Mechanical Heat Treatment of Municipal Solid Waste

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Department for Environment Food and Rural Affairs

Contents

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Preamble

This Waste Management Technology Brief, updated in 2007, is one of a series of documents prepared under the New Technologies work stream of the Defra Waste Implementation Programme. The Briefs address technologies that may have an increasing role in diverting Municipal Solid Waste (MSW) from landfill. They provide an alternative technical option as part of an integrated waste strategy, having the potential to recover materials & energy and reduce the quantity of MSW requiring final disposal to landfill. Other titles in this series include: An Introductory Guide to Waste Management Options; Mechanical Biological Treatment, Advanced Biological Treatment, Advanced Thermal Treatment, Incineration; Renewable Energy and Waste Technologies, and Managing Outputs from Waste Technologies.

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. It should be noted that these documents are intended as guides to each generic technology area. Further information can be found at the Waste Technology Data Centre, funded by the Defra New Technologies Programme and delivered by the Environment Agency (www.environment-agency.gov.uk/wtd). These Briefs deal primarily with the treatment and processing of residual MSW. Information on the collection and markets for source segregated materials is available from Defra and from ROTATE (Recycling and Organics Technical Advisory Team) at the Waste & Resources Action Programme (WRAP).

These waste technologies can assist in the delivery of the Government's key objectives, as outlined in *The Waste Strategy for England 2007*, for meeting and exceeding the Landfill Directive diversion targets, and increasing recycling of resources and recovery of energy.

The Defra New Technologies Demonstrator Programme has provided nine projects aimed at proving the economic, social and environmental viability (or not) of a selection of waste management technologies. For information on the demonstrator projects see the Defra website or email Wastetech@enviros.com.

1. 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. Historically, the quantity of MSW has risen year on year[1], presenting a growing problem for local authorities particularly as legislation, which limits (by implication[2]) the amount of mixed MSW that can be sent to landfill, becomes more stringent over time. This legislation also stipulates the requirement for pre-treatment of waste before it is sent to landfill.

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 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 62% of all MSW generated in England is disposed of in landfills[3]. However, European and UK legislation has been put in place to limit the amount of biodegradable municipal waste (BMW) sent for disposal in landfills[4]. A key driver for this focus on biodegradable waste is to reduce the uncontrolled release of greenhouse gas emissions to atmosphere. The diversion of this material is currently one of the most significant challenges facing the management of Municipal Solid Waste in the UK.

There are a variety of alternative waste management options and strategies available for dealing with BMW 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 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's Waste Implementation Programme. Further details about the new technologies featured in this report are available from Waste Technology Data Centre:

www.environment-agency.gov.uk/wtd

The technologies described in this Brief - Mechanical Heat Treatment - have a limited track record worldwide. The aim of this document is to raise awareness of this type of technology and present the most current information regarding their implementation.

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 Waste Technology Data Centre. Other relevant sources of information are identified throughout the document.

1 This is now showing signs of slowing down and in some areas waste arisings are falling, and indeed in 2005/6 there was a 3% fall nationally. However, this may be partly explained by other factors occurring in that particular financial year.
2 Targets pertain to the biodegradable fraction in MSW
3 Results from WasteDataFlow http://www.defra.gov.uk/environment/statistics/wastats/bulletin.htm
4 The Landfill Directive, Waste and Emissions Trading Act 2003 and Landfill Allowances Trading Scheme Regulations

2. How it works

This section gives an overview of the principles of Mechanical Heat Treatment (MHT) processes, i.e. technologies that use thermal treatment in conjunction with mechanical processing. Alternative waste management technologies which use other (higher temperature) thermal treatment processes are dealt with in separate Briefs in this series: 'Advanced Thermal Treatment' and 'Incineration'.

2.1 Aim of the Processes

Mechanical Heat Treatment is a relatively new term[5]. It is used to describe configurations of mechanical and thermal, including steam, based technologies. The generic purpose of these processes is to separate a mixed waste stream into several component parts, to give further options for recycling, recovery and in some instances biological treatment. The processes also sanitise the waste, by destroying bacteria present, and reduce its moisture content.

2.2 History of the Processes

The most common system being promoted for the treatment of MSW using MHT is based around a thermal autoclave (see Table 1). Autoclaving has been used for many years to sterilise hospital and surgical equipment using the action of steam and pressure. This technology is also in common use for the sanitisation treatment of some clinical wastes, and for certain rendering processes for animal wastes, prior to sending to landfill. However its application to MSW is a recent innovation and there is limited commercial experience on this feedstock material.

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

Table 1: Heat Treatment Options

Heat Treatment process	Description
Type 1: Autoclaving – batch, steam processing in a vessel under the action of pressure	waste is subjected to steam under pressure, followed by mechanical sorting and separation of the sterilised waste
Type 2: Continuous heat treatment in a vessel, not under the action of pressure	waste is dried using externally applied heat, followed by mechanical sorting and separation of the sanitised waste

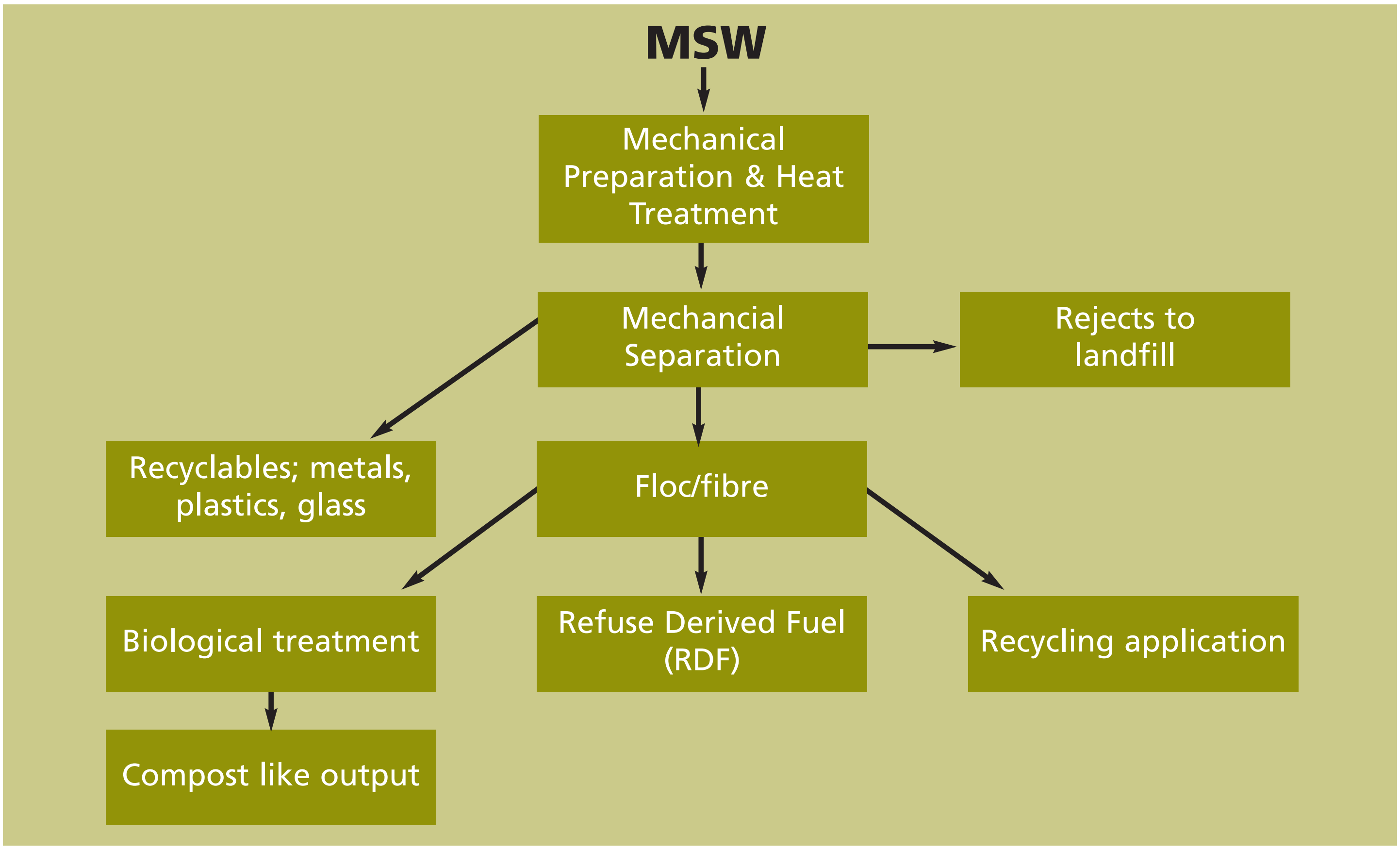
Details of the Process

Figure 1 illustrates the various stages in the process, and some possible options for dealing with the outputs.

5 Throughout this guide the term Mechanical Heat treatment is used; the Waste technology Data Centre chooses to use the term Physical Treatment to describe the same type of technology

2. How it works

Figure 1: Mechanical Heat Treatment Schematic



2.3 Mechanical Preparation

Some processes carry out a basic initial screening process to remove any large items from the waste stream unsuitable for further processing in the system; for example, large metal objects, rubble or particularly bulky items such as carpets. Several processes shred the waste to homogenise the particle size. The waste is then loaded into the heat treatment vessel. In some systems waste is loaded into the heat vessel in a raw form, however in such instances there is usually some mechanical abrasion tool within the heat chamber (e.g. blades / helix) to break up the waste.

2.4 Heat Treatment

All MHT processes use heat and/or steam treatment, which may or may not be applied under pressure.

The treatment vessel is loaded with waste and either an autoclave or continuous process is used as follows:

- the autoclave process is a batch process, so the vessel is sealed. Steam is injected into the vessel, wetting the waste. Pressure is applied in the range of 5-7 bar, and the vessel is rotated to mix the waste. These conditions are maintained for up to one hour, after which the pressure is released, and the contents emptied from the vessel.
- an alternative heat treatment process, which usually accepts shredded waste, is a continuous process. This means the waste continuously passes through the vessel as it is treated. Water is added to the waste to give a pre-determined moisture content. The vessel is under atmospheric pressure, and the waste is rotated as a hot air stream

passes through the vessel. The residence time of the waste in the vessel is generally up to 45 minutes, after which the treated waste is removed for mechanical separation.

The aim of the autoclave process is to 'cook' the waste, and has the following effect on the waste:

- biodegradable materials, including paper and card, are broken down into a fibre;
- glass bottles and tins have their labels removed as the glue disintegrates under the action of the heat;
- plastics are softened, and labels are removed. Certain types of plastics are deformed by the heat, but remain in a recognisable state, whereas other plastics soften completely forming hard balls of dense plastic.

The resulting outputs from this heat/steam processing are relatively clean 'hard' recyclables (tins, glass and plastics with no labels and most of the food waste removed) a fibrous material from the breakdown of paper, card and green/kitchen waste constituents, and a reject fraction.

Both systems apply temperature in the range of 120-170ºC, which is sufficient to destroy bacteria present in the waste. This has benefits in terms of storage, transport and handling of the outputs as they are sanitised, and are free from the biological activity that may give rise to odour problems. There is also a significant volume reduction of the waste.

2.5 Heat/Steam Efficiency

MHT processes using steam and pressure usually release the pressure in the vessel via a condenser, to trap and recycle water within the process. The depressurisation of the vessel causes most heat and moisture contained within the waste to vaporize, and so a further drying stage prior to materials separation is not usually required.

MHT processes operating at atmospheric pressure and using heat usually return hot gases exiting the vessel to the front end to provide some pre-heating for incoming waste. The remaining hot gases are released to atmosphere via an economiser and a condenser gas scrubbing system, which creates a liquid effluent stream.

2.6 Materials Separation

The materials removed from the MHT vessels are potentially recyclable and include glass, metals and plastics and a 'fibre' or floc.

MHT systems invariably utilise a number of separation techniques to extract the various recyclable components post-heat treatment. These are likely to be similar mechanical separation technologies used in Mechanical Biological Treatment systems, and are described in Table 2. A high-quality ferrous and non-ferrous metal stream, cleaned of labels and foodstuffs is always extracted for recycling. Some systems may also extract a glass / aggregate stream, and a plastics stream for recycling. There may be small amounts of fibre / contrary material trapped within containers destined for recycling, and so whilst the recyclate is likely to be considerably cleaner than materials extracted for example from an MBT process, there may still be some quality issues for some reprocessors. As with any waste treatment process there will be a reject fraction which must be disposed of.

The fibre comprises the biodegradable elements of the waste stream (green waste, kitchen waste, paper, card etc). There are a number of potential options available for the remaining fibre after removal of recyclables, and these are discussed in the next section.

Table 2: Mechanical Waste Separation Techniques

Separation Technique	Separation Property	Materials targeted
Trommels and Screens	Size	Oversize – paper, plastic Small – kitchen waste, glass, fines
Manual Separation	Visual examination	Plastics, contaminants, oversize
Magnetic Separation	Magnetic Properties	Ferrous metals
Eddy Current Separation	Electrical Conductivity	Non ferrous metals
Air Classification	Weight	Light – plastics, paper Heavy – stones, glass
Ballistic Separation	Density and Elasticity	Light – plastics, paper Heavy – stones, glass
Optical Separation	Diffraction	Specific plastic polymers

2.7 Configurations

Different MHT systems may be configured to meet various objectives with regard to the waste outputs from the process (Figure 1). The alternative objectives, depending on the system employed, may be one or more of the following:

- separate an biodegradable component of the waste for subsequent biological processing, for example to form a low grade compost-like output;
- produce a segregated high calorific value waste (see Box 1), potentially high in biomass, 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, plant should be configured according to availability of markets and outlets for the outputs (see Markets and Outlets 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 over time.

2.8 Summary

This section illustrates two types of MHT process, with autoclaving being the more familiar example. Waste is 'cooked' by the processes to destroy bacteria, and facilitate onward separation of materials. Cleaned recyclables are one of the outputs, with a sanitised fibre as the majority output. There are several potential options for further recycling/recovery of the fibre which are all dependent on availability of sustained markets and outlets.

3. Markets and outlets for the outputs

In the UK, at present, the markets for most of the outputs from MHT have yet to be proven on a commercial scale. 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 underdeveloped market and clearly it is prudent to install or at least maintain operational flexibility in terms of the degree and types of separation of materials that any proposed plant can achieve.

The following sections summarise some key issues with regard to the markets and outlets for outputs derived from MHT processing of MSW.

3.1 Materials Recycling

Glass, Metals and Plastics

Glass and metals derived from some MHT processes have the potential to be significantly cleaner than those from Mechanical Biological Treatment processes due to the action of steam cleaning, which removes glues and labels. Metals in particular can have higher revenue value if labels / foodstuffs have been removed, and cleaner recyclables may be easier to market.

Other recyclables such as plastics may also be extracted from some systems. However, most plastic materials are deformed by the heat of the process, some to a greater extent than others, potentially making them more difficult to recycle in some instances. Appropriate plastics could be recycled, or alternatively could be blended with other secondary fuels and combusted to recover energy where outlets or markets exist.

Fibre

As with any output from a waste treatment facility, the fibre is still classified as a waste, and as such is subject to legislative requirements concerning its handling, storage and disposal.

The main options available for the fibre output are:

- use as a raw material in recycled products;
- biologically process for use as a low grade compost-like output, or as a bio-stabilised residue for disposal; or
- use for its combustible properties as a fuel.

The separated fibre contains most of the biodegradable municipal waste and is the main output of the process. Potential recycling applications for this fibre are being developed.

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). Other options may include mixing with cement to produce building products, and washing the fibre to extract the long cellulose fibres suitable for paper-making. However, the market for recycled products made with fibre from MHT processes is not yet established and is subject to ongoing development.

For more information on the contribution of MHT to Best Value Performance Indicators and recycling see section 9, and for the latest developments see the local authority performance pages on the Defra website http://www.defra.gov.uk/environment/waste/localauth/perform-manage/index.htm and http://www.wastedataflow.org/Documents/BVPI%20FAQs.pdf

3. Markets and outlets for the outputs

The second option is to biologically process the fibre. Since the autoclave process is a sanitisation process that kills most of the microbes present in the waste, the fibre may need to be 'seeded' with microbes (e.g. mixed with material that has already undergone biological treatment) to accelerate the onset of the biological process. Either composting or anaerobic digestion techniques could be used. Compost-like outputs or digestate from these processes would still be classified as a waste and therefore subject to Waste Management Licensing regulations.

As with any waste treatment process for mixed waste containing animal products, it will be necessary to comply with the Animal By-Product Regulations (ABPR). If the fibre from an MHT process is destined to be spread on land (which includes its use as landfill daily cover), without further biological processing, the MHT process must comply with ABPR standards. If the fibre is to be biologically processed, and the MHT process does not comply with ABPR, the biological process must be approved under ABPR. If material is destined for landfill or incineration only, neither the MHT nor the biological process need comply with ABPR. For further information please see the Advanced Biological Treatment Brief in this series.

For further information on this topic see www.defra.gov.uk/animalh/by-prods/default.htm

3.2 Energy Recovery

Where MSW is sorted or treated to produce a high calorific value waste stream comprising significant proportions of the available combustible materials such as mixed paper, plastics and card, and potentially some kitchen/green waste matter, this stream is termed Refuse Derived Fuel (RDF - see Box 1).

3. Markets and outlets for the outputs

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 or segregate a fuel fraction from MSW include the 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). Preliminary standards have been published in June 2006, and are following an evaluation process, during which the functioning of the specifications will be verified. The technical specifications classify the SRF by thermal value, chlorine content and mercury content. For example, the thermal value class will be based on the number of megajoules one kilogram of recovered fuel contains. In addition, there are many characteristics for which no specific values have been determined. Instead, they can be agreed upon between the producer and the purchaser of SRF.

Along with the standardisation process, a validation project called QUOVADIS (http://quovadis.cesi.it/) on solid recovered fuels is currently being implemented.

It is anticipated that once standards are developed and become accepted by users, then 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).

European standards for SRF are important for the facilitation of trans-boundary shipments and access to permits for the use of recovered fuels. There may also be cost savings for co-incineration plants as a result of reduced measurements (e.g. for heavy metals) of incoming fuels. Standards will aid the rationalisation of design criteria for combustion units, and consequently cost savings for equipment manufacturers. Importantly standards will guarantee the quality of fuel for energy producers.

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

The fibre from an MHT process may be combusted as a Refuse Derived Fuel to release the energy contained within. The fibre is typically of a fine homogenous nature consisting of broken down biodegradable matter, paper and card, providing a consistent feedstock for onward thermal combustion.

Fibre produced by an MHT plant is visibly different to an RDF produced by an MBT plant. The predominant difference is that RDF from a MBT plant usually contains recognisable components, including plastic, paper and card, and may also contain organic material from certain systems. It is also likely to be less homogenous in nature than RDF from MHT. There may be different operational requirements regarding thermal combustion of each of these types of RDF.

However some systems are designed to process RDF to a particular fuel specification tailored to a specific market demand.

3. Markets and outlets for the outputs

3.3 Legislative Requirements

RDF is a waste and therefore any facility using the fuel will be subject to the requirements of the Waste Incineration Directive.

Electricity generated from the biodegradable fraction of waste in certain technologies is eligible for support under the Renewables Obligation (RO). Electricity recovered from the biomass component of RDF qualifies for support if it is generated in 'advanced conversion technologies', including pyrolysis or gasification plant (see the Advanced Thermal Treatment Brief), or in a conventional combustion facility with Good Quality Combined Heat and Power (CHP). Fuels over 90% biomass in content also qualify for ROCs if burnt in a conventional boiler, ATT facility or co-combusted for power generation. Producing a fuel of this quality from MSW would require considerable refinement, which potentially could be achieved through technologies such as MHT.

Up-to-date information regarding RDF and ROCs can be obtained from the DTI website http://www.dti.gov.uk/energy/renewables/. Also see the Defra New Technologies Demonstrator Programme for demos using RDF.

3.4 Types of Facility accepting RDF

The process of separation and refinement of an RDF fraction from mixed waste can use significant amounts of energy. It is therefore particularly important that as much energy as possible which is stored within the RDF is captured during combustion, to make the energy expended during separation and refinement worthwhile. A high conversion efficiency process should be used to combust the RDF. Whichever combustion route is chosen, the individual process should be examined in detail to establish its energy conversion efficiencies.

There are several options available for the thermal combustion of RDF within the UK, including: dedicated waste treatment plant accepting RDF as a fuel (e.g. incinerator or Advanced Thermal Treatment plant); or combustion in an existing industrial process.

Potential outlets for RDF

Defra has identified 6 potential outlets for RDF. The viability of some of these is dependent on legislative changes being made, which may or may not happen. The 6 potential outlets are:

1. Industrial intensive users for power, heat or both (Combined Heat and Power, CHP)
2. Cement kilns
3. Purpose built incinerators with power or power and heat (CHP)
4. Co-firing with coal at power stations
5. Co-firing with fuels like poultry litter and biomass which are eligible for Renewable Obligation Certificates (ROCs see later in this section) in conventional technologies
6. Advanced thermal technologies, such as pyrolysis and gasification which are ROC eligible technology

3. Markets and outlets for the outputs

RDF from a UK MBT facility is already utilised at a cement works as an energy source, replacing other fuels. Industrial intensive energy users are not yet using RDF but some interest from industry is being shown in the market place.

There is currently only one dedicated conventional combustion plant (incinerator) in the UK that uses RDF as a fuel to generate electricity. Another facility which accepts prepared fuel, (generated from raw MSW delivered at the front end of the plant) which could be termed crude RDF is also combusted in a recently commissioned Fluidised-Bed incinerator in Kent, illustrated in Table 3.

Table 3: Combustion technology plant generating electricity from RDF in England

RDF Combustion plant	Operator	K tonnes/year
Slough Berkshire	Slough Heat & Power	100
Allington Kent	Kent Enviropower	500

RDF may also be utilised within some appropriate Advanced Thermal Treatment (ATT) processes. A suitably 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.

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 then a high efficiency process (e.g. Advanced Thermal Treatment or Incineration with Combined Heat and Power) needs to be used, or the RDF needs to be used as a fossil-fuel replacement fuel to establish any environmental benefit over directly combusting the residual waste in an incinerator. Not all ATT processes will offer the efficiencies appropriate.

The advantage of co-combusting RDF at power stations or other large thermal processes 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. An estimate of the potential market for RDF in the UK is provided in the table 4 below.

3. Markets and outlets for the outputs

Table 4: Estimated size of the RDF market

Output	Outlet	Predicted Market size (t/a)	Source
RDF	UK Cement Kilns	350,000	Resource Recovery Forum, 2004[6]
Packaging & Packaging waste (incl. municipal derived RDF)	UK Cement Kilns	500,000	British Cement Association, 2003[7]
RDF	Paper Industry	300,000 – 600,000 NB: Required construction of dedicated RDF plant at paper mills	Resource Recovery Forum, 2004

The co-combustion of RDF is an emerging market. It is currently anticipated that cement kilns along with large industrial energy users and the power generation sector will provide the majority of potential capacity for using RDF. 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. A local authority currently would have to pay for the RDF to be used in a cement kiln. 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 and others to try and meet their specifications and provide a useful industrial fuel and waste recovery operation.

Renewable Energy

RDF is classified as a waste and therefore any facility using the fuel will be subject to the requirements of the Waste Incineration Directive (WID). As with the cement industry, power stations would need to be WID compliant. This would represent a significant capital investment for the industry. However WID only requires an operator to upgrade those facilities at a power station in which waste is handled to WID standards[8]. If an operator has more than one boiler then only one would need to be upgraded. This might make RDF a more attractive option for the power generation industry.

Electricity generated from the biodegradable fraction of waste in certain technologies is eligible for support under the Renewables Obligation (RO). Electricity recovered from the biomass component of RDF qualifies for support if it is generated in 'advanced conversion technologies', including pyrolysis or gasification plant (see the Advanced Thermal Treatment Brief), or in a conventional combustion facility with Good Quality Combined Heat and Power (CHP).

Up-to-date information regarding RDF and ROCs can be obtained from the DTI website http://www.dti.gov.uk/energy/renewables/. Also see the Defra New Technologies Demonstrator Programme for demos using RDF.

6 RDF Opportunities: Coal and Cement Industries, Fichtner Consulting, RRF 2004
7 Submission of Evidence to House of Commons Select Committee, January 2003
8 Written answers to Alan Whitehead MP from Ben Bradshaw, Minister of State for Defra, 07/03/2007

4. Track record

The autoclave process has been used to treat clinical waste for many years and is a proven and effective technology for this waste. It has also been used for many years to sterilise hospital and surgical equipment. The concept of MHT is new for MSW and therefore most of the operational experience is based on small scale or mobile demonstration plant. Listed below are some examples of MHT processes currently in the marketplace.

4.1 Estech Europe

This technology is under development. Discussions are in progress for supply to a number of UK Local Authorities. The Estech technology for processing MSW originated in the USA with a prototype autoclave for mixed waste, which lead to a patentable technology. A 5,000 tpa mobile demonstration plant began UK testing in September 2003. Planning permission has been obtained for a 100,000 tpa plant for Hereford and Worcester.

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 primary product is a fibre for which potential applications are being examined in the manufacture of insulation or fibre board, door and wall panelling, and roof tiles, or as an absorbent material. 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 clean due to the action of the steam, and are all potentially recyclable.

The full cycle of loading, treatment and sorting is normally completed within 90 minutes. Capacity of each unit is indicated at 20 tonnes (per batch).

This information has been sourced from the Waste Technology Data Centre www.environment-agency.gov.uk/wtd

4.2 Orchid Environmental

A 25,000 to 40,000 tpa demonstration plant has been built in Adlington, Lancashire, which proved the efficacy of the process and produced representative products. A plant is due to be built under the Defra New Technologies Demonstrator programme, in Merseyside, with a capacity of up to 50,000 tpa.

The process is a heat treatment process, drying and sanitising MSW, to allow easier separation of recyclables and to produce a refined biomass material which could be used as RDF.

Household waste and other materials are delivered to the site, and any large inappropriate items, such as rubble, carpets, etc are removed and disposed of to landfill. The remaining material is shredded, wetted and transferred to the heat processing drum, which operates at atmospheric pressure on a continuous basis. This heat treatment dries, sanitises and disrupts the materials, rendering them easier to subsequently separate. The residence time in the processor is typically between 30 and 40 minutes. The bulk of the hot exhaust gases exiting from the processor are immediately returned to the feed-end, providing some pre-heating and consequent energy recovery. The balance of the exhaust hot gas discharges to atmosphere via an economiser and a condenser gas scrubbing system, this in turn creates a liquid effluent stream.

The processed waste then passes through a series of trommel and sieving operations to separate metals, plastics and inert materials. The remaining fibre can be used as a RDF.

This information has been sourced from the Waste Technology Data Centre www.environment-agency.gov.uk/wtd

4.3 Sterecycle

Development began in 1991 with international patents dating back to 1993. A demonstration plant consisting of 3 tonne vessels for demonstration and R&D is operating in Nevada, USA. A 70,000 tpa MHT plant has been operating on MSW in Minnesota, USA from July 2004.

The Sterecycle system is a two-stage process: in the 1st stage steam autoclaving takes place at temperatures in excess of 140°C; the 2nd stage is the mechanical separation of the resulting autoclaved material.

The following sterilised recyclate materials – with labels and foodstuffs removed - can be recovered by using a variety of existing well-proven mechanical separation techniques: aluminium cans, steel cans, glass, plastics, and textiles

A variety of possible uses exist for the high-biomass content fibre, including:

- Substituting in place of a paper fibre;
- Anaerobic digestion and /or composting to produce a compost-like output;
- Gasification: the fibre can be gasified to produce energy and/or heat; and
- Briquetting: the fibre can be converted into a pellet or briquette as a high biomass RDF, with potential markets with third party energy producers.

This information has been sourced from the Waste Technology Data Centre www.environment-agency.gov.uk/wtd

Sterecycle propose to have an operation MHT plant for processing MSW in the UK in summer 2007.

4.4 Fernwood Group Limited

The Company's initial facility is currently under construction in Anaheim, California and is scheduled to begin partial operation in 2006. The two autoclave vessels being installed are designed to process up to 160,000 tpa of MSW. In 2006, the Company intends to begin the planning process for a facility elsewhere in the USA which management expects will contain eight, 250 ton per day units.

This process is an autoclave MHT system which utilises a sealed rotating vessel to combine steam, heat, atmospheric pressure and agitation to convert MSW into usable materials. It is claimed that the main fibre fraction is further processed for use in paper and packaging products. Other recyclable materials such as aluminium, steel, tin and plastics are also captured and sold for recycling.

Residual MSW is delivered on-site, large unsuitable items are removed, and the remaining waste is loaded into large autoclaves, holding approximately 30 tons of MSW per batch.

4. Track record

MSW is then processed using the autoclave process at proprietary conditions of time, temperature, moisture, and agitation while, using a patented process, the volatile organic compounds are captured and rendered inert. As there are 2 vessels in the installation, the depressurisation steam from one vessel can be used to accomplish the purging step in the other vessel, thus conserving energy and facilitating depressurisation of the pressurised vessel due to the pressure differential as the steam entering the lower pressure vessel condenses.

At the cycle's conclusion, the resulting sterilised materials are mechanically separated by type of material. Ferrous and non-ferrous metals are baled for sale to recycling markets. Plastics are extracted for recycling. The fibre is then claimed to be further processed for use by the packaging manufacturing industry.

The remaining waste fraction consisting mainly of grit, stones, and rejected fibre is transported to landfill for disposal.

5. Contractual and financing issues

Grants and Funding

Development of 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 'prudential' system of capital finance controls;

PFI Credits and Private Sector Financing: under the Private Finance Initiative a waste authority can obtain grant funding from central Government to support the capital expenditure required to deliver new facilities. This grant has the effect of reducing the financing costs for the Private Sector, thereby reducing the charge for the treatment service;

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 but generally it is through raising taxes.

The Government is encouraging the use of different funding streams, otherwise known as a 'mixed economy' for the financing and procurement of new waste infrastructure to reflect the varying needs of local authorities.

Contractual Arrangements

Medium and large scale municipal waste management contracts are usually procured through EU Competitive Dialogue under the Public Contract Regulations (2006).

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

5. Contractual and financing issues

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 grant funding from Government as a supplement to finance from its own and private sector sources. The PFI grant is only eligible for facilities treating residual waste and is payable once capital expenditure is incurred.

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:

- Local Authority funding http://www.defra.gov.uk/environment/waste/localauth/funding/pfi/index.htm
- The Local Government PFI project support guide www.local.odpm.gov.uk/pfi/grantcond.pdf
- For Works Contracts: the Institution of Civil Engineers 'New Engineering Contract' (available at www.ice.org.uk).
- For large scale Waste Services Contracts through PFI and guidance on waste sector projects see the 4ps, local government's project delivery organisation http://www.4ps.gov.uk/PageContent.aspx?id=90&tp=Y

6. Planning and permitting issues

This section contains information on the planning and regulatory issues associated with MHT facilities based on legislative requirements, formal guidance, good practice and in particular drawing on information contained in the Office of the Deputy Prime Minister's research report on waste planning published in August 2004[9].

6.1 Planning Application Requirements

All development activities are covered by Planning laws and regulations. Minor development may be allowed under Permitted Development rights but in almost all cases new development proposals for waste facilities will require planning permission.

Under certain circumstances new waste facilities can be developed on sites previously used for General Industrial (B2) or Storage and Distribution (B8) activities. In practice even where existing buildings are to be used to accommodate new waste processes, variations to existing permissions are likely to be required to reflect changes in traffic movements, emissions etc.

Under changes to the planning system introduced in 2006 all waste development is now classed as 'Major Development'. This has implications with respect to the level of information that the planning authority will expect to accompany the application and also with respect to the likely planning determination period. The target determination periods for different applications are:

- Standard Application – 8 weeks
- Major Development - 13 weeks
- EIA Development - 16 weeks

The principal national planning policy objectives associated with waste management activities are set out in Planning Policy Statement (PPS) 10 'Planning for Sustainable Waste Management' published in July 2005. Supplementary guidance is also contained within the Companion Guide to PPS 10. Both of these documents can be accessed via the Department of Communities and Local Government (DCLG) website[10].

PPS 10 places the emphasis on the plan led system which should facilitate the development of new waste facilities through the identification of sites and policies in the relevant local development plan. Separate guidance on the content and validation of planning applications is also available from DCLG through their website[11]. Individual Planning Authorities can set out their own requirements with respect to supporting information and design criteria through Supplementary Planning Documents linked to the Local Development Framework. It is important that prospective developers liaise closely with their Local Planning Authorities over the content and scope of planning applications.

[9] http://www.communities.gov.uk/embeddedindex.asp?id=1145711

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

[11] http://www.communities.gov.uk/pub/494/BestPracticeGuidanceontheValidationofPlanningApplicationsPDF326Kb_id1144494.pdf

6. Planning and permitting issues

6.2 Key Issues

When considering the planning implications of a MHT facility the key issues that will need to be considered are common to most waste management facilities and are:

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

A brief overview of the planning context for each of these issues is provided below.

6.3 Plant Siting

Mixed waste processing (such as MHT) can take place in many different buildings at a variety of locations. PPS 10 and its Companion Guide contains general guidance on the selection of sites suitable for waste facilities. This guidance does not differentiate between facility types but states that:

"Most waste management activities are now suitable for industrial locations, many fall within the general industrial class in the Use Classes Order.[12]

The move towards facilities and processes being enclosed within purpose designed buildings, rather than in the open air, has accentuated this trend. The guidance goes on to state:

"With advancement in mitigation techniques, some waste facilities may also be considered as light industrial in nature and therefore compatible with residential development. In more rural areas, redundant agricultural and forestry buildings may also provide suitable opportunities, particularly for the management of agricultural wastes"

The following general criteria would also apply to the siting of new MHT plants:

- MHT processes can be similar in appearance and characteristics to various process industries. It would often be suitable to locate facilities on land previously used for general industrial activities or land allocated in development plans for such (B2) use.;
- Facilities are likely to require good transport infrastructure. Such sites should either be located close to the primary road network or alternatively have the potential to be accessed by rail or barge;
- The location of such plants together with other waste operations can be advantageous. The potential for co-location of such facilities on resource recovery parks or similar is also highlighted in the Companion Guide;
- General concerns about bio-aerosols from biological processing may require an MHT site to be located away from sensitive receptors.

6.4 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 and road configuration will need to be suitable to accept a range of light and

[12] The Town and Country Planning (Use Classes) Order 1987. SI 1987 No. 764

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 50,000 tpa plant would be 20 – 30 refuse collection vehicles per day. This would be reduced if bulk transport systems are used.

6.5 Air Emissions and Health Effects

Concerns regarding air emissions and health impacts for this type of facility are most likely to be linked to traffic movements and potentially vapours from the release of pressure from the autoclave vessel. The relatively high temperatures in the autoclave vessel should be sufficient to eliminate the risks posed by micro-organisms. The facility should be designed to ensure that there are no significant releases of volatile organic compounds or particulate matter from the autoclave vessel.

Steam-raising plant would also need to be designed to ensure that there are no significant effects on local air quality, although this should not normally be problematic.

MHT processes result in the production of a fibrous material. This could be recycled or disposed to landfill as a stabilised waste material, or could be burnt as a refuse-derived fuel. Combustion of RDF is subject to the stringent emission control requirements of the Waste Incineration Directive and would result in a similar range of emissions to those from the incineration of waste, although this may well take place at a separate facility to the MHT process.

6.6 Dust and Odour

Any waste management operations can give rise to dust and odours. The control of odour from waste reception areas and from the autoclave component of MHT facilities needs careful consideration. Because MHT facilities are located within an enclosed building, potential odour emissions can normally be controlled through the process emissions control and building ventilation system. The process of air extraction and ventilation will dilute odorous air. It may be necessary to disperse extracted air from an elevated point, and/or treat the air. Biofiltration systems, systems using ultraviolet light, or other odour abatement plant could be used to control of odours in air extracted from working areas if required. The need for, and design of odour control systems would need to be assessed on a site-by-site basis.

6.7 Flies, Vermin and Birds

The enclosed nature of MHT operations will limit the potential 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 passed through fresh input waste to bring temperatures to levels above which flies can live. .

6. Planning and permitting issues

6.8 Noise

Noise is an issue that will be controlled under the waste licensing regulations and noise levels received at nearby receptors can be limited by a condition of a planning permission. The main contributors to noise associated with MHT are likely to be:

- hydraulic motors that drive the treatment vessel tilting mechanisms;
- the pressure generator;
- loading vehicle and bucket moving waste around the transfer hall;
- loading operation for the vessels;
- vehicle movements and manoeuvring;
- traffic noise on the local road networks;
- mechanical processing such as screens, trommels and air classification; and
- air extraction fans and ventilation systems.

6.9 Litter

Any waste which contains plastics and paper are more likely to lead to litter problems. With 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.

6.10 Water Resources

Common most new waste processes the enclosed nature of the operations significantly reduces the potential for impacts on the water environment. The greatest potential for pollution to surface and ground water is linked to the arrangement for delivery of waste and collection of residues. Disperse pollution to water is unlikely although wash down waters or liquid within the waste will need to be managed using an appropriate drainage system on site. Under normal circumstances the risks are very low.

Some water is likely to be used in MHT processes: either in the form of steam injected into the process, or simply adding water to the waste to a pre-determined moisture content. Hot exhaust gases from the process, usually containing water vapour, are often cited as being reused within the process, and those which are vented, do so via a condenser. This would produce a liquid effluent stream; such process water will need to be managed.

The case studies on the Waste Technology Data Centre include an assessment of water usage.

6.11 Design Principles and Visual Intrusion

The new planning guidance emphasises the importance of good design in new waste facilities. Good design principles and architect input to the design and physical appearance of waste facilitates is essential. Buildings should be of an intrinsically high standard and should not need to be screened in most cases.

Good design principles also extend to other aspects of the facility including issues such as:

- Site access and layout;
- Energy efficiency;

6. Planning and permitting issues

- Water efficiency; and
- General sustainability profile

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.
- Many of these facilities are housed in 'warehouse' type clad steel buildings, however use of good design techniques can help minimise visual intrusion.

Box 2 summarises the key planning issues and overall design for a proposed Estech facility in Worcestershire.

Box 2: Proposed Estech facility

Image kindly provided by Estech Europe

- The facility will incorporate 2 x 20 tonne batch autoclave systems
- It is designed to treat 100,000 tpa
- Site footprint is 3.6 ha
- Site was an industrial vacant plot next to a landfill and allocated for industrial employment in the Local Plan, but not identified specifically in the Waste Local Plan
- Application submitted September 2004 and approved in February 2005
- A full EIA was conducted and the Environmental Statement took 6 months to prepare
- The design and environmental protection measures are considered to be in excess of minimum requirements
- The site is not located within close proximity of residential areas or other key receptors

6.12 Size and Landtake

Table 4 shows the land area required for the building footprint and also for the entire site (including supporting site infrastructure) for MHT facilities.

Table 4: Landtake

	Size	Buildings Area	Total Landtake
MHT Plant A[a]	150,000tpa	4,300 m^2	-
Estech B[b]	100,000tpa	6,500 m^2	20,000 m^2
Sterecycle C[b]	100,000tpa	3,000 m^2	-
Thermsave D[b]	150,000tpa	4,300 m^2	-
Orchid Environmental[b]	100,000tpa	5,400 m^2	10,000 m^2

[a] Source: Review of Residual Waste Treatment Options, 2003, AiIE
[b] Source: Waste Technology Data Centre, 2006

An average MHT 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 the Waste Technology Data Centre (www.environment-agency,gov.uk/wtd).

6.13 Public Concern

Section 7, Social and Perception Issues, relates to public concern. In general public concerns about waste facilities in general relate to amenity issues (odour, dust, noise, traffic, litter etc). Public concern founded upon planning reasons can be taken into account when considering a planning application.

6.14 Environmental Impact Assessment

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

Whether a development requires a statutory EIA is defined under the Town and Country Planning (Environmental Impact Assessment)(England and Wales) Regulations 1999. The existing additional guidance in DETR circular 02/99 is currently being revised. This new guidance is likely to focus on appropriate criteria for establishing need for EIA and not relate to the general nature of proposals.

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. www.communities.gov.uk/pub/713/PlanningforWasteManagementFacilitiesaresearchstudyPDF1908Kb_id1145713.pdf

6.15 Licensing and Permitting

If a MHT plant processes over 50 tonnes 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 licence 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. The Environmental Permitting Programme (EPP) is due to be implemented in April 2008 which will combine waste licensing and permitting systems.

For more information on licensing and permitting see www.environment-agency.gov.uk/subjects/waste/?lang=_e

7. Social and perception issues

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

7.1 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.

A MHT facility may also provide positive social impacts in the form of employment and educational opportunities. Typical employment for a 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.

7.2 Public Perception

Changes in waste management arrangements in local areas are gaining a higher profile through the media. Many people as a result of greater publicity and targeted education are now embracing the need for waste reduction, recycling and to a lesser extent the need for new waste facilities. The wider perception of waste facilities as a bad neighbour will take longer to overcome. New waste facilities of whatever type are rarely welcomed by resident close to where the facility is to be located.

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 MHT by the public, since it 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 Mechanical Biological Treatment. 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' and 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. Defra is funding the development of small to medium scale demonstration plant in England for local authorities to visit and for Defra to publish data on performance. For more information contact Wastetech@enviros.com.

8. Cost

The cost of constructing, operating and maintaining MHT facilities are addressed using a common cost model on the 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 MHT systems are sensitive to the markets and outlets for recycled materials, RDF and compost-like outputs that are produced by different processes. Partnerships between MHT 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.

There is little published information on the cost of MHT facilities. Technology suppliers suggest between £25 – 45 per tonne operating costs for the autoclave/separation components of the process. Capital costs are estimated at around £15 million for a 100,000 tpa facility.

These facilities 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 or outputs of these processes needs to be reflected in cost models. Any building should have sufficient capacity to house new separation equipment.

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

9. Contribution to national targets

9.1 Recycling

Recyclate derived from a mixed waste processing plant (including 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.

The Government has recently increased national recycling and composting targets for household waste through the *Waste Strategy for England 2007.* Targets are at least 40% by 2010, 45% by 2015 and 50% by 2020. For more information on the contribution of MBT to Best Value Performance Indicators and recycling see the local authority performance pages on the Defra website http://www.defra.gov.uk/environment/waste/localauth/perform-manage/index.htm and http://www.wastedataflow.org/Documents/BVPI%20FAQs.pdf

9.2 Composting

Where MHT processes are configured to produce an organic-rich (biodegradable) stream to be further composted to produce a low grade compost-like output, this material may (but is 'unlikely to' see below) qualify as composting under BVPI 82b. The CLO 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 biodegradable fraction from mixed waste processing, see the Advanced Biological Treatment Brief, in this series.

9.3 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. 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 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.

9. Contribution to national targets

However, MHT plant are unlikely to significantly bio-stabilise waste prior to landfilling. This is due to the fact that the process does not involve any biological treatment of the waste, and therefore does not significantly reduce the waste's potential to degrade and produce methane once landfilled. The Environment Agency (EA) have developed a methodology to determine the 'stability' or 'biodegradablity' of any outputs from waste treatment plant which are sent to landfill. This test can be used to determine the amount of biodegradable material being landfilled in accordance with the Landfill Allowance Trading Scheme (LATS).

As any MHT plants developed in the UK are likely to vary in their method of operation, the stability test is likely to be applied to each MHT plant on a regular basis, as would be the case regarding testing the outputs from MBT plant. The Environment Agency has stated that a mass balance approach will be used to determine the amount of BMW sent to landfill. Up to date information can be obtained from Defra's LATS information webpage: http://www.defra.gov.uk/environment/waste/localauth/lats/index.htm

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

9.4 Recovery

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).

The Government has recently increased national recovery targets foe municipal waste through the *Waste Strategy for England 2007.* Targets are 53% by 2010, 67% by 2015 and 75% by 2020. For more details see http://www.defra.gov.uk/environment/waste/localauth/perform

9.5 Renewables

The Renewables Obligation (RO) was introduced in 2002 to promote the development of electricity generated from renewable sources of energy. The Obligation requires licensed electricity suppliers to source a specific and annually increasing percentage of the electricity they supply from renewable sources, demonstrated by Renewables Obligation Certificates (ROCs). The target currently rises to 15.4% by 2015/16. In essence, the RO provides a significant boost to the market price of renewable electricity generated in eligible technologies.

Electricity generated from the biomass (renewable) fraction of waste (including RDF) in 'advanced conversion technologies' (including AD, gasification and pyrolysis) or incineration plant with good quality heat and power is eligible for support under the RO. This can provide an important additional revenue stream for a proposed plant, as long as it meets the qualifying requirements. As the value of a ROC is not fixed, the long term value would need to be assessed in detail to determine its overall financial value to the project.

The Department for Industry (DTI) is considering providing greater support to technologies producing renewable energy and assessing methods for removing barriers to renewable energy generation.

Up-to-date information regarding RDF and ROCs can be obtained from the DTI website www.dti.gov.uk/energy/sources/renewables/index.html.

10. Further reading and sources of information

WRATE (Waste and Resources Assessment Tool for the Environment)
http://www.environment-agency.gov.uk/wtd/1396237/?version=1&lang=_e

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

New Technologies Demonstrator Programme Wastetech@enviros.com

Defra New Technologies website
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

Local Authority funding
http://www.defra.gov.uk/environment/waste/localauth/funding/pfi/index.htm

The Local Government PFI project support guide
www.local.odpm.gov.uk/pfi/grantcond.pdf

For Works Contracts: the Institution of Civil Engineers 'New Engineering Contract'
(available at www.ice.org.uk).

For large scale Waste Services Contracts through PFI and guidance on waste sector projects see the 4ps, local government's project delivery organisation
http://www.4ps.gov.uk/PageContent.aspx?id=90&tp=Y

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
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 and Emerging Technologies', Dr Stuart McLanaghan
www.number10.gov.uk/files/pdf/technologies-landfill.pdf

11. Glossary

Aerobic	In the presence of oxygen.
Aerobic Digestion/Composting	Biological decomposition of organic materials by micro-organisms under controlled, aerobic, conditions to a relatively stable humus-like material called compost.
Anaerobic	In the absence of oxygen.
Anaerobic Digestion	A process where biodegradable material is encouraged to break down in the absence of oxygen. Material is placed in to an enclosed vessel and in controlled conditions the waste breaks down typically into a digestate, liquor and biogas.
Animal By-Products Regulation	Legislation governing the processing of wastes derived from animal sources.
Biodegradable	Capable of being degraded by plants and animals.
Biogas	Gas resulting from the fermentation of waste in the absence of air (methane/carbon dioxide).
Biodegradable Municipal Waste (BMW)	The component of Municipal Solid Waste capable of being degraded by plants and animals. Biodegradable Municipal Waste includes paper and card, food and garden waste, 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 (CO2), methane (CH4), nitrous oxide (N2O), 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.
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.

11. Glossary

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 (ROCs), within each electricity supplier 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.