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Mechanical Biological Treatment & Mechanical Heat Treatment of Municipal Solid Waste

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Waste Implementation Programme
New Technologies

This Waste Management Technology Brief is one of a series of documents prepared under the New Technologies work stream of the Defra Waste Implementation Programme. The Briefs are addressing potentially important new technologies which may have an increasing role in diverting Municipal Solid Waste (MSW) from landfill into a more sustainable and integrated waste management alternative, extracting materials and energy from MSW for recovery and reducing quantities remaining for disposal. Other titles in this series include: An Introductory Guide to Waste Management Options; Advanced Biological Treatment; and Advanced Thermal Treatment.

It should be noted that these documents are intended as guides to each generic technology area and for more detailed or specific information on any particular technology, it is recommended that the Defra Waste Technology Data Centre is used as a resource. These Briefs deal primarily with the treatment and processing of unsorted MSW and not source segregated wastes which are addressed by the activities of the Waste & Resources Action Programme (WRAP). Relevant references and sources of further information are cited throughout each document in this series.

The prime audience for these Briefs are local authorities, in particular waste management officers, members and other key decision makers for MSW management in England. For further information on new technologies contact the New Technologies Supporter Helpline on 0870 2409894, email: Wastetech@enviros.com

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Introduction

Municipal Solid Waste (MSW) is waste collected by or on behalf of a local authority. It comprises mostly household waste and it may include some commercial and industrial wastes. Nationally, the quantity of MSW is currently increasing year on year, presenting a growing problem for local authorities particularly as new legislation, which limits (by implication[1]) the amount of mixed MSW that can be sent to landfill, comes into effect.

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 either materials and/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 organic waste composting) or generate energy from the wastes (for example through incineration, or digesting biodegradable wastes to produce usable gases).

At present more than 75% of all MSW generated in England is disposed of in landfills. However, European and UK legislation has been put in place to limit the amount of biodegradable municipal waste (BMW) sent for disposal in landfill. The diversion of this material is currently the most significant challenge facing the management of Municipal Solid Waste in the UK.

There are a wide variety of alternative waste management options and strategies available for dealing with Municipal Solid Waste to limit the residual amount left for disposal to landfill. The aim of this guide is to provide impartial information about the range of technologies referred to as Mechanical Biological Treatment (MBT) and Mechanical Heat Treatment (MHT). These technologies are pre-treatment technologies which contribute to the diversion of MSW from landfill when operated as part of a wider integrated approach involving additional treatment stages. They are part of a range of new alternatives currently being assessed and investigated through the New Technologies work stream of Defra.

[1]Targets pertain to the biodegradable fraction

Further details about the new technologies featured in this report are available from Defra's Waste Technology Data Centre:

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

The technologies described in this Brief - Mechanical Biological Treatment and Mechanical Heat Treatment - have a varying, track record in England (and the UK). MBT plant, have a chequered history in the UK, early examples of similar processes including 'Refuse Derived Fuel' (RDF) processing plant and residual waste Materials Recovery Facilities ('Dirty MRFs'). The new MBT technologies are now second or third generation plant including many well proven examples. On the continent many of these processes are established viable and bankable. The aim of this document is to raise awareness and help bring the UK up to that standard.

This guide is designed to be read in conjunction with the other Waste Management Technology Briefs in this series and with the case studies provided on Defra's Waste Technology Data Centre. Other relevant sources of information are identified throughout the document.

This section comprises an overview of the principles of Mechanical Biological Treatment (MBT) and Mechanical Heat Treatment (MHT) processes. It should be noted that there are a myriad of acronyms and titles ascribed to different treatment technologies falling within this Brief, however for the purpose of clarity this document differentiates only two principle technology categories. Those involving biological treatment in conjunction with mechanical processing (MBT) and those using thermal treatment in conjunction with mechanical processing (MHT).

The generic purpose of all these processes is to separate a mixed waste stream into several component parts, to give further options for recycling and recovery.

Mechanical Biological Treatment Facility, Cologne

Mechanical Biological Treatment

Mechanical Biological Treatment 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 plant. MBT plant can incorporate a number of different processes in a variety of combinations. Additionally, MBT plant can be built for a range of purposes.

A common aspect of all MBT plant used for MSW management is to sort mixed waste into different fractions using mechanical means; and to extract materials for recycling. The exact mix of technologies employed in an MBT facility will depend on the additional objectives of the plant. These objectives would typically be one or more of the following:

- part stabilise the waste prior to landfilling;
- biologically process a segregated 'organic rich' component of the waste [for example, to form a low grade soil conditioner]; and
- produce a segregated high calorific value waste to feed an appropriate thermal process to utilise its energy potential.

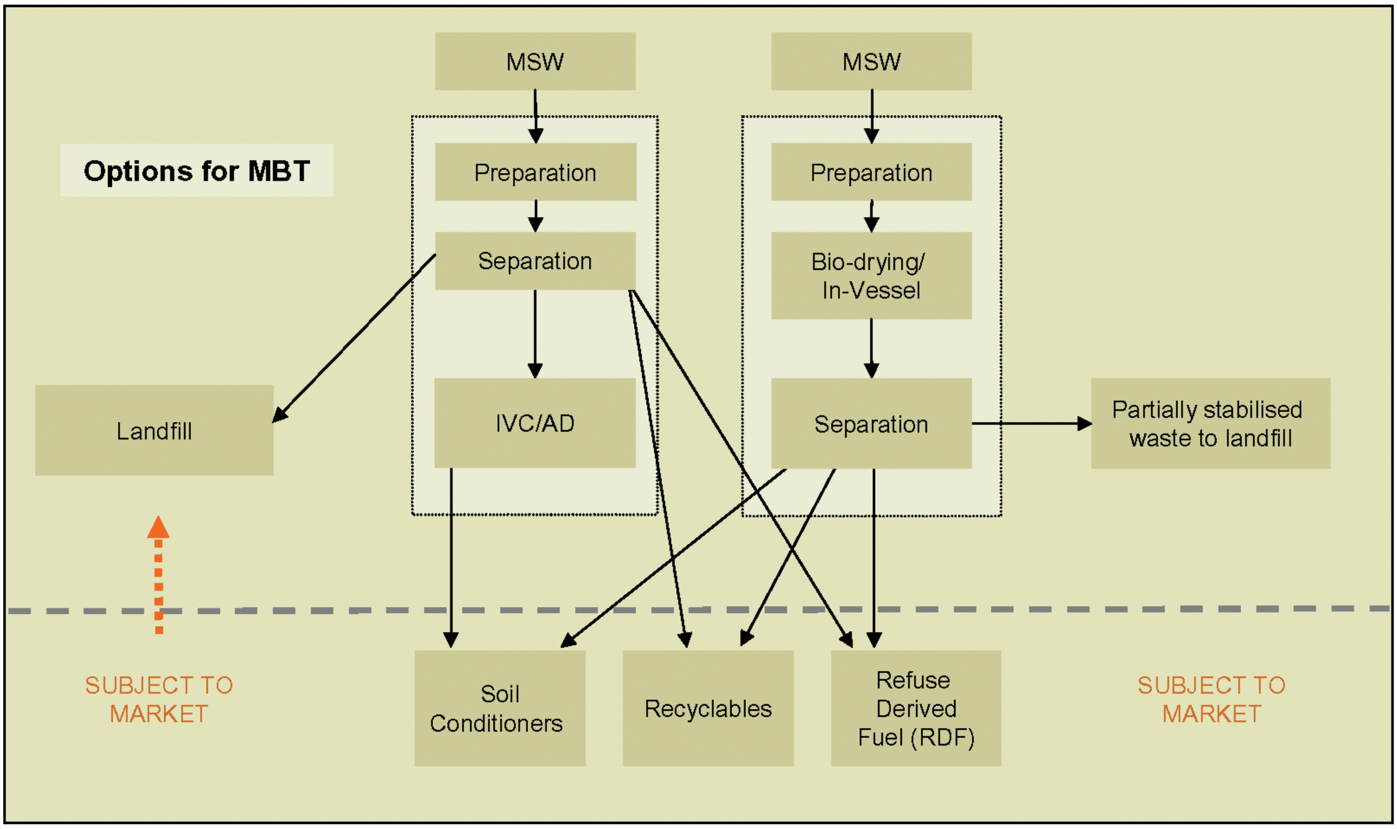
Box 1 Fuel from mixed waste processing operations

The current prevalent term used for a fuel produced from combustible waste is Refuse Derived Fuel (RDF). The types of technologies used to prepare/segregate a fuel fraction from MSW include many of the MBT/BMT and MHT processes described within this Brief. A CEN Technical Committee (TC 343) is currently progressing standardisation work on fuels prepared from wastes, classifying a Solid Recovered Fuel (SRF). It is anticipated that once standards are developed and become accepted by users that SRF will become the terminology used by the waste management industry. Other terminology has also been introduced to the industry as various fuel compositions may be prepared from waste by different processes. Examples include 'Biodegradable Fuel Product' (BFP) and 'Refined Renewable Biomass Fuel' (RRBF).

Within this Brief, Refuse Derived Fuel will be used as a term to cover the various fuel products processed from MSW.

The biological element of an MBT process may either take place prior to or after mechanical sorting of the waste, as illustrated in Figure 1. Each approach has its own particular application and examples of both methodologies are described in the case studies below and in more detail on the Waste Technology Data Centre.

Figure 1 : An illustration of the potential Mechanical Biological Treatment options



The combination of mechanical waste preparation and separation techniques used and their configurations are many and varied. Box 2 illustrates the typical options used in MBT systems.

Box 2

Mechanical Waste Preparation Technologies

Technology	Principle	Key Concerns
Hammer Mill	Material significantly reduced in size by swinging steel hammers	Wear on Hammers, pulverising and 'loss' of glass/aggregates, exclusion of pressurised containers
Shredder	Rotating knives or hooks rotate at a slow speed with high torque. The shearing action tears or cuts most materials	Large, strong objects can physically damage, exclusion of pressurised containers
Rotating Drum	Material is lifted up the sides of a rotating drum and then dropped back into the centre. Uses gravity to tumble, mix, and homogenize the wastes. Dense, abrasive items such as glass or metal will help break down the softer materials, resulting in considerable size reduction of paper and other biodegradable materials	Gentle action - high moisture of feedstock can be a problem
Ball Mill	Rotating drum using heavy balls to break up or pulverise the waste	Wear on balls, pulverising and 'loss' of glass/aggregates
Wet Rotating Drum with Knives	Waste is wetted, forming heavy lumps which break against the knives when tumbled in the drum	Relatively low size reduction. Potential for damage from large contraries
Bag Splitter	A more gentle shredder used to split plastic bags whilst leaving the majority of the waste intact	Not size reduction, may be damaged by large strong objects

Mechanical Waste Separation Technologies

Technology	Separation Property	Materials Targeted	Key Concerns
Trommels and Screens	Size and density	Oversize - paper, plastic Small - organics, glass, fines	Air containment and cleaning
Manual Separation	Visual examination	Plastics, contaminants, oversize, not usually for MSW	Ethics of role, Health & Safety issues
Magnetic Separation	Magnetic Properties	Ferrous metals	
Eddy Current Separation	Electrical Conductivity	Non ferrous metals	
Wet Separation Technology	Differential Densities	Floats - Plastics, organics Sinks - stones, glass	Produces wet waste streams
Air Classification	Weight	Light - plastics, paper Heavy - stones, glass	Air cleaning
Ballistic Separation	Density and Elasticity	Light - plastics, paper Heavy - stones, glass	
Optical Separation	Optical properties	Specific plastic polymers	Rates of throughput

In addition to the various mechanical technologies there are also a variety of different biological treatment techniques which are used in MBT plant. These are described in greater detail in the Advanced Biological Treatment Brief, in this series. Box 3 below outlines the key categories of biological treatment.

Box 3 Biological Treatment Options

Biological Treatment	**Key Concerns**
Aerobic - Bio-drying/ Biostabilisation: partial composting of the (usually) whole waste	See Advanced Biological Treatment Brief
Aerobic - In-Vessel Composting: may be used to either biostabilise the waste or process a segregated organic rich fraction	See Advanced Biological Treatment Brief
Anaerobic Digestion: used to process an segregated organic rich fraction	See Advanced Biological Treatment Brief

Whilst a variety of treatment and mechanical separation options are offered, these need to be optimised in terms of the outputs in order to find outlets for the various materials/fuels derived from the process (see Markets for the Outputs section). It is important to retain the flexibility (for example by allowing sufficient space within buildings) to adapt the process to produce different outputs to meet the needs of the market.

Case Studies

The following case studies illustrate examples of MBT systems and relate these to the different mechanical preparation, separation and biological treatment techniques, described in Boxes 2 & 3.

The Arrow Bio Process

The key process stages of the Arrow Bio process include: MSW reception, bag splitting, a wet separator (where the biodegradable material is separated from the ferrous and non ferrous metals and other heavy material), the "Hydrocrusher" (which separates the fibres in the biodegradable material), followed by a two stage anaerobic digestion. The gas from the digesters is burnt in an engine-powered generator.

It is accepted that the rate-controlling step in the anaerobic digestion of MSW is the hydrolysis of complex materials, such as cellulose and lignin, into small soluble molecules such as glucose, which can be easily digested. In the Arrow Bio process the mechanical shredding of the material in the "Hydrocrusher" accelerates the process. This results in substantially more of the biodegradable material being made available for conversion into gas.

Arrow Bio uses two digesters in series. The two-vessel design provides better control of the digestion process with a consequential increase in efficiency. The biogas is burnt in a spark ignition engine driving a generator. Steam could be raised in a waste heat boiler using the hot exhaust gas from the engine.

Ecodeco Process

The main process steps proposed for a UK facility are: waste reception; shredding to around 200mm; forced aeration composting to give bio-drying; and finally material separation in a MRF.

In the composting stage air is drawn through the waste which has been heaped in a hall. The bio-decomposition generates heat, that, in turn, dries the material to the stage where further composting cannot proceed. Air from the hall is cleaned via a bio-filter prior to release.

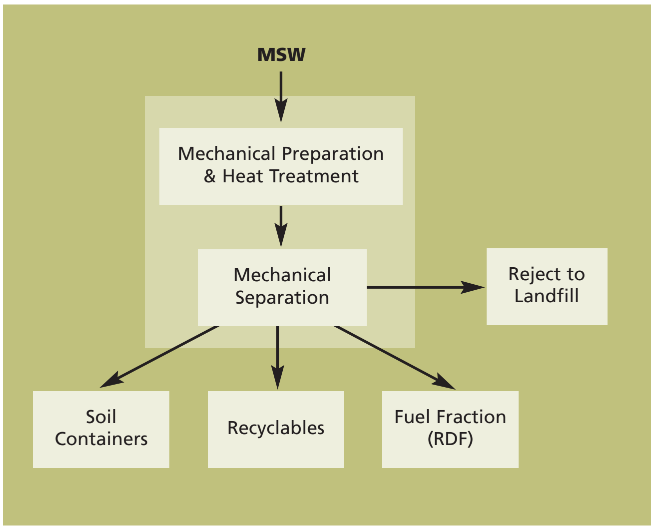
In the MRF facility, metals are removed and recycled, and the dense and light fractions separated. The dense fraction normally goes to landfill. The lighter organic and plastics fraction needs a market. It can be further separated or processed to a specification needed for a particular application. Various applications including land remediation and use as a fuel are currently under development.

Mechanical Heat Treatment

Mechanical Heat Treatment (MHT) is a relatively new term. It is used to describe configurations of mechanical and thermal, including steam, based technologies. New waste management technologies which use other (higher temperature) thermal treatment processes are dealt with in a separate Brief in this series 'Advanced Thermal Treatment'.

Figure 2 below illustrates the variety of options with the concept of MHT, which are likely to use similar mechanical preparation and separation technologies to those described in Box 2, page 5. This is also illustrated by the case studies which follow.

Figure 2 : Mechanical Heat Treatment



The most common system being promoted for the treatment of MSW using MHT is autoclaving (see Box 4). This technology is in common use for the treatment of some clinical wastes and also for certain rendering processes for animal wastes. However its application to MSW is a recent innovation, and there is limited commercial experience on this feedstock material.

Box 4 Heat Treatment Options

Heat Treatment Process	Key Concerns
Autoclaving - batch, steam processing in a vessel under the action of pressure	Batch nature of process
Continuous heat treatment in a vessel, not under the action of pressure	Limited track record

Different MHT systems may be configured to meet various objectives with regard to the waste outputs from the process (Figure 2). The alternatives (depending on the system employed) may be one or more of the following:

- Separate an 'organic rich' component of the waste for subsequent biological processing [for example to form a low grade soil conditioner];
- produce a segregated high calorific value waste (RDF/SRF see box 1, p.3) to be applied in an appropriate process to utilise its energy potential; and
- extract materials for recycling (typically glass and metals, potentially plastics and the 'fibrous' organic and paper fraction).

Whilst a variety of treatment and mechanical separation options are offered, these need to be optimised in terms of the outputs in order to find outlets for the various materials/fuels derived from the process (see Markets for the Outputs section). It is important to retain the flexibility (for example by allowing sufficient space within buildings) to adapt the process to produce different outputs to meet the needs of the market.

Case Studies

The following case studies illustrate examples of MHT system and relate these to the different mechanical preparation, separation and heat treatment techniques, previously described in Boxes 2 & 4.

Fairport Process

This process uses conventional mechanical handling and processing plant.

The Fairport process dries the waste to enable it to be more efficiently separated and hence produce several recyclate streams. The final stage of the separation uses the "Fairport separator". This high efficiency device results in several separations on the basis of size and density. Fairport then blend these fractions together with other materials to produce a fuel meeting a predefined specification.

The energy for the drying stage is from a gas burner, this ensures that the more valuable renewable energy in the feed is not lost from the products.

A demonstration plant has already been built and tested in Lancashire. The technology will likely be most appropriate at the +70,000 T/yr. scale and hence serve a large town or city.

Estech Process

This process uses wet steam under pressure (autoclave) to clean materials, soften plastics and reduce biodegradable material into a fibre. Following the autoclaving or "cooking" process the materials can be more easily and effectively separated in a MRF.

The key process stages include waste reception and storage, waste feeding, autoclaving, materials separation with recyclates recovery.

The autoclave stage is central to the process and operates as a batch operation. After charging with waste the autoclave drum is sealed and rotation started. Saturated steam at c. 160°C is injected into the vessel and the pressure maintained at 5 bar gauge for a period of up to 45 minutes to allow the process to fully "cook" the waste. After "cooking", the steam flow is stopped and the pressure vented via a condenser. The "cooked" material is discharged and separated by a series of screens and recovery systems. The primary product is a fibre. It is understood that a number of development projects and joint ventures have been created by Estech to generate useful markets for the fibre. Alternatively the fibre could constitute a Refuse Derived Fuel.

The secondary streams comprise of mixed plastics, a glass and aggregate stream and separate ferrous and non-ferrous metals. All these streams are exceptionally clean having been steam cleaned.

The full cycle of loading, treatment and sorting is normally completed within 90 minutes.

Summary

This section illustrates that Mechanical Heat Treatment and Mechanical Biological Treatment systems can be described as two simple concepts: either to separate the waste and then treat; or to treat the waste and then separate. The treatment phase may be either thermal or biological and there are a wide variety of separation techniques.

MBT and MHT, as illustrated by the case studies, represent significant facilities, which are capital intensive (see Costs of MBT/MHT Systems section) and are anticipated to be in operation for 15 - 20 years. In this instance of emergent markets for outputs from such processes it is prudent to ensure sufficient installed capacity for flexibility within any plant (which may require new equipment, etc) to adapt to the needs of the market.

In the UK, at present, the market for many of the outputs from MBT and MHT does not exist. Considerable effort is being undertaken by a number of organisations and individuals to change this situation. Plants being specified today will need to provide materials into an as yet undeveloped market. Clearly it is prudent to design for, or at least maintain the option of creating, flexibility in the degree and type of materials separation that any proposed plant can achieve.

The following section summarises some key issues with regard to the outlets for outputs derived from MBT and MHT processing of MSW.

Recovery from MBT

Attention needs to be paid to the quality of recovered materials arising from MBT processes. Certain technologies have the ability to achieve exceedingly clean materials, others do not (see case studies and the Waste Technology Data Centre).

When considering quantities and quality of recovered materials it is important that any mass balance accurately reflects the nature of materials fed into the plant.

Materials Recycling

Recyclables derived from the various MBT processes are typically of a lower quality than those derived from a separate household recyclate collection system and therefore have a lower potential for high value markets. The types of materials recovered from MBT processes almost always include metals (ferrous and non-ferrous) and for many systems this is the only recyclate extracted. However these plant can help enhance overall recycling levels and enable recovery of certain constituent items that would not otherwise be collected in household systems (e.g. steel coat hangers, paper clips etc.).

Other materials which may be extracted from MBT processes include glass, textiles, paper/card, and plastics.

The most common of these is glass, which may be segregated with other inert materials such as stones, for use as a low grade aggregate. The extent of glass recovery is enhanced by the nature of any waste preparation process (see Box 2, page 5).

Textiles, paper and plastics, if extracted, are unlikely to receive a significant income as a recyclate and in some instances may not yield a positive value. Most of these plant can experience problems with the heavier textiles such as carpets. Clearly none are likely to separate textiles into different types of fibre.

Paper is unlikely to be segregated in isolation of some textiles, plastic film, etc. unless hand-picked.

The plastics separated from these processes will almost always be mixed plastics, whilst the technology is available to separate individual plastic types it is expensive and unlikely to be applied to most MBT processes. Whilst markets are being developed for mixed plastics, these applications are limited at present.

For more information on the contribution of MBT to Best Value Performance Indicators and recycling see page 21 and for the latest developments, see the BVPI website http://www.defra.gov.uk/environment/waste/localauth/index.htm or contact the Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com

Soil Conditioners

The mechanically separated organic fraction from mixed waste streams will typically represent a lower value output than that from source segregated organic materials. This is largely due to the high inclusion of non-biodegradable material likely to be present in compostable materials from mixed waste streams. This will also limit the potential applications of the material.

It should be noted that many of the aerobic MBT processes are designed for *bio-drying* and not *bio-stabilisation* as required by compost/soil conditioner, therefore further biological processing of these wastes would be required prior to any use on land.

Markets for the Outputs

The output from this type of process is expected to be a low grade soil conditioner which may be utilised in applications such as landfill restoration or some engineering end uses (provided that the appropriate biological, quality and aesthetic standards are achieved).

These markets are traditionally low value and materials may be in competition with other more traditional soil improvers such as sewage sludge, poultry waste or source segregated green waste derived compost. There is also the issue of gaining the confidence of the market in terms of the quality of the product.

Additionally, the process used to develop these soil conditioners will need to comply with the Animal By-Products Regulations in order for the materials to be used on land. Furthermore, at present, low grade soil conditioners generated by MBT plants require a waste management license, or an exemption from licensing, if they are to be spread on land. The current status for these materials (EA Feb. 2005) is that unless an exemption is granted, the material will not be classified as having been diverted from landfill, and therefore may count (if not bio-stabilised) against Landfill Allowances.

For more information on Animal By Products and outlets for the organic outputs from MBT, see the Advanced Biological Treatment Waste Management Technology Brief, as part of this series and the State Veterinary Service[2].

For more information on the contribution of MBT to Best Value Performance Indicators and composting see page 21 and for the latest developments, see the BVPI website[3] or contact the Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com

Materials Recovered for Energy

Where the MSW is sorted/treated to produce a high calorific value waste stream comprising significant proportions of the available combustible materials such as mixed paper, plastics and card, this stream may be known as Refuse Derived Fuel (RDF - see Box 1, p.3).

There are a number of dedicated conventional combustion plant that use RDF as a fuel to generate electricity (see Table 1). This type of fuel that would also be appropriate for a Fluidised-Bed energy from waste plant (which requires a prepared waste feedstock for the combustion process).

Table 1 : Conventional technology plant generating electricity from RDF

RDF Combustion plant	Operator	K tonnes/ year	Net Capacity (MW)
Pebsham	Utilised by Slough Heat & Power	75	2.5
Neath Port Talbot (currently not operational)	HLC	135	8.2

RDF may also be utilised within some Advanced Thermal Treatment (ATT) processes. An appropriately scaled, dedicated ATT plant could represent a part of an integrated strategy in combination with MBT. A separate Waste Management Technology Brief, in this series, is available on the subject of ATT processes. Please also see page 22, Renewables, for extra information.

The energy use incurred in the separation of waste typically involves around 15 - 20% of the energy value of the waste. If the RDF is to be used as an energy source, to establish any environmental benefit as opposed to combusting the waste in a mass burn Energy from Waste plant, then either: a high efficiency Advanced Thermal Treatment process needs to be used, or; the RDF needs to be used as a replacement fuel, for example for fossil fuels. Not all ATT processes will offer the efficiencies appropriate.

2 www.defra.gov.uk/animalh/by-prods/default.htm

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

Refuse Derived Fuel

The other option for RDF is to co-combust with other fuels, such as coal, in power generation, cement production or other large thermal processes. The advantage of this option is that the infrastructure may already be in place; a disadvantage is that the outlet for the fuel is subject to obtaining a contract of sufficient duration and tonnage, with a commercial partner.

The co-combustion of RDF is an emerging market. It is currently anticipated that cement kilns provide the majority of potential capacity for using RDF, given the current political, regulatory and commercial environment. It is estimated that the British cement industry will be able to utilise up to 500,000 tonnes per annum of RDF or other packaging waste. There is however, competition from other wastes to be processed within the cement production process including tyres, some hazardous wastes, secondary liquid fuels etc.

Consequently it is expected that there may be competition (and competitive gate fees) for acceptance of RDF at cement kilns. Emphasis should be put on developing sustainable markets for materials.

As an emerging market there are also potential risks in terms of the operations of large thermal facilities accepting RDF from mixed waste processing as a fuel source. However, waste contractors are developing relationships with the cement industry to try and meet their specifications and provide a useful industrial fuel and waste recovery operation.

RDF is currently classified as a waste and therefore any facility using the fuel will be subject to the requirements of the Waste Incineration Directive. None of the RDF material can be processed in any of the UK coal fired power stations if the Waste Incineration Directive is deemed to be applicable.

The processing of waste to generate electricity will, in certain circumstances, be eligible for a Government incentive for renewable energy production. The incentive scheme is known as the Renewables Obligation Order and the sale of electricity derived from these processes could qualify for Renewables Obligation Certificates (or ROCs) thereby securing a premium price for electricity sales. RDF does not currently qualify for ROCs unless it is used in 'advanced conversion technologies', including pyrolysis or gasification plant (see the Advanced Thermal Treatment Brief). The Renewables Obligation Order is due to be consulted upon this year (2005) for possible revisions to the system. Up-to-date information regarding RDF and ROCs can be obtained from the DTI website[4] or the New Technologies Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com.

For more information on the contribution of MBT to Best Value Performance Indicators see page 21 and for the latest developments, see the BVPI website[5] or contact the Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com

Recovery from MHT

Materials Recycling

Glass and metals derived from some MHT processes have the potential to be significantly cleaner than those from MBT processes due to the action of steam cleaning, which removes glues and labels. Other recyclables such as plastics may also be extracted from some systems; however certain plastic materials may also be deformed by the heat of the process, potentially making them more or less difficult to recycle in some instances.

An emerging area of potential recycling from some MHT systems is the use of the separated cellulose fibrous material which may be a by-product of the process.

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4 http://www.dti.gov.uk/energy/renewables/

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

This fibre may be used as a raw material in recycled products, biologically processed for use as a low grade soil conditioner, as a bio-stabilised residue for disposal, or utilised for its combustible properties as a fuel (see below).

Work is being undertaken to evaluate use of the fibre as a raw material for example by mixing the fibre together with crushed shale and a resin to manufacture products (e.g. composite such as floor tiles). The market for recycled products made with fibre from MHT processes is under development at present.

For more information on the contribution of MHT to Best Value Performance Indicators and recycling see page 21 and for the latest developments, see the BVPI website[6] or contact the Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com

Materials Recovery for Energy

Some MHT systems are configured to produce RDF (or alternatives, see Box 1, page 3) for combustion in another process, as described under MBT. The same market issues are anticipated for this output as for the equivalent MBT output. However some systems are designed to process RDF to a particular fuel specification tailored to a specific market demand. For more detail on RDF markets refer to the MBT section above. The fibre produced by an MHT plant will have different characteristics to an RDF produced by an MBT plant and this may affect the operational requirements for this material.

For more information on the contribution of MHT to Best Value Performance Indicators and recovery see page 22 and for the latest developments, see the BVPI website[6] or contact the Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com

[6] http://www.defra.gov.uk/environment/waste/localauth/index.htm

Mechanical Biological Treatment

The concept of MBT originated in Germany where it is an established waste treatment method. Regulatory restrictions on landfill space, the search for alternatives to incineration / Energy from Waste, and increased costs of landfill disposal have been the major drivers for the development of these technologies. The largest European markets for established MBT plant include Germany, Austria, Italy, Switzerland and the Netherlands, with others such as the UK growing fast. Furthermore, other countries outside Europe are also using this technology.

Since the early 1990s, MBT processes have changed significantly, so today, numerous configurations of plant have developed, and these are provided by a variety of companies.

There are over 70 MBT facilities in operation in Europe, with over 40 MBT facilities operating in Germany. However, not all of these facilities are commercial and some of those included in Table 2 include pilot and demonstration plants.

Mechanical Heat Treatment

The concept of Mechanical Heat Treatment is new for MSW and therefore most of the operational experience is based on small scale or mobile demonstration plant. There is due to be a 70,000tpa MHT plant operating on MSW in Minnesota from CR3 Inc.

Table 2 : Examples of MBT plant operational in Europe

Technology Provider	Country	No of Plants
Hese Umwelt	UK	1
EcoDeco	UK	1
Cambridge Recycling Services Ltd	UK	1
Civic Environmental Systems	UK	1
Sutco	Germany	5
Electrowatt-Ekono	Germany	1
Herhof	Germany	3
Dranco	Germany	2
ISKA	Germany	1
Horstmann	Germany	4
Wehrle Werk	Germany	1
BTA	Germany	1
BTA	Italy	1
Dranco	Italy	1
Ionics Itabila	Italy	1
Snamprogetti	Italy	1
Valorga	Italy	1
EcoDeco	Italy	4
Herhof	Italy	1
Valorga	Spain	2
Linde	Spain	1
Dranco	Spain	1
BTA/Roediger	Poland	1
Citec	Finland	1
Citec/Vagron	Holland	1
Valorga	Belgium	1
Valorga	France	2
Vagron	Netherlands	1
Dranco	Switzerland	1
Dranco	Austria	1
VKW	Austria	1
VKW	Italy	1
VKW	Turkey	1

Contractual and Financing Issues

Grants & Funding

Development of MBT and MHT plant will involve capital expenditure of several million pounds. There are a number of potential funding sources for Local Authorities planning to develop such facilities, including:

Capital Grants: general grants may be available from national economic initiatives and EU structural funds;

Prudential Borrowing: the Local Government Act 2003 provides for a new 'prudential' system of capital finance controls;

PFI Credits and Private Sector Financing: under the Private Finance Initiative a waste authority can obtain an annual subsidy from central government through a Special Grant;

Other Private-Sector Financing: A contractor may be willing to enter a contract to provide a new facility and operate it. The contractor's charges for this may be expressed as gate fees; and

Existing sources of local authority funding: for example National Non-Domestic Rate payments (distributed by central government), credit (borrowing) approvals, local tax raising powers (council tax), income from rents, fees, charges and asset sales (capital receipts). In practice capacity for this will be limited.

Contractual Arrangements

Medium and large scale municipal waste management contracts are usually procured through the negotiated procedure of the OJEU process.

The available contractual arrangement between the private sector provider (PSP) and the waste disposal authority (or partnership) may be one of the following:

Separate Design; Build; Operate; and Finance:The waste authority contracts separately for the works and services needed, and provides funding by raising capital for each of the main contracts. The contract to build the facility would be based on the council's design and specification and the council would own the facility once constructed;

Design & Build; Operate; Finance: A contract is let for the private sector to provide both the design and construction of a facility to specified performance requirements. The waste authority owns the facility that is constructed and makes separate arrangements to raise capital. Operation would be arranged through a separate Operation and Maintenance contract;

Design, Build and Operate; Finance: The Design and Build and Operation and Maintenance contracts are combined. The waste authority owns the facility once constructed and makes separate arrangements to raise capital;

Design, Build, Finance and Operate (DBFO): This contract is a Design and Build and Operate but the contractor also provides the financing of the project. The contractor designs, constructs and operates the plant to agreed performance requirements. Regular performance payments are made over a fixed term to recover capital and financing costs, operating and maintenance expenses, plus a reasonable return. At the end of the contract, the facility is usually transferred back to the client in a specified condition; and

DBFO with PFI: This is a Design, Build, Finance and Operate contract, but it is procured under the Private Finance Initiative. In this case the waste authority obtains funding for future payment obligations from Government as a supplement to finance from its own and private sector sources.

The majority of large scale waste management contracts currently being procured in England are Design, Build, Finance and Operate contracts and many waste disposal authorities in two tier English arrangements (County Councils) are currently seeking to partner with their Waste Collection Authorities (usually District or Borough Councils). Sometimes partnerships are also formed with neighbouring Unitary Authorities to maximise the efficiency of the waste management service and make the contract more attractive to the Private Sector Provider.

Before initiating any procurement or funding process for a new waste management treatment facility, the following issues should be considered: performance requirements; waste inputs; project duration; project cost; available budgets; availability of sites; planning status; interface with existing contracts; timescales; governance and decision making arrangements; market appetite and risk allocation.

Further guidance on these issues can be obtained from:

- Procurement Toolkit[7]
- For Works Contracts: the Institution of Civil Engineers 'New Engineering Contract'[8]
- For large scale Waste Services Contracts through PFI AND following the Negotiated Procedures the 4ps 'Waste Procurement Pack'[9]
- The Local Government PFI project support guide[10]

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7 http://lasupport.defra.gov.uk/Default.aspx?Menu=Menu&Module=Article&ArticleID=102

8 available at www.ice.org.uk

9 available at www.4ps.gov.uk

10 www.local.odpm.gov.uk/pfi/grantcond.pdf

Planning and Permitting Issues

This section contains information on the planning and regulatory issues associated with MBT/MHT facilities based on case studies of existing facilities and information on planning from the Office of the Deputy Prime Minister research report.

Planning

When considering the planning implications for an MBT/MHT facility the following issues have been considered:

- Plant/Facility Siting;
- Traffic;
- Air Emissions/Health Effects;
- Dust/Odour;
- Flies, Vermin and Birds;
- Noise;
- Litter;
- Water Resources;
- Visual Intrusion; and
- Public Concern.

Some of these criteria are discussed elsewhere in this guide but a brief overview of each is provided here.

Plant Siting

Mixed waste processing (such as MBT and MHT) can take place in many different buildings at a variety of locations but the following considerations should be made:

- Preference should be given to industrial or degraded sites or sited close to or with existing waste management facilities;
- General concerns about bio-aerosols from biological processing may require an MBT site to be located at least 250m from any sensitive receptors; and
- The site chosen should be close to the Primary Road Network, especially if it is to be a large scale/centralised facility where the site should be appropriate for the movement of HGV traffic without major restriction.

Traffic

Centralised waste facilities will most likely be served by large numbers of HGVs with a potential impact on local roads and the amenity of local residents. It is likely that the site layout/road configuration will need to be suitable to accept a range of light and heavy vehicles. Mixed waste processing operations are designed to split a mixed waste stream into a number of individual streams some of which are low tonnage or low bulk density. As a result traffic implications may be greater than initially considered.

The traffic movements anticipated from a 50,000tpa plant would be 20 - 30 refuse collection vehicles per day. This would be reduced if bulk transport systems are used.

Air Emissions/Health Effects

Air emissions and health impacts for this type of facility are most likely to be linked to traffic movements and potentially bio-aerosols from biological processing. Although there is not much experience of this type of technology in the UK there is extensive work which can be drawn upon about biological processing which could be used in planning applications.

Progress has been made in Europe towards thermal emissions clean-up using 850°C for two seconds. Other systems use biofilters to clean up emissions. For more details see the case studies and the Waste Technology Data Centre (www.environment-agency.gov.uk/wtd).

Dust/Odour

Any waste management operations can give rise to dust and odours. These can be minimised by good building design, performing all operations under controlled conditions indoors and good working practices and effective management undertaken for dust suppression from vehicle movements. Many mixed waste processing operations such as MBT and MHT operate under negative pressure within buildings with air passed through an emissions clean up process.

Flies, Vermin and Birds

MBT and MHT processing is unlikely to attract vermin and birds due to majority of waste throughput and operations being completely enclosed in buildings. However, during hot weather it is possible that flies could accumulate, especially if they have been brought in during delivery of the waste. Effective housekeeping and on site management of tipping and storage areas is essential to minimise the risk from vermin and other pests. In some operations waste heat from the process may be used in fresh input waste to bring temperatures to levels above which flies can live. Similarly, waste storage in some MBT plant is designed to be less that the breeding cycle of vermin such as rats.

Noise

Noise is an issue that will be controlled under the waste licensing regulations. The main contributors to noise associated with MBT/MHT are likely to be:

- vehicle movements/manoeuvring;
- traffic noise on the local road networks;
- mechanical processing such as shredders, screens, trommels and ball mills; and
- air extraction fans and ventilation systems.

Litter

Any waste which contains plastics and paper are more likely to lead to litter problems. With MBT / MHT as long as good working practices are adhered to and vehicles use covers and reception and processing are undertaken indoors, litter problems can be minimised.

Water Resources

Pollution to water is unlikely due to MBT facilities being under cover and rainfall is unlikely to come into contact with the process. Even so, any wash down waters or liquid within the waste will need to be managed using a drainage system on site. Some water is likely to be used in MHT processes. This is often cited as being reused within the process, but again such process water will need to be managed. The case studies on the Waste Technology Data Centre include an assessment of water usage.

Visual Intrusion

Construction of any building will have an effect on the visual landscape of an area. Visual intrusion issues should be dealt with on a site specific basis and the following items should be considered:

- Direct effect on landscape by removal of items such as trees or undertaking major earthworks;
- Site setting; is the site close to listed buildings, conservation areas or sensitive viewpoints;
- Existing large buildings and structures in the area;
- The potential of a stack associated with some air clean up systems for mixed waste processing operations may impact on visual intrusion;
- Use of screening features (trees, hedges, banks etc); and
- The number of vehicles accessing the site and their frequency.

Most of these facilities are housed in 'warehouse' type clad steel buildings.

External view of MBT facility

Planning and Permitting Issues

Size and Landtake

Table 3 shows the land area required for the building footprint and also for the entire site (including supporting site infrastructure) for Mechanical Biological and Mechanical Heat Treatment facilities.

Table 3 : Landtake

	Size	Building Area	Total Landtake
MBT Plant A[b]	50,000tpa	3,000m^2	
MBT Plant B[c]	75,000tpa	5,500m^2	15,000m^2
MBT Plant C[c]			0.36m^2/t
MBT Plant D[a]	140,000tpa	9,000m^2	
MBT Plant E[a]	180,000tpa		35,000m^2
MHT Plant A[c]	100,000tpa		18,000m^2
MHT Plant B[a]	150,000tpa	4,300m^2	

a Source: Review of Residual Waste Treatment Options, 2003, AiIE

b Source: Planning for Waste Management facilities, ODPM, 2004

c Source: Waste Technology Data Centre, 2004

An average MBT plant may have a height of 10 - 20m. Some facilities may also have a stack if using particular air clean-up systems, potentially increasing overall height. For more information on Landtake for specific waste management operations, see Defra's Waste Technology Data Centre[11].

Public Concern

The Social and Perception Issues section, relates to public concern. In general public concerns about waste facilities in general relate to amenity issues (odour, dust, noise, traffic, litter etc).

Environmental Impact Assessment

It is likely that an Environmental Impact Assessment (EIA) will be required for an MBT or MHT facility as part of the planning process.

Whether a development requires a statutory EIA is defined under the Environmental Impact Assessment (England and Wales) Regulations 1999. Further guidance is available in the DETR circular 02/99 on Environmental Impact Assessment.

For more information on Planning issues associated with waste management options see Planning for Waste Management Facilities - A Research Study. Office of the Deputy Prime Minister, 2004[12].

Licensing/Permitting

If a MBT/MHT plant processes over 50tonnes per day it may be assumed that they will require a Pollution Prevention & Control (PPC) permit to operate, if processing less than this quantity a waste management license would be required. If the process is shown to produce a fuel (e.g. RDF) rather than a waste, then it would be subject to PPC irrespective of the tonnage threshold. For more information on licensing & permitting see the Enviroment Agency website[13].

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[11] www.environment-agency.gov.uk/wtd

[12] http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_030747.pdf

[13] http://www.environment-agency.gov.uk/subjects/waste/?lang=_e

This section contains a discussion of the social and public perception considerations of MBT and MHT facilities.

Social Considerations

Any new facility is likely to impact on the local residents and may provide both positive and negative impacts. Potential impacts on local amenity (odour, noise, dust, landscape) are important considerations when siting any waste management facility. These issues are examined in more detail in the Planning Section of this brief. Transport impacts associated with the delivery of waste and onward transport of process outputs may lead to impacts on the local road network. The Planning and Permitting section of this document provides an estimate of potential vehicle movements.

An MBT or MHT facility may also provide positive social impacts in the form of employment opportunities and educational opportunities. Typical employment for a MBT / MHT plant of 50,000tpa capacity would be 2 - 8 persons at any one time (more if manual picking operations are used). The plant may be operated on a shift system, for example to allow for 24 hour operations. These facilities are also likely to provide vocational training for staff. Many new facilities are built with a visitors centre to enable local groups to view the facility and learn more about how it operates.

Public Perception

Public opinion on waste management issues is wide ranging, and can often be at extreme ends of the scale. Typically, the most positively viewed waste management options for MSW are recycling and composting. However, this is not necessarily reflected in local attitudes towards the infrastructure commonly required to process waste to compost, or sort mixed recyclables. It should be recognised that there is always likely to be some resistance to any waste management facility within a locality.

At present there is a relatively low level of understanding of the concept of MBT by the public. In public consultations these technologies scores inconsistently when explained in detail as a residual waste treatment technology.

Two examples of public consultations highlighting the diversity of opinion with regard to MBT are highlighted in Box 5.

Box 5 Public consultation on MBT

A public consultation in an area of Wales resulted in a clear preference that any waste that could not be recycled or composted should be dealt with through MBT. Respondents felt that an MBT-led strategy was a positive approach for residual waste whether it aims to achieve or exceed diversion targets.

Conversely, a large scale public consultation in an area of England revealed the opposite reaction with MBT being the least favoured approach of the residual waste treatment options.

Mechanical Heat Treatment is a more recent concept and it is unclear as to the public perception of this option at present. Indeed, there is limited international experience with MHT and so public perception has yet to be fully tested. It may be that, as a mixed waste processing facility, MHT will have a similar perception as that for MBT. Alternatively, there may be a more negative perception due to a distrust of 'thermal' based techniques.

Overall, experience in developing waste management strategies has highlighted the importance of proactive communication with the public over waste management options. The use of realistic and appropriate models, virtual 'walk - throughs' / artists impressions should be used to accurately inform the public. Good practice in terms of public consultation and engagement is an important aspect in gaining acceptance for planning and developing waste management infrastructure.

Costs of MBT/MHT Systems

The cost of constructing, operating and maintaining MBT and MHT facilities are addressed using a common cost model on Defra's Waste Technology Data Centre. Both capital and operating costs are included on specific technologies which may be used for the purposes of indicative comparisons rather than accurate reflections of actual costs.

It should also be noted that MBT and MHT systems are sensitive to the markets and outlets for recycled materials, RDF and soil conditioners that are produced by different processes. Partnerships between MBT operators and potential users of outputs should be established at the earliest opportunity and indeed care should be taken to ensure plant can deliver materials of sufficient quality.

Typically around 50% of the capital costs for operating an MBT plant will be to cover capital depreciation. As a result these need to be viewed as large capital investments with a lifespan of not less than 10 or more usually 20 years.

It is vital in any negotiation, that a true appreciation of the cost of essential repairs and refurbishment be taken into account. Additionally the undeveloped markets (and risks associated with loss of markets) for products/outputs of these processes needs to be reflected in cost models. Any building should have sufficient capacity to house new separation equipment. Typically plants less than 40ktpa capacity are unlikely to be viable.

For cost information on examples of different processes see Defra's Waste Technology Data Centre www.environment-agency.gov.uk/wtd

Recycling

Recyclate derived from a mixed waste processing plant (either MBT or MHT) of household waste qualifies for BVPI 82a (Recycling) at the point at which it leaves the plant to be sent to the reprocessor. The material must pass to the reprocessor (and not be rejected for quality reasons) to count as recycling. The same would also apply to glass used as an aggregate. It should be noted that some materials may have market limitations due to being derived from a mixed MSW source. For example British Standard BS EN 643 states that 'Recovered paper from refuse sorting stations is not suitable for use in the paper industry.' Although this standard is not legally binding, it is supported by the main trade associations for the paper recycling sector.

Further information about BVPIs can be obtained from the Defra website[14].

Composting

Where MBT or MHT processes are configured to produce an organic rich stream to be utilised as a low grade soil conditioner for example, this material may (but is 'unlikely to' see below) qualify as composting under BVPI 82b. These types of mixed waste processing technologies are expected to produce a low grade soil conditioner which could be utilised in applications such as landfill restoration or some bulk fill uses (provided that the appropriate engineering and quality standards are met).

These materials will only qualify as 'composted' under the Best Value Performance Indicator (BVPI 82b) if the output meets the appropriate criteria for use in the intended application. Some waste management contractors have demonstrated that there is a market for these materials, however the current Best Value Performance Indicator Guidance (as of November 2004) states the criteria for composting should be '*a product that has been sanitised and stabilised, is high in humic substances, and can be used as a soil improver, as an ingredient in growing media or blended to produce a top soil that will meet British Standard BS2882 incorporating amendment no.1...*' It also states that it is '*unlikely that products of a Mechanical Biological Treatment process will meet this definition.*' However if the definition could be achieved then the product would qualify as BVPI 82b.

The definition of BVPI 82b has been amended to include waste which has been treated through a process of anaerobic digestion.

For more information on the processes for the organic fraction from mixed waste processing, see the Advanced Biological Treatment Brief, in this series.

For the latest position with regard to Best Value Performance Indicators for MBT and MHT see the Defra website or contact the Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com

Landfill Allowance Trading Scheme (LATS)

The European Landfill Directive and the UK's enabling act, the Waste & Emissions Trading Act 2003, require the diversion of biodegradable municipal waste (BMW) from landfill. Both MBT and MHT systems have the potential to divert BMW from landfill. Any outputs that are recycled, used as soil conditioner (under an exemption) or burnt as RDF and which are not landfilled will count directly towards diversion targets. The ability of MBT & MHT to meet a high level of landfill diversion will therefore depend upon the availability of markets for, and the quality of, the process outputs.

However, MBT plant can also be used to bio-stabilise waste prior to landfilling. In this case biological treatment is used to reduce the waste's potential to degrade and produce methane once landfilled. The Environment Agency (EA) are currently developing a methodology to determine the 'stability' or 'biodegradablity' of any outputs from an MBT plant which are sent to landfill. This test will be used to determine the amount of biodegradable material being landfilled in accordance with the Landfill Allowance Trading Scheme (LATS).

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[14] http://www.defra.gov.uk/environment/waste/localauth/index.htm

Contribution to National Targets

As any MBT plants developed in the UK are likely to vary in their method of operation, the stability test is likely to be applied to each MBT plant on a regular basis. Figure 3 shows a hypothetical mass balance calculation showing the contribution of an MBT plant to BMW diversion. Up to date information relating to LATS can be obtained from the New Technologies Supporter Helpline and Defra's LATS information webpage[15].

As the requirements of the Landfill Directive relate to the amount of biodegradable material landfilled, the stability of materials diverted from landfill via MBT will not need to be measured.

Recovery

MBT and MHT technologies will only contribute towards recovery targets through the waste streams that are sent to an energy recovery process. This may be either RDF combusted or degraded in a thermal plant (e.g. Energy from Waste, Advanced Thermal Treatment or co-combusted in a Cement Kiln), or the biological stream that is processed in an Anaerobic Digestion plant (see the specific guidance for BVPI 82c and also 82b for AD). For more details see the Defra website[16].

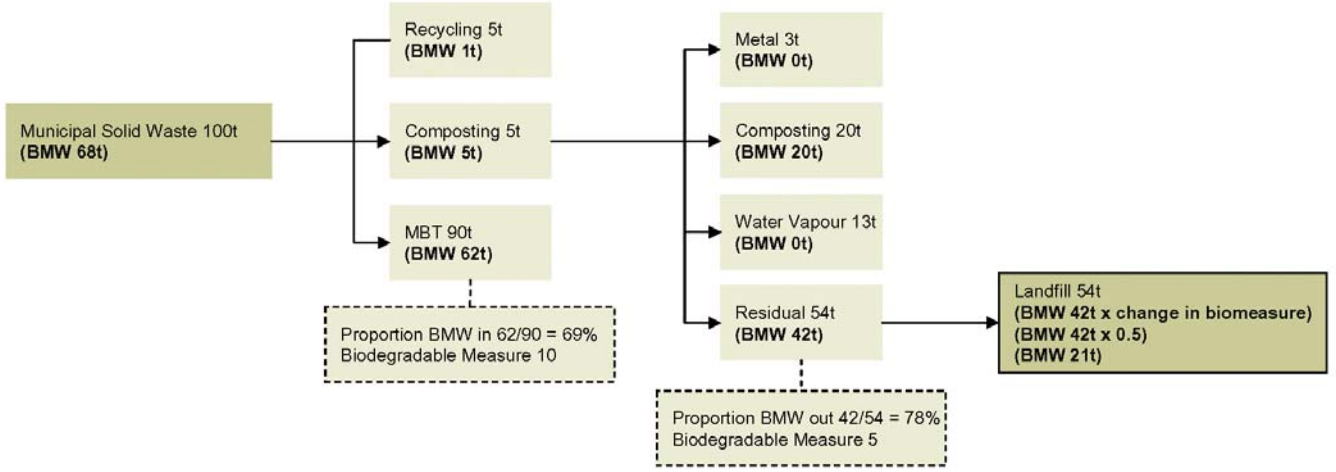
Renewables

If energy is recovered from the sorted materials (RDF) arising from an MBT or MHT plant, this would count as renewable under the Renewable Energy targets.

The Government has also introduced an incentivised market for Renewable Energy through the 'Renewables Obligation'. The combustion of Refuse Derived Fuel from an MBT or MHT process in an Energy from Waste plant at present would not qualify for this incentive and a co-combustion application is also unlikely to qualify. But the other recovery techniques of Anaerobic Digestion and Advanced Thermal Treatment (see the other Briefs in this series) do qualify for Renewables Obligation Certificates (ROCs) under this scheme (for more information see page 11).

The ROCs scheme is currently out to consultation, for up-to-date information regarding RDF and ROCs see the DTI website[17] or the New Technologies Supporter Helpline tel. 0870 2409894 Wastetech@enviros.com

Figure 3 : Hypothetical MBT Mass Balance



This hypothetical example is based on information available from the Environment Agency at the time of writing. It can be seen that although the proportion of BMW in the rejects from the MBT plant is higher in the residual output than in the input (78% vs 69%), this is off-set by a decrease in overall tonnage and by the decreased biodegrabability (increased stability) of the material. In this hypothetical example, 62 tonnes of BMW enters the plant (with a biodegradability measure of 10) and the residual material contains 42 tonnes of BMW (with a biodegrabability measure of 5). The Environment Agency have indicated that the tonnes of BMW counted as being landfilled from an MBT plant will take into account the material's increased stability (based on testing the material) and that therefore in this example the BMW tonnage being landfilled from the MBT plant would be equivalent to 21 tonnes (as the biodegradability measure has halved).

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

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

17 http://www.dti.gov.uk/energy/renewables/

Further Reading and Sources of Information

The Waste Technology Data Centre
www.environment-agency.gov.uk/wtd

New Technologies Supporter Helpline
Tel. 0870 240 9894
E: Wastetech@enviros.com

Defra New Technologies website,
http://www.defra.gov.uk/environment/waste/wip/newtech/index.htm

Integrated Pollution Prevention and Control, Draft Reference Document on Best Available Techniques for the Waste Treatments Industries, *European Commission - Directorate General Joint Research Centre*, January 2004

Refuse Derived Fuel, Current Practice and Perspectives (B4-3040/2000/306517/Mar/E3), *European Commission - Directorate General Environment*, July 2003

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http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_030747.pdf

AiIE Ltd, 2003, Review of residual waste treatment technologies, Report prepared on behalf of Kingston upon Hull City Council and East Riding of Yorkshire Council
http/www.eastriding.gov.uk/environment/pdf/waste_treatment_technologies.pdf

The Additional Paper to the Strategy Unit, Waste Not Want Not study, 'Delivering the Landfill Directive: The Role of New & Emerging Technologies', Dr Stuart McLanaghan
http://www.number10.gov.uk/files/pdf/technologies-landfill.pdf

WRAP Organics website
http://www.wrap.org.uk/materials/organics/

The Composting Association, including reports on Anaerobic Digestion and Directory of In-Vessel Composting.
http://www.compost.org.uk/dsp_home.cfm

Chartered Institution of Wastes Management.
http://www.ciwm.co.uk

Mechanical Biological Treatment: A Guide for Decision Makers, Processes, Policies and Markets (2005), by Juniper consultancy Ltd for Sita Environmental Trust.
http://www.sitaenvtrust.org.uk/research/overview

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. 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 (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, and a proportion of other wastes, such as textiles.
Co-combustion	Combustion of wastes as a fuel in an industrial or other (non waste management) process.
Digestate	Solid and/or liquid product resulting from Anaerobic Digestion.
Feedstock	Raw material required for a process.
Floc	A small loosely aggregated mass of flocculent material. In this instance referring to Refuse Derived Fuel or similar.
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.
Green Waste	Waste vegetation and plant matter from household gardens, local authority parks and gardens and commercial landscaped gardens.
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 form man - made sources.

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.
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 stable compost can be produced much more quickly than outdoor windrow composting.
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.
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.
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.
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.
Solid Recovered Fuel	Refuse Derived Fuel meeting a standard specification, currently under development by a CEN standards committee.
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 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 and Composting PIs have statutory targets attached to them which Authorities are required to meet.

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