject to the Animal By-Product Regulations.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre
http://www.defra.gov.uk/ environment/ waste/wip/newtech/index.htm

MBT Technologies - contact the Local Authority New Technologies Supporter Helpline
0870 240 9894
wastetech@enviros.com

Energy from Waste

Energy from Waste (EfW) facilities combust waste under controlled conditions, to reduce its volume and hazardous properties, and to generate electricity and/or heat. The majority of EfW plant operating in the UK are designed to process significant quantities of Municipal Solid Waste with no need to pre-treat the wastes before processing. However, a part of an integrated waste management strategy plants should be sensitively scaled after targeted levels of source segregated recyclate and biodegradable waste collection.

EfW plants require process control measures for emissions and extensive flue gas cleaning equipment. There is also a requirement to deal with the residues of the combustion process. There are two principal solid residues from thermal treatment systems: the bottom ash, which is the solid remainder of the waste feedstock after processing; and the flue gas treatment residues from the air pollution control process. Some of the residues from the flue gas treatment 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. Some EfW plant also recover metals for recycling from the bottom ash.

The decision to use one larger plant or a number of smaller scale facilities may have implications for: the number of planning permissions and permits required, as well as economies of scale issues, although smaller plants maybe integrated into a more local solution for smaller communities.

Moving Grate Plant

Modern Energy from Waste plants are typically moving grate incinerators: that 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 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 EfW plant range from 45 - 200,000 tonnes per annum. Site capacities may range up to 600,000 tonnes per annum (if more than one unit is used on a particular site).

Fluidised Bed Technology

The combustion of MSW using a fluidised bed (FB) system involves pre-sorting of Municipal Solid Waste 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 or similar bed medium. This bed is typically '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.

Other Kilns

Oscillating Kilns are also used in other countries for MSW Energy from Waste plant. These 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 being developed in the UK using an oscillating kiln design. This plant uses technology more prevalent in France, which is appropriate for smaller scale Energy from Waste facilities (25-60,000 tonnes per annum), in this instance incorporating district heating. Smaller scale EfW plant may be integrated into a more local solution for smaller communities.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Advanced Thermal Treatment

There are a wide variety of Advanced (or alternative) Thermal Treatment (ATT) systems incorporating 'advanced' or 'emerging' technologies for the treatment of municipal wastes. The most common ATT systems marketed for MSW fall under one of two headings: Pyrolysis and Gasification, although both can be used sequentially.

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 to around 500ºC, and breaks down plastics, paper and other organic derived materials to produce a gas. 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 gas clean up measures would be required for Pyrolysis facilities. A solid slag (Pyrolysis char) is also produced which may require disposal or additional processing.

Gasification

Gasification operates at a higher temperature range than Pyrolysis, typically 1000 - 1200ºC. 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. At these high temperatures the water 'cracks' into 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 (known as Syngas) can be combusted to generate electricity (as described above). A solid residue (char) 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. However there is potential for ATT systems to be components in an integrated municipal waste management strategy. They may also be appropriate for processing specific 'problem' waste streams or to link in with other pre-processing MSW facilities such as MBT. Their typical small scale (e.g. 30 - 60,000 tonnes per annum) in contrast to many traditional Energy from Waste plant has potential advantages in terms of the Proximity Principle and could yield benefits in terms of public perception and planning permission relative to larger facilities. The energy production aspects of the processes and the eligibility for Government renewable energy production incentives (Renewables Obligation Certificates or ROCs) for part of the electricity generated from such processes are also positive characteristics of these facilities.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

New ATT - contact the Local Authority New Technologies Supporter Helpline 0870 240 9894
wastetech@enviros.com

Renewables Obligation
http://www.dti.gov.uk/energy/renewables/

Other Waste Management Alternatives

Autoclaving

There are a limited number of other generic options for the treatment of MSW. An example of a pre-treatment system is Autoclaving. Autoclave technology has been used to sterilise certain hospital type wastes (clinical waste) for many years and is essentially a steam treatment process. It may be used in a municipal waste context where, for example, shredded MSW is processed in a pressurised sealed drum under the action of steam. After around an hour of processing the waste is reduced to a 'flock' like material, with metals and glass partially cleaned for extraction as recyclables, the process deforms plastics making them either more or less difficult to recycle, depending on the process and the polymer type. The remaining material may be sorted and the highly calorific fraction thermally treated as a type of Refuse Derived Fuel (RDF). There will typically be a residue for disposal from mixed MSW processing.

Alternative Treatment Technologies

Other specific technologies are under demonstration at a pilot scale in the UK or may be operational overseas for the treatment of MSW. For the latest information on such treatment technologies see the Waste Technology Data Centre.

WHERE DO I LOOK FOR MORE INFORMATION ON THIS?

Waste Technology Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

New technologies - contact the Local Authority New Technologies Supporter Helpline
0870 240 9894
wastetech@enviros.com

Where do I go next for support for BMW diversion?

Waste Technology Data Centre

Run by the Environment Agency, this website will be the focus for providing detailed and impartial technical data on new and existing waste management options. The site will provide authoritative and comparable information on waste management technologies.

Waste Technologies Data Centre
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Local Authority New Technologies Supporter

The main aim of this programme is to provide impartial information, support and training to local authorities and key decision makers with regards to achieving their BMW diversion targets through new technologies for municipal waste management.

Training

There will be technical briefing sessions for waste management professionals in the form of residential courses. These will cover detailed reviews of the new technologies, decision making, and overcoming barriers to implementation. The courses are due to start in 2005. There will also be non-technical sessions for members, planners, environmental health officers, senior officers etc. who may be involved in waste management decisions as a part of their job.

Information & Impartial Advice

A dedicated helpline has been established to deal with any queries, and waste specialists will be available to visit local authorities for face-to-face impartial advice on new technology issues. Literature available from the helpline includes this guide for BMW Diversion Options, specific technical and technology guidance and case studies. There will also be regular updates in the trade and technical press on new technology issues through the Supporter programme.

Site visits and Demonstration plant

Local authority members and officers will have the opportunity to visit Demonstration plants of new waste technologies, and any other operational new technologies, to assess at first hand the technicalities of the operations. This will be supported by literature in the form of case studies.

Local Authority New Technologies Support Helpline
0870 240 9894 wastetech@enviros.com

Local Authority Support Unit

Defra's Local Authority Support Unit aims to establish an enhanced support infrastructure to help local authorities overcome the barriers to improved performance and meet, or exceed, challenging statutory targets on the recycling and composting of municipal waste. The Unit works alongside existing local authority networks and other organisations to make support better, more accessible and 'joined up'.

The Unit has initiated a number of projects, which will help local authorities reach their statutory recycling targets, by providing best practice, guidance and toolkits in waste management. The Unit will identify further barriers to improved recycling performance, and, where necessary, initiate further projects or provide support to local authorities to achieve their statutory recycling targets.

Local Authority Support Unit
http://www.defra.gov.uk/environment/waste/wip/support/index.htm

Waste & Resources Action Programme (WRAP)

As part of the Waste Implementation Programme, WRAP, has a number of roles to support and find solutions to waste management issues including:

- Providing 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 composting technologies, business development advice, continued work on compost standards, research and development work, and specific initiatives with the landscaping and horticultural industries.
- An advisory service to local authorities on recycling and organics (ROTATE). This provides technical advice and training for local authorities looking to implement and improve collection systems for recyclable materials and organic wastes. A key aim is to optimise the management of organic wastes through the appropriate mix of home composting, kerbside collection, and use of civic amenity sites.
- A national waste awareness and consumer campaign to raise public awareness of waste and recycling issues, and a programme of support for locally - managed awareness schemes to increase participation in new or expanded recycling schemes.
- A range of issue - specific waste minimisation initiatives on home composting, reusable nappy schemes, retailer campaigns and other key areas.

WRAP http://www.wrap.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 broken down in the absence of oxygen. Material is placed in an enclosed vessel and in controlled conditions the waste breaks down, typically into a digestate, liquor and biogas.

Animal By-Products Regulations - Legislation governing the processing of wastes derived from animal sources.

Best Practicable Environmental Option BPEO - BPEO is defined within PPG10 as 'the outcome of a systematic and consultative decision making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO establishes for a given set of objectives, the option that provides the most benefits or the least damage to the environment, as a whole, at acceptable cost, in the long term as well as the short term.'

Biodegradable - Capable of being biologically degraded. Biodegradable municipal waste includes paper and card, food and garden waste, and a proportion of other wastes, such as textiles.

Biogas - Gas resulting from the fermentation of waste in the absence of air (comprising mainly methane/carbon dioxide).

Biodegradable Municipal Waste (BMW) - The component of Municipal Solid Waste capable of being biologically degraded. Biodegradable Municipal Waste includes paper and card, food and garden waste, and a proportion of other wastes, such as textiles.

Bottom Ash - The ash that arises from a combustion process in a furnace .

Bring Site - Facilities provided at supermarkets or other convenient locations visited by householders, in which recyclable waste may be deposited.

Char - Solid material remaining following partial combustion, gasification or pyrolysis.

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 in combination with other fuels such as coal.

Co-mingled - Different recyclable materials collected in the same container.

Digestate - Solid and/or liquid product resulting from Anaerobic Digestion.

Feedstock - Raw material required for a process.

Fermentation - A chemical/biochemical 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.

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 process used to produce town gas from coal.

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 (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, water vapour and some of the chlorofluorocarbons. Greenhouse gases are a cause of global warming.

Green Waste - Vegetation and plant matter from household gardens, local authority parks and gardens and commercial landscaped gardens.

Glossary

Global Warming - The progressive gradual rise of the earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns. An increase in the near surface temperature of the Earth. Global warming has occurred in the distant past as the result of natural influences, but the term is most often used to refer to the warming predicted to occur as a result of increased emissions of greenhouse gases.

Incineration - The controlled thermal treatment of waste by burning, either to reduce its volume or toxicity. Energy recovery from incineration can be made 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 (IVC) - 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 / separation of recyclable materials.

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 - The most common type of grate mechanism in an Energy from Waste plant, designed to carry the feedstock through the furnace.

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.

Proximity Principle - This principle requires that waste should generally be disposed or treated as near to its place of production as possible.

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.

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.

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 (ROCs), for which each supplier of electricity must demonstrate compliance with increasing Government targets for renewable energy generation.

Glossary

Reuse - Can be practised by the commercial sector with 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/Source-separated - Usually applies to household waste collection systems where recyclable and/or organic fractions of the waste stream are separated by the householder and are collected separately.

Statutory Best Value Performance Indicators - Local Authorities submit performance data to Government in the form of annual performance indicators (PIs). The Recycling and Composting PIs have statutory targets attached to them 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 (in a single tier area) 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 (in a single tier area) with responsibility for safe disposal of all waste arisings in a particular geographical area. The Environmental Protection Act 1990 requires 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'. 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 month.

www.defra.gov.uk

Waste Implementation Programme
New Technologies