Appendix 3.2

Briefing Note 11

Staffordshire County Council

Technical Briefing Note 11 – Inclusion of MHT and MBT with SRF in Options Appraisal

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DATE : February 2008

SUBJECT : Options Appraisal of MHT and MBT with RDF

1. Staffordshire Waste

Staffordshire currently produces about 605,997 tonnes of MSW annually, which is predicted to rise to over 700,000 tonnes by 2020. The Staffordshire and Stoke on Trent Municipal Waste Management Strategy sets out plans to increase recycling/composting rates to 55% by 2020, and to achieve zero waste to landfill.

In order for these ambitious targets to be achieved, and to meet LATS obligations, it has been agreed that a new facility needs to be built to take the remaining 45-50% of MSW. Currently there is an EfW plant at Hanford, but the majority of the residual waste from South Staffordshire is being sent to landfill sites. It is expected that the new plant would need to be in the order of 150,000 tpa capacity to enable the councils to achieve the objective of zero waste direct to landfill in 2020.

2. Options Considered

In the Staffordshire and Stoke on Trent Waste Strategy, a number of technology options were considered for meeting this shortfall in waste diversion. The strategy options assessment comprised three tiers of Tier 1: waste minimisation and reuse, Tier 2: recycling and composting and Tier 3: residual waste treatment. The recycling and composting of waste is seen as a priority and following the waste hierarchy, treatment of the remaining residual waste stream should be using recovery of heat and/or electricity, as opposed to simply disposal to landfill.

In the Tier 3 assessment, landfill was used as the baseline for comparison of all other residual treatment technology processes deemed operational and achievable in the UK market. These technologies were assessed on the basis that they would be treating waste once the collected recycling/green waste and the residual waste already treated at the Hanford EfW plant, had been removed from the stream. Those technologies assessed were:

- Energy from Waste (EfW);
- Mechanical Biological Treatment (MBT - SRF);

- Mechanical Biological Treatment (MBT - Biostabilisation);
- Anaerobic Digestion (AD); and
- Autoclave, also known as Mechanical Heat Treatment (MHT)

For each technology, performance was scored using 21 assessment criteria, with the baseline scenario scoring the lowest. These criteria cover environmental, socio-economic, operational and waste management policy objectives, including cost, planning likelihood, noise, CO_2 emissions and eutrophication. The performance scores for each indicator were derived through a robust and transparent process involving a combination of quantitative evaluation using the Environment Agency LCA software and professional judgment.

3. Shortlisted Options

The total valued performance scores were calculated and ranked. The options assessment process concluded that the two technologies most suited to managing Staffordshire's remaining residual waste and ensuring zero waste to landfill by 2020, are MHT and Energy from Waste (EfW) with equal ranking. Since the conclusion of the strategy options appraisal there have been significant developments in the waste market for MBT technologies and, in particular, the market for supply and use of Solid Recovered Fuel (SRF) from MBT plants. As such, the option of developing an MBT facility that would produce SRF suitable for export to market was included on the OBC short list with EfW and Autoclave.

This paper discusses the MHT and MBT with SRF options in more detail in relation to Staffordshire and compares them to EfW.

3.1. Mechanical Heat Treatment Technology

MHT uses mechanical and thermal processes to separate or prepare unsegregated waste in to several component fractions, providing further options for recycling and recovery, and in some instances, biological treatment. MHT is a pre-treatment technology which can contribute to the diversion of MSW from landfill when operated as part of a wider integrated approach involving additional treatment stages. The process can also sanitise the waste, by destroying the animal pathogenic bacteria present. There are two basic methods of MHT treatment (Table 1).

Table 1. Methods of MHT Treatment

Heat Treatment Process	Description
Batch (autoclave) – steam processing in a vessel under the action of pressure	The vessel is sealed. Steam is injected in to the vessel, wetting the waste. Pressure is applied in the range of 5-7bar and the vessel is rotated to mix the waste. These conditions are maintained for up to 1 hour, after which the pressure is released and the contents emptied from the vessel. This is followed by mechanical sorting and separation of the sterilised waste.
Continuous - heat treatment in a vessel, not under the action of pressure	The waste continuously passes through the vessel as it is treated. Water is added 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 for waste in the vessel is about 45 minutes. This is followed by mechanical sorting and separation of the sanitised waste.

The most common form of MHT being promoted for the treatment of MSW is the batch process. Batch MHT has been used for many years to sterilize hospital and surgical equipment and also used for sanitising clinical wastes and some rendering processes for animal wastes, before they are sent to landfill. The technology itself is therefore not new, however, its application in terms of MSW is a recent innovation and there is limited commercial experience on this feedstock material.

Some MHT processes carry out basic initial screening to remove any large items that are not suitable for treatment. Systems can also include shredding of the materials in order to homogenise the particle size. The waste is then loaded in to the treatment vessel and subjected to steam or hot air in a rotating vessel. Mechanical agitation gives rise to the physical breakdown of the organic material. The temperatures used are between 120 and 170°C, which is sufficient to destroy the pathogenic bacteria in the waste. In some systems, there is a significant volume reduction due to the removal of moisture, but in steam based treatments moisture may be added to the system rather than removed. This is followed by mechanical sorting and separation of the sterilized waste. The process itself does not result in any significant reduction in biodegradability and further treatment of the process outputs is necessary in order to produce the required diversion of BMW from landfill.

MHT has the following effects on the waste:

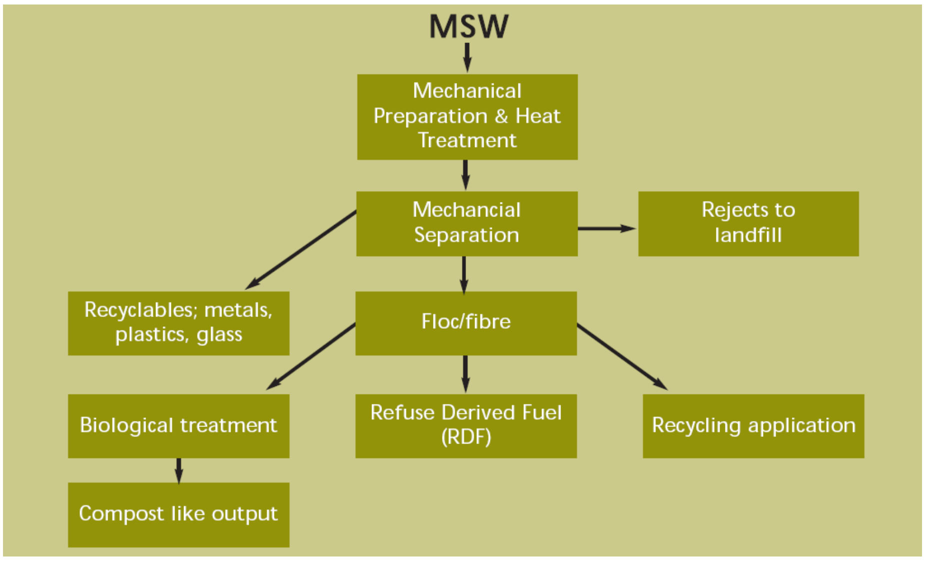
- Organic materials such as paper and card are broken down in to a fibre;
- Glass bottles and tins have their labels removed as the glue disintegrates under the action of the heat;
- Plastics are softened and deformed by the heat, and labels are removed.

The resulting outputs are:

- Cleaned recyclables such as tins, glass and plastic;
- A fibrous material or floc;
- A reject fraction for landfill.

Figure 1 shows more detail on the inputs and potential outputs from the MHT treatment process.

Figure 1. Inputs and Outputs of MHT



3.2. Mechanical Biological Treatment Technology

MBT uses mechanical and biological processes to separate or prepare unsegregated waste in to several component fractions, providing further options for recycling and recovery. MBT is a pre-treatment technology which can contribute to the diversion of MSW from landfill when operated as part of a wider integrated approach involving additional treatment stages. Typically, MBT processes fall into one of the following three arrangements:

3.2.1. 'Composting' MBT

'Composting' MBT is one of the most common options provided by technology suppliers. It is most often used to produce an SRF and stabilise the remaining organics.
This technology can also be used to stabilise all the residual waste material before going to landfill, thus removing the need for SRF outlets.

3.2.2. Bio-Drying MBT

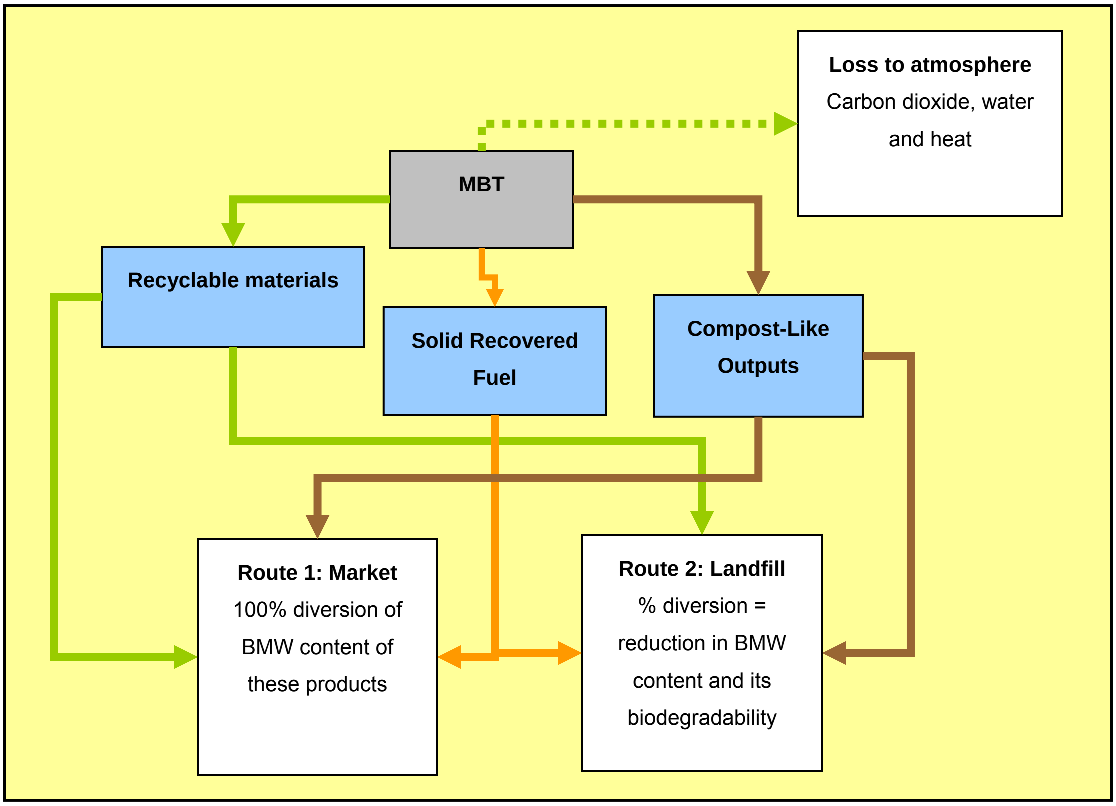
A few technology suppliers provide bio-drying solutions. Here, the main output of the process is SRF with an increased calorific value over traditional SRF production. The stabilisation of the remaining organics is more of a secondary consideration as this is dried, rather than stabilised during the process, before typically going to landfill. The waste is initially dried using the heat produced by initial biodegradation; it is then sorted into various outputs.

3.2.3. AD MBT with or without a 'composting' stage

AD MBT achieves similar BMW diversion to 'Composting' MBT, only the remaining organics after SRF separation are wetted before anaerobic digestion to produce biogas for energy production. The wet digestate may then be composted.

A summary of the potential inputs and outputs from MBT processes is shown in Figure 2 below.

Figure 2. Inputs and Outputs from MBT



3.3. Energy from Waste Technology

The term 'energy from waste' refers to the combustion of waste in order to generate energy in the form of electricity, heat or both. Very little preparation of the residual MSW is required prior to treatment. To allow the combustion to take place a sufficient quantity of oxygen is required to fully oxidise the fuel. Combustion temperatures are in excess of 850°C and the waste is mostly converted in to carbon dioxide and water. Any non-combustible materials remain as a solid, known as bottom ash. The MSW is delivered via a waste collection vehicle and tipped in to a bunker where it is mixed to blend the waste and ensure combustion is as even as possible. There are three main combustion technologies that can be employed to burn MSW.

Table 2. Combustion Technologies for EfW Plants

Technology	Description
Grate Technologies	Moving Grate: The waste is slowly propelled through the combustion chamber by a mechanically actuated grate. Fixed Grate: These are a series of steps with the waste being moved by a series of rams. Each grate represents a different process in the combustion to include drying, combustion and carbon burn-out. This is the most commonly used technology for high through-put MSW processing in the UK.

Fluidised Bed	This involves pre-sorting the MSW to remove heavy and inert objects prior to combustion, followed by mechanical particle size reduction. Combustion is in a lined chamber with a granular bubbling bed of coarse sand or silica. The bed is fluidised by air being blown vertically through the material at a high flow rate. This is less commonly used for MSW in the UK and more widely applied to sewage sludge.
Rotary Kiln	Two stage process consisting of a kiln and separate combustion chamber. The rotation moves the waste through the kiln with a tumbling action which exposes the waste to heat and oxygen. There is one example of this system for processing MSW in the UK.

Raw MSW typically has an energy content, or net calorific value, of 9 – 11MJ/kg. The standard approach to recovering this energy is to utilise the combustion heat through a boiler to generate steam. This is used to generate electricity via a steam turbine. To increase the plants efficiency, heat can also be extracted at this point. The plant would then be referred to as a combined heat and power (CHP) plant.

The resulting outputs from the technology are:

- Electricity
- Heat
- Metals (if separation technology included)
- Residual material – Bottom Ash and Fly Ash

The bottom ash is the non-combustible residual material. The quantity will largely depend of the level of pre-treatment prior to combustion and it may contain metals that can be recovered for recycling. Bottom ash handling facilities are often included on the site and it can be recycled for aggregates or sent to landfill.

Fly ash and other flue gas treatment residues are classified as a hazardous waste and are disposed to suitably licensed landfill sites.

4. Issues in relation to Staffordshire

There are a number of significant factors that need to be considered when deciding upon the preferred and most appropriate residual treatment option for Staffordshire.

4.1. Outputs and Markets

As discussed above, there are several potential outputs from an MHT processor and their estimated proportions are illustrated below.

Table 3. Proportions of MHT Outputs

Output	Percentage of Output Material
Recyclate	18% (8% metals, 10% plastics)

Floc/Fibre	50 – 70%
Rejected Material (vary dependent on market)	10 – 90%

In the UK at present, the markets for most of the outputs from MHT facilities have yet to be proven on a commercial scale.

MHT and MBT plants can be configured in a variety of ways depending on the availability of markets and outlets for the outputs. It may therefore be necessary to allow sufficient space within the buildings to adapt the process to produce different outputs to meet the needs of the market over time.

In terms of EfW, the outputs are more easily quantified. The aim would be for the majority of recyclate to have been sorted at source through a separate kerbside scheme. 20-30% by weight (10% by volume) of the output from the remaining residual waste would be bottom ash, the rest of original weight leaving as metals, air pollution control residues and emissions to the atmosphere. In addition, the EfW plant would contribute significant quantities of electricity and potentially heat. For example, a 225,000 tpa plant in Sheffield generates a maximum of 19MW electricity and 39MW of heat.

4.1.1. Recycling and Composting

Glass and metals derived from some MHT processes have the potential to be significantly cleaner than those from MBT treatment processes, due to the action of steam cleaning, which removes glues and labels. In terms of glass, this is only the case if there has been little or no mechanical shredding or agitation. This would smash the glass and mix it with other fines such as ceramics, stones and grit. It could then be used for lower grade recycling as aggregate.

Metals that are clean can achieve higher prices and are expected to be easier to market than those that may result from a simple MBT plant for example. However, the plastics can often be deformed by the heat, making them more difficult to segregate, sort into polymer types and to recycle. There may be small amounts of fibre trapped within containers destined for recycling, as so whilst the recyclate is likely to be considerably cleaner than materials extracted from an MBT process, there may still be quality issues for some reprocessors.

The primary output from an MHT plant is the floc or fibre which contains most of the biodegradable municipal waste. This is still classified as waste and therefore is subject to legislative requirements concerning its handling, storage and disposal.

There are three potential alternative outlets for the fibre:

- incorporated into products as a raw material
- separate out organic rich fraction for subsequent biological processing into a “compost like output” (CLO).

- produce a high calorific value refuse derived fuel (RDF)

Recyclables from MBT processes are mainly metals and occasionally some aggregates (glass and stone). These materials are not biodegradable and so do not contribute to BMW diversion, but can add to Councils' recycling and composting performance.

In EfW plants, the majority of recyclates would have been removed through separate kerbside collections prior to treatment. Some remaining metals may be recovered from the bottom ash and recycled. With the present definition of the Best Value Performance Indicator BV82a for recycling, the recovery of metals may only be classified as recycling if they are extracted at the front end of the facility.

4.1.1.1. Use as Raw Material

There are options being investigated in relation to using the MHT fibre as a raw material in recycled products. These options include mixing with crushed shale and resin to manufacture products and mixing with cement to produce building products. It is also possible to wash the fibres and extract the long cellulose fibres suitable for paper making. However, these markets for recycled products made with fibre from MHT processes are not yet established and are subject to ongoing development.

The most likely scenario is that the fibre will require further treatment before its full potential is realised.

4.1.1.2. Compost-like Output (CLO)

The fibre from MHT treatment could be subjected to biological processing such as composting or anaerobic digestion. Due to the MHT process sanitising the waste, it may need to be seeded with microbes in order to aid the onset of the biological process. The resulting compost-like-outputs or digestate would still be classified as waste and so still subject to the waste management licensing regulations. It is not guaranteed that this product would then be suitable for application to agricultural land. If the fibre is destined to be spread on land, including being used as a daily cover for landfill sites, without further biological processing, it will need to comply with the Animal By-Products Regulations (ABPR) as the source is a mixed waste. If the fibre is destined for landfill or incineration then neither the MHT or biological process needs to comply with ABPR.

In the case of MBT, the finer fraction obtained through mechanical separation (shredding and screening) contains a higher proportion of biodegradable organics such as garden waste, kitchen waste, and fines. This material can then be 'composted' to form a biologically stable material for use as a soil improver.

If produced the organic fraction composted to form CLO usually makes up around 40 – 50% (by mass) of MBT outputs.

For this material to have any chance of being used as a product, it must first undergo further refinement to remove contaminants such as plastics, glass, metals and stones. Usually this is done through further screening as well as metals separation (magnetic and eddy current separators) and possible air classification to remove dense inert material.

4.1.1.3. Refuse Derived Fuel (RDF) and Solid Recovered Fuel (SRF)

The MHT process treats MSW to produce a high calorific value waste comprising significant proportions of the available combustible material such as mixed paper, plastics, textiles, card and kitchen/green waste. The fibre product is therefore classified as Refuse Derived Fuel (RDF). The RDF from MHT is generally of a fine homogenous nature, providing a consistent feedstock for onward combustion.

Almost all MBT technologies produce an RDF, either by simple mechanical shredding and separation (screening) of the incoming waste or screening and air-classification after biologically drying the waste (bio-drying). RDF usually makes up around 50 – 60% (by mass) of MBT outputs. RDF contains larger and lighter waste fractions including plastics, paper and card, and some woodier waste materials. Therefore, RDF achieves BMW diversion through the energy recovery of paper/card and woody materials. The components of RDF have a higher calorific value than unsorted waste, and it can be used as a fuel. Bio-drying may also incorporate some kitchen waste into the RDF as the material is dried and air-classified.

When produced to a recognised standard, RDF is referred to as a solid recovered fuel (SRF). CEN 343 is the standard for SRF. However, the cement industry has other criteria for use of the SRF as a fuel in order to maintain quality of their product, and consequently tighter specification of calorific value, moisture content, particle size and chlorine content may be stipulated. Additional processing or drying of the RDF may be required in order to achieve this. For example, strict chlorine limits will require removal of pvc plastic. For the purposes of this paper, it is assumed that an SRF would be produced, since this is most likely to secure a market.

Any facility using the SRF will be subject to the requirements of the Waste Incineration Directive, such as stringent emission controls, which would represent a significant capital expenditure for the chosen industry. However, heat or electricity generated could be eligible for support under the Renewables Obligation (RO) to the extent of the biomass element of the SRF. The SRF would need to be used in a high efficiency process and/or as a fossil fuel replacement to establish any environmental benefit over directly combusting the residual waste in an incinerator.

Work carried out by Defra's WIDP team has identified potential markets in the following areas:

- Cement Kilns;
- Power Stations;
- Industry; and
- Dedicated EfW or CHP plant.

The market for SRF in the UK is emerging, primarily within the cement industry, but significant future opportunities via dedicated plants, such as Ineos Chlor or Peel Holdings, are likely to arise in the North West region.

Most of the plants currently being developed to supply SRF are designed for a biodrying process.

The following provides a brief summary of SRF market conditions.

Cement Kilns

Cemex

Cemex is committed to taking SRF as a fuel at all three of its plants. The South Ferriby and Barrington Plants have undergone trials on this material and are capable of burning 70,000 and 80,000 tonnes per annum respectively. This represents 30% of the solid fuel input at these plants.

The capital investment is currently being made at the Rugby plant to enable it to take SRF. Cemex are securing a variation to their PPC permit to allow them to take SRF. If the trials are successful as anticipated Cemex plan to ramp the use of SRF up to 60% by 2008. This would mean taking 240,000 tonnes SRF per annum. Cemex anticipate that the Rugby plant could act as a hub for receiving and directing SRF to its other cement kilns.

Trials with SRF from the Ecodeco bio-drying plant at Frog Island and the MBT plant run by Biffa Leicester have shown that the drier material from Frog Island is more suitable for use. Cemex have been in negotiations with Donarbon Ltd to take SRF from the proposed plant in Cambridgeshire. This is an MBT plant based on VKW technology.

As part of the Substitute Fuels Protocol Cemex have carried out public consultation with respect to their plants taking SRF as a fuel. The public response to this proposal has been on the whole positive. Local stakeholders see the requirement to be WID compliant as a positive step in the management of these facilities. They also appear to understand the carbon emission impacts of substituting fossil fuels for higher biomass fuels.

Cemex are keen to use locally sourced SRF and therefore are likely to be interested in taking SRF from Staffordshire to fuel their Rugby plant.

Cemex, representing 20% of the cement industry in the UK, believe that the other cement companies are likely to become interested in SRF if Cemex's trials are successful. At 60% fuel substitution levels it is estimated that Cemex could make use of 500,000 tpa of SRF from across the country.

It is understood that the other cement companies are already interested in accepting SRF as an alternative fuel. It is known that Castle Cement have been trialling SRF use at their Ketton plant and have had formal agreements with Biffa Leicester and Shanks.

Both Lafarge and Buxton Lime were 'pre-qualified' to Greater Manchester's call for potential users of the SRF produced from their proposed MBT plants and it is also understood that various cement kilns have been in discussions with a number of Local Authorities/waste companies currently going through procurement. If the entire cement industry embraces SRF as a fuel, the market for SRF from cement kilns could potentially rise to 2.5 Mtpa across the UK. However, only around 1Mtpa of waste derived alternative fuel were used in 2005.

Geographically, a number of alternative kilns exist within a reasonable distance of Staffordshire and it may be possible to secure markets for SRF at these.

Lafarge sites at:

Hope (Derbyshire) currently accepts tyres. PSP (processed sewage pellets) and packaging waste have been identified as potential future fuels. .
Dunbar (E Lothian): Currently takes tyres and SLF (secondary liquid fuels)
Cauldon (Staffordshire): Currently takes tyres and PSP, application is with the Environment Agency for trial use of packaging waste.
Barnstone (Notts): No alternative fuels taken

Castle Cement sites at Ketton (Rutland), Padeswood (Flintshire) and Ribblesdale (Lancs).

Production of alternative fuels is overseen by Castle Cement's sister company, SRM. Alternative fuels used by the company are 'Cemfuel' which is derived from waste solvents/hydrocarbons which are not suitable for recycling, 'Profuel' which is derived from specific paper, plastics and fibre waste streams (and has a slightly lower CV than coal), tyres and agricultural waste derived fuel (AWDF).which is essentially sterilised, ground abattoir waste. Information provided by Richard Butcher at SRM, is that volumes of Profuel used at Ketton (70-100ktpa) and Padeswood (35-70ktpa) are already contracted out.
Buxton Lime Industries (BLI) is the lime and cement division of Tarmac.

Tunstead (Buxton) is a new dry process plant, not currently using any alternative fuels. The following information was provided by Dr Martin Kenny, Technical and Environment Manager.
BLI are looking at a range of substitute fuels, including SRF, and have had several approaches from the waste management industry. They are in active discussions with 2 or 3 of the 'main players' who are currently bidding for local authority contracts and looking for potential SRF outlets. Their main concerns are chemical composition and CV. They would also be looking more at schemes that are fairly local eg Derbyshire/Staffordshire area as this is more sustainable and 'politically' acceptable than delivering from further afield.

Power Stations

At the present time no conventional power stations in the UK are using RDF to produce electricity. The principle reason for this is that existing plant would need to be retrofitted to accept the SRF. This is likely to include the need for new kilns, new feed and storage systems for the SRF and abatement technologies to ensure compliance with the WID.

As with the cement industry, the power stations would need to be WID compliant. This would represent a significant capital investment for the industry and is unlikely to be viable. However, it is understood that discussions have been taking place between the power industry, the waste industry and government to determine whether SRF may be a viable fuel for the future and to stimulate this market.

Industry

Industrial intensive energy users are another potential market for SRF. Shanks report that they are developing agreements with intensive energy users, in particular, they have identified the steel, glass, paper, chemical and industrial sectors as potential users.

Most of these users would look to take SRF through a Good Quality Combined Heat and Power Plant or a gasification or pyrolysis plant in order to obtain ROCs for the energy generated. Only the biodegradable or renewable fraction of the SRF would be ROC eligible and it is reported that there are currently various teething problems satisfying Ofgem on the biodegradable content of SRF. It is likely that these problems can be resolved.

Dedicated plant

The last option would be to burn the SRF in a dedicated Energy from Waste (EfW) plant with or without CHP. The only EfW plant currently taking SRF is the Slough Heat and Power plant which is taking 100 ktpa.

As with the intensive energy users, this option is made more economically viable if ROCs can be obtained for the SRF. This would require the EfW plant to conform to the requirements for a good quality CHP plant or to make use of gasification or pyrolysis.

It is unlikely that an existing EfW plant could take SRF unless already designed to do so as the calorific value of SRF is higher than that of unprepared MSW. This would probably rule out the use of existing EfW plant unless they are planning to upgrade or install an SRF compatible line.

An example of this type of facility will be the Defra Demonstrator project being developed by Energos to receive SRF produced by Biffa's plant on the Isle of Wight. Other proposals that could provide a major boost to the SRF market in the North West region are those in planning by Ineos Chlor and Peel Holdings.

4.2. BMW Diversion Performance

MHT and MBT systems have the potential to divert significant quantities of BMW away from landfill. Any outputs that are recycled, used as a soil conditioner (under an exemption) or burnt as SRF which are not landfilled will count directly towards landfill diversion targets. However, this therefore depends heavily on the availability of markets for, and the quality of, the process outputs.

If markets are not available and the MHT system is simply being used to reduce volume/biodegradability of waste prior to landfilling then there may be additional issues. MHT processes alone are unlikely to significantly bio-stabilise waste as no biological treatment is involved. The waste's potential to degrade and produce methane once landfilled is therefore not reduced significantly. As about 70% of the waste input to an MHT facility remains as the final floc or fibre, then with out finding reliable markets, the impacts of this technology on BMW diversion will be minimal.

MHT is a pre-treatment technology and although there is a volume reduction, the biodegradable content is not altered significantly. Therefore, further treatment of the fibre, such as additional combustion or biological treatment, is required in order to meet the diversion targets.

In MBT systems, markets for biostabilised outputs are very uncertain, but BMW content may still be significantly reduced even if this material is disposed of to landfill. Depending on whether the organic fines are biostabilised, the total BMW abatement is likely to vary between 50% up to 90% (if SRF is burnt and all organic material is biostabilised).

In contrast, EfW can significantly contribute to BMW diversion targets, since 100% of biodegradable content is abated. The only non-combustible waste remaining following treatment is also non-biodegradable.

4.3. Waste to landfill

As with most waste treatment technologies there is an element of the waste that will ultimately need to be disposed of to landfill. In the case of MHT and MBT, basic screening prior to treatment and sorting to retrieve recyclables afterwards should help to keep this element to a minimum. In order for Staffordshire to meet their targets for BMW diversion and zero waste to landfill by 2020, there will need to be secure markets or further treatment options for both the recyclables and the fibre components produced. The remaining waste fraction would consist mainly of grit, stones, rejected fibre, and in the case of MBT, organic material.

If further treatment such as combustion of SRF is chosen, then this process will also generate a residual component that will ultimately have to be disposed of to landfill.

With the EfW option, again, there will be a residual element that could be disposed of to landfill. However, there are also options to recycle this bottom ash in to aggregate on site. This would significantly reduce the quantities of waste being deposited in landfill sites. Only fly ash and other flue gas treatment residues must be landfilled, since they are classified as hazardous.

4.4. Track record in the UK

The MHT technology has a limited track record worldwide. MHT comes under the title of "new technologies" and to date there are no commercial plants operating in the UK. The concept of using MHT for treating MSW is new and therefore most of the operational experience is based on small scale or mobile demonstration plants. Although more MHT projects are emerging, none are yet operating and some projects that have secured planning consent, have already failed to progress into development. A sample of UK MHT projects are provided in Appendix 1.

The fact that MHT technology is in its infancy in the UK and is not yet proven on a significant scale may make securing PFI funding difficult. None of the projects in the UK where MHT will be employed were procured under the PFI. Other avenues would need to be investigated using extensive resources and with limited chance of success.

A number of MBT plants have recently been commissioned or are in procurement, including Shanks Eco Deco plants in East London and Dumfries and Galloway, Biffa facilities in Leicester (see Appendix 1) and proposed plants in Lancashire, Wiltshire, Cambridgeshire and Greater Manchester. In addition, planning applications have been submitted for dedicated large scale thermal treatment facilities that could accommodate SRF produced from a large catchment around the north west region. If these planning proposals proceed to development then this is likely to have a major impact in providing long term security of markets for SRF, which will help boost the deliverability of MBT plants.

In contrast, EfW already accounts for the disposal of 9% of the total MSW in England (2005/06), which is the equivalent to 2.8 million tonnes per annum. The UK has 18 EfW plants varying in scale from 23,000 tpa in Shetland to 500,000 tpa in Edmonton, with several further plants in planning and development. Please refer to Appendix 3 for a more detailed list.

Staffordshire already has an effective EfW plant serving the north of the county at Hanford. It is a 180,000tpa capacity plant built in 1997 and generates 12.5MW of electricity. The plant successfully reduces the waste volume by 90%, minimising the waste being disposed of to landfill. They are also popular in Europe with several hundred plants in operation. Denmark, France, Switzerland and the Netherlands have the largest installed capacities as a percentage of total MSW generated. Therefore, there is far less risk involved in the planning, constructing and operating of an EfW plant which can then deliver benefits in terms of energy production.

4.5. Planning and Public Acceptance

Obtaining planning permission is often one of the primary barriers to commissioning a waste treatment facility. A key element is to ensure local public and business engagement from the outset so that they feel involved and empowered. This will also serve to educate them and raise awareness of the issues in order to lessen objections.

As MHT is not widely used in the UK, particularly for full scale waste treatment plants, public knowledge of the process will be limited. MBT is gaining examples of operating plants in the UK and public knowledge and acceptance of the process is increasing. Focus would need to be put on the SRF production and its potential use in cement kilns in order to encourage public backing. However, perceptions of cement kilns can be as emotive as waste facilities. However, as part of the PPC process cement kilns must consult the public prior to using any new alternative fuel.

4.6. Landtake/Visual

An important consideration in terms of deciding on a technology type, is the amount of land it will require and also the impact on the landscape such as through building/chimney height. In the case of MHT and MBT plants, the land requirement can vary considerably between technology providers and the waste composition.

It is often the case that some form of treatment prior to the MHT is required. This can include basis initial screening to remove and large items from the waste stream that are unsuitable for further processing, and also shredding in order to homogenize the particle size.

An average MHT plant may have a height of 10-20m and so can often be housed in buildings similar to industrial warehouses. If the process requires a particular air clean-up system then a stack may be required, which would increase the overall height. The Orchid plants do not require stacks as they use biofilters to filter out the dust and emissions, however, more height is required in order to incorporate pre treatment sorting. In terms of land area required a 100,000tpa Sterecycle plant has a building area of 3,000m^2 whereas the same capacity plant provided by Estech has buildings covering 6,500m^2. The footprint of the entire site when supporting site infrastructure is included is likely to be between 10,000m^2 and 20,000m^2 for the 100,000tpa facility.

As the MHT process itself is only a pre-treatment technology, it is also necessary to consider what further treatment/sorting will be required in order to satisfy the local markets. In this respect, co-location could be a benefit to increase the process efficiency and in particular reduce transport impacts. In the case of Orchid Environmental, in order to produce a biomass fuel, additional processing buildings increasing the land take to 18,000m^2 may be required. Estech Europe send the waste to a MRF following the autoclave treatment to effectively separate out the recyclables.

An average MBT plant may have a height of 12-20m and so can often be housed in buildings similar to industrial warehouses. If the process requires a particular air clean-up system then a stack may be required, which would increase the overall height, but most plants do not require stacks as they use biofilters to filter out the dust and emissions. However, more height is required in order to incorporate pre treatment sorting.

In terms of land area required a 180,000tpa biodrying plant is estimated to require an area of some 30,000m^2 to 35,000m^2. A composting MBT or MBT with AD will require a larger land area to accommodate the composting process areas.

In contrast, outputs from EfW plants rarely require significant further treatment. A more significant factor is the location of potential end users for the electricity and heat generated. The main other consideration is the option of bottom ash treatment. In the case of Staffordshire and the policy of zero waste to landfill, it is expected that facilities for treating this would be provided on site. The ash would be ground down for use as road aggregate.

In general, EfW buildings take up about 4,000 – 7,000m^2. However, if large fluidised bed technology is used then this can be significantly greater. When including the supporting site infrastructure 17,000 – 40,000m^2 is a common range. A stack is required for EfW plants and so the visual impact can be more significant than with MHT. Typical stack heights would range from 60 – 90m depending on the plant capacity. For this reason, planning permission is more likely to be granted for sites neighbouring other industrial facilities and away from urban areas. Stack height is dictated by air dispersal characteristics and it is unlikely this can be modified significantly.

The reference site for Staffordshire's chosen waste treatment technology is approximately 40,000m^2 allowing ample space for either of the technologies discussed.

For any of the three technologies, if the plant capacity is greater than 100,000tpa, the landtake would not increase to the same degree as much of the infrastructure would be the same for a plant of any size.

4.7. Energy Balance

By the nature of the process for heating and then mechanically sorting the waste, MHT is extremely energy intensive, resulting in a net energy requirement. The initial screening of the waste and then the rotation of it within the chambers, as well as the requirement to maintain extremely high temperatures for long periods of time, all add to the plants energy demand.

The MHT process alone does not generate any energy with which to balance this demand. Further treatment of the fibre such as burning the SRF is the main method by which electricity and potential heat could be generated. This requires an additional facility which may not be located on the same site, thus adding further to the energy demands through increased transportation of the materials. The facility at Rainham plans to overcome this issue by utilising electricity generated in an adjacent plant from landfill gas. However, this option is very location specific and in general, the demand would be from the national grid and fossil fuels.

A biodrying MBT will have a high energy demand for shredding and screening the waste and subsequent mechanical sorting of the waste.

The low rate biodegradation generates heat for biodrying, but overall the MBT process alone does not generate any energy with which to balance this demand. Burning the SRF is the main method by which electricity and potential heat could be generated. However, this would be incorporated into third party arrangements for treating the SRF and would not be a direct benefit to the MBT plant operator.

When considering EfW plants, the primary fuel source is the waste itself. Significant quantities of electricity are generated, part of which may be considered to offset electricity generated by fossil fuel powered generating plants.

The plant will have a parasitic load which can be kept to a minimum through energy efficiency measures. The EfW technology provider CNIM estimates that about 610kwh of electricity are generated per tonne of waste, with a parasitic load of about 90kwh per tonne. Therefore, the plant can power itself as well as contributing a renewable energy supply into the national grid which will replace that previously sourced from fossil fuels. If community CHP is incorporated, the energy efficiency of the plant rises three fold to 50 -70% and the carbon offset is even greater. This is also a method of providing noticeable benefit to the local residents and businesses. If district heating is used then this will be eligible for ROCs as it is considered a renewable resource.

4.8. Cost

Due to the lack of commercially operating MHT facilities for treating MSW, it is very difficult to estimate likely costs. Capital costs are estimated to be about £30 - £35 million for a 100,000tpa facility without any additional facilities for treatment of SRF. For an MBT facility the equivalent cost of £40-50 million would be appropriate for a 180,000tpa facility.

In order to achieve targets for BMW diversion and zero waste to landfill, a MHT or MBT facility can not be solely relied upon. It is only one stage in a treatment process and additional facilities at considerable cost would be required in order to meet the requirements of the Counties Waste Strategy and significantly mitigate the social and environmental issues related to waste disposal. A dedicated SRF burner could more than double the capital cost.

The cost of an EfW plant is more inclusive as the need for further waste treatment to reduce biodegradability is eliminated. A 100,000tpa plant would be likely to cost in the region of £50 million. The addition of bottom ash treatment on site, as suggested by Staffordshire County Council, would increase this figure.

All technologies will incur life cycle costs for maintenance and replacement of equipment during their operating life, but it can be reasonably expected that an EfW plant will have a significantly longer design life. An EfW plant will, therefore, have a greater residual value at the end of a typical 25 year contract period than an MHT plant.

For further detail of the comparative capital, operating costs and revenues please refer to the Staffordshire Waste and Cost Model.

4.9. Transport

Due to the nature of the MHT or MBT technology and the likelihood for requiring basic screening prior to treatment, and further sorting and treatment of the fibre/SRF, options for co-locating near other waste operations and end users would be advantageous. This however, puts additional constraints on potential site locations. In the absence of co-location, the necessary transportation of the waste outputs would be significantly increased and add to the negative impacts of the facility. There are likely to be a significant number of outputs that would require transportation to disposal sites or for further treatment/processing. These may include recyclables, aggregates, fibre/floc or SRF, and residual waste.

With EfW, transport in terms of inputs to the facility would be similar to an MHT plant, however, the majority of waste is then utilised in the furnace and the only physical outputs would be a small amount of residual waste to landfill, possibly some metal recovery and the bottom ash for aggregate. The other generated products are heat and electricity and once the infrastructure is in place, no further traffic will be generated.

4.10. Noise

Noise is an issue that would be controlled under the waste permitting regulations. Noise levels at nearby sensitive receptors can be limited by a condition of a planning permission. With MHT, MBT and EfW waste treatment facilities there will be noise associated with vehicles. The heavy trucks will have to regularly make trips on the local road network and manoeuvre around the site itself. This is likely to be one of the primary causes of noise and would increase in frequency with the plant capacity. Air extraction fans and ventilation systems are also likely to be noisy and present on all three treatment options. In addition to this, most MHT plants will also have noise generated by loading vehicles moving waste around the transfer hall and, in the case of MHT, in to vessels. There will also be mechanical noise from processing in screens, trommels, shredders and air classification. The pressure generator and hydraulic motors that drive the treatment vessel tilting mechanisms will also contribute to the noise levels from MHT and MBT facilities. There is less mechanical processing involved in EfW plants but there may be noise generated by the steam turbine and air condenser units.

4.11. Odour/Dust

The issues of dust and odour are associated with any waste management operations. In terms of MHT facilities, it is in the waste reception areas and autoclave component where this needs serious consideration. As MHT facilities are located within an enclosed building, potential odour emissions can be controlled through the process emissions control and building ventilation system. Biofiltration systems can be used to control odours in air extracted from working areas if it is required.

EfW facilities are not normally a source of dust or odour as the process uses the air demand of the combustion process to operate the working areas under negative pressure. Air is therefore drawn in to the building through the waste handling area, minimising the risks of dust and odour problems. Particular care will be needed in the design and management of ash handling systems. Good building design, performing operations under controlled conditions indoors, good working practices and effective management to suppress dust from vehicle movements should further reduce the risk.

The enclosed nature of MHT, MBT and EfW operations will also limit the potential to attract vermin and birds.

4.12. Labour/Job Creation

Any new facility will result in both positive and negative impacts on the local residents. MHT, MBT and EfW plants will employ staff on a shift system in order to allow for 24 hour operation. For a 50,000tpa MHT plant, each shift would have between 2 and 8 workers. For a 180,000tpa MBT plant, a total of around 24 operating staff would be required. Some facilities are required to ensure employees are sourced locally.

A legal agreement has been attached to the planning approval for the MHT plant at Rainham, which requires Veolia Cleanaway to draw up a "recruitment programme" before the commencement of the development. Veolia Cleanaway will commit to providing local recruitment and training and there is the additional potential to increase jobs and businesses through further processing and use of the waste products. Facilities can also provide vocational training and education opportunities and can incorporate a visitor centre to enable local groups to view the facility and learn more about how it operates.

4.13. Political Fit

In terms of the National Waste Strategy, the use of the waste hierarchy encourages waste prevention, reuse, recycling and composting as priorities. This is being reflected in Staffordshire's various plans, including the high recycling targets. Both MHT and MBT technologies would allow for the option of increasing these targets as there can be high recovery rates for recyclates.

Next in the hierarchy is energy recovery, above the final option of landfill. If the residual waste remaining once all recyclates etc have been removed, can be utilised to generate energy that offsets that normally sourced from fossil fuels, this is much preferable to landfill. The National Waste Strategy also sets high targets for diverting biodegradable waste away from landfill. MHT, MBT and EfW provide options for diverting BMW from landfill either directly, or indirectly. However, MHT and MBT rely upon there being a market for the fibre/floc or SRF output. If this market was threatened or disappeared then the fibre/SRF is likely to be sent to landfill. The MHT and MBT facilities would then perform less well regarding LATS, adding to the costs incurred by the council through fines and landfill tax. In this case, both MHT and MBT would be easily out performed by other technologies such as EfW where diversion levels are high and the markets for heat and electricity guaranteed.

4.14. Air Emissions/Health Effects

This is often an issue raised by the public when the building of a waste facility in their region is suggested. No studies in to the health effects or emissions from MHT facilities have been carried out in the UK to date, and only limited studies have been undertaken on MBT facilities. In MHT plants, these impacts are most likely to be associated with traffic movements and vapours from the release of pressure from the autoclave vessel. However, the high temperatures 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.

In an MBT facility, traffic movements, dust and bioaerosols from the mechanical and biological treatment processes would be the main contributors.

If the resulting fibre/SRF from either technology is combusted, it is subject to stringent emissions control requirements of the Waste Incineration Directive (WID) and would result in a similar range of emissions to those from the incineration of waste.

EfW plants, in order to prove compliance with the WID, are required to continuously monitor and sample emissions such as dioxins, particulates and metals. Levels have improved substantially in recent decades and the long operating record provides a good database of information on emissions and health effects compared to other options for managing waste. Research carried out to date shows no credible evidence of adverse health effects for those residing in the vicinity of incinerators / EfW plants.

5. Conclusions

A summary of the key advantages and risks for the MHT, MBT with SRF and EfW options are presented below:

	Advantages	Risks/Challenges
MHT	• Potential for achieving high recycling performance through recovery of metals, glass, inerts for aggregate, and floc used as a raw product in composite materials • Good public acceptance and relatively low planning risk • Significant volume reduction potential; • Full sanitisation of the waste • Stack may not be required • Suitable for modular construction	• Negligible BMW diversion without further treatment of the floc fibre • BMW diversion performance is unreliable and dependent on market for SRF or market for compost like output or additional thermal treatment on site • Floc will require additional treatment and processing to prepare to an acceptable specification for current market requirements • Market for Compost-like Output (CLO) is unreliable • Limited track record of operation in the UK; • Perceived as a new technology and bankability is uncertain; • Limited existing facilities of capacity greater than150,000tpa • Highly energy intensive

	Advantages	Risks/Challenges
		• Significant transportation of outputs required • Subject to landfill risk • Relatively high operating costs due to intensive processing, transport of products and landfill disposal • Limited flexibility to increase capacity • Modest residual value at end of typical 25 year contract
MBT with SRF	• Potential to achieve reduction in BMW disposal to landfill • Able to recover value from residual waste in terms of recycling or other materials that may have beneficial use • Inherent flexibility to respond to some future changes in waste management • Can be designed as a modular facility • Potentially greater public acceptability with manageable planning risk • Stack may not be required • Modest residual value at end of contract	• Uncertain and unproven operational performance in achieving BMW diversion • Generally low quality of recovered recyclable materials • Markets for SRF are emerging but not secure • Markets for use of compost like material are insecure and not well established • Significant risks due to regulatory change • Lack of whole life cost certainty • Relatively high operating and energy costs due to intensive processing, transport of products and landfill disposal • Significant transportation of outputs required • Subject to landfill risk • Less bankable due to risks as perceived by funders
EfW	• Proven technology for treating MSW • Bankable • Electricity and heat generation offsets fossil fuels and may be eligible for ROC's (heat aspect) • High and reliable BMW diversion performance • Ability to meet LATS diversion targets • Secure market for recovered metals and bottom ash aggregate • Limited transportation of outputs required • Minimal dependence on landfill • Generates enough electricity to power the facility as well as for export to the grid • Can incorporate community heating	• Public distrust of the technology and objections from local environmental groups • High stack required together with large building so finding a suitable site for the facility and obtaining planning permission more challenging • Without CHP, it has relatively low heat recovery efficiency compared with modern power stations • Limited flexibility for modular development or modification • Needs careful sizing to ensure recycling is not inhibited

	Advantages	Risks/Challenges
	schemes • Significant residual value at end of typical 25 year contract	

This study demonstrates that whilst EfW, MHT and MBT are able to operate as waste treatment facilities, there are substantial risks associated with the later two options. Both MHT and MBT are both only pre-treatment options and can not be considered as a disposal process, only as an intermediate step towards achieving the goals of the Waste Strategy.

As pre-treatment technologies, there is a need to secure end markets for the process outputs from both MHT and MBT facilities. MHT requires a specialist market for the Compost-like Output (CLO) and the Floc for the treatment solution to divert waste from landfill in its own right. With MBT there remains a dependence on securing markets for SRF and Compost-like Output to ensure adequate BMW abatement is achieved. These risks may be mitigated through the inclusion of an incinerator that will accept the CLO, Floc or SRF to burn to produce energy; essentially an EfW combined with the MHT or MBT facility. However, this approach offsets some of the benefits perceived with the pretreatment options because it introduces the disadvantages of the EfW encountered regarding public perception and planning risk.

MHT is not entirely unproven in the UK, but there are no large scale operational facilities to date. The reliability of this technology for treating MSW is therefore questionable and its variables difficult to predict. MBT is gaining an operational track record in the UK and although markets for SRF appear to be opening up, considerable uncertainties remain for the long term security and pricing of RDF.

In contrast, EfW is a proven technology that can reliably treat the waste, generate usable outputs (electricity and heat) and meet the targets for BMW diversion whilst not inhibiting the achievement of high local recycling and composting targets. All of the risks and challenges presented by EfW can be mitigated by proactive management by the Authority. The greatest risk with the EfW plant is public perception and the ability to obtain planning permission for the facility. Measures can be undertaken by the Authority to demonstrate planning precedent for the selected site and mitigate the risk of planning failure.

In summary, based on the findings of this review, it may be concluded that the MHT and MBT options are inherently more risky with regards the deliverability of the solution. EfW offers a significantly more deliverable solution.

1. Appendix Selected Examples of MHT Plants in the UK

1.1. Veolia Cleanaway

Veolia Cleanaway received planning permission to develop an autoclave facility on its existing landfill site in Rainham. The plant will treat the residual waste from Tower Hamlets, which hopes to benefit by raising its low recycling rate from 7% to a potential 80%. The £20 million facility could process 160,000 tonnes of waste every year and the aim is to power the facility using the energy generated by the neighbouring landfill site. This is a requirement imposed by the London Plan as the energy consumption of the plant is estimated to be high. The waste can be shipped along the Thames from Tower Hamlets to the facility and Veolia Cleanaway intends to compost the resulting fibre for 12 weeks to reduce the biodegradability prior to use as landfill cover.

1.2. Sterecycle

Sterecycle Ltd, a waste management company who has created a patented advanced autoclave process, is in the process of installing a plant in Cumbria. This will take local authority MSW and commercial waste with a capacity of 80-90,000tpa. Sterecycle has two plants operating in the USA, neither of which are operating on the scale required by Staffordshire and one of which is actually a demonstration plant for paper pulp recovery and R&D and so is not directly comparable to the desired MSW feedstock.

1.3. Estech

The Estech Fibrecycle technology for processing MSW originated in the USA and planning permission was obtained for a 100,000 tpa plant for Hereford and Worcester. However, it is understood this proposal will not be developed. The technology is also being supported by the Defra New Technologies Demonstrator Programme through a proposed 25,000 tpa facility in Sunbury, Surrey. The technology is a batch autoclave system, using wet steam under pressure.

The process washes and sterilises the waste and breaks it down in to its organic and non-organic fractions. The processed material is then separated and screened to remove the fibre fraction from the recyclables and residuals in a MRF. The primary product is a cellulose fibre (64% of the outputs) and Estech are exploring its potential applications to include manufacture of fibre or insulation board, wall panelling, roof tiles or as an absorbent material. Alternatively the fibre could be used as an SRF. Detailed discussions are in progress in relation to the supply of the technology to several UK local authorities.

1.4. Orchid Environmental Ltd

As part of the Defra New Technologies Demonstrator Programme, Orchid Environmental Ltd, in partnership with Fairport Engineering, are building a facility capable of treating 50,000 tonnes of MSW annually in Merseyside. Processing is expected to begin by the end of 2007.

The company aims to apply proven technologies from other industries to treat MSW, separate out recyclables and generate a refined biomass product. The plant will use a heat treatment process, drying and sanitising the waste to allow easier separation of the recyclables and to produce a refined fibre that can be used as an SRF. Prior to treatment, large items are removed and disposed to landfill. The remaining material is shredded, wetted and transferred to the heat processing drum which operates at atmospheric pressure on a continuous basis.

The -50mm fraction is fed through the Fairport Biomass Density Separator. This incorporates vacuum technologies which firstly remove the residual heavier elements such as glass and metal. The lighter element is then air separated to remove plastics and fine material, leaving the mostly organic matter. Glass and grit can be used as road aggregates and the organic matter (35-40% of the of input) can be compressed in to fuel pellets for use in power generation, industrial boilers or gasification plants. However, in order to achieve some of the specifications of biomass fuel, additional materials may need to be added to the blend. This may be necessary before the fibre can contribute towards landfill diversion targets and LATS. Cemex, however, have provisionally offered to use the SRF (130,000 tonnes) in their 4 UK cement kilns. Although significant research is being funded in to the viability of this technology, more time will be required before the process is fully tested and proved at larger capacities.

1.5. Waddington Recycling, Bradford

Bradford City Council recently confirmed that it has named Yorwaste and Waddington Recycling as preferred bidder for a new 5 year waste treatment contract. If signed, the deal would see the two companies developing an autoclave plant next to Waddington Recycling's Buck Street site in Bradford, to be fully operational by 2009 with a capacity of around 75,000 tonnes a year. Details of the markets proposed for the outputs from the process are yet to be finalised.

2. Appendix Selected Examples of MBT Plants operating in the UK

1.6. Shanks/Eco Deco

The new technology being introduced is a bio-MRF system, which uses heat produced by biodegradation to dry and stabilise waste prior to further recycling and recovery. Two Bio-MRF sites have been developed in East London:

- **Frog Island** is located on the north bank of the R Thames on land leased by Shanks, around 1.5km south west of Rainham. This new facility was built on a site currently used as a bus/lorry park within an industrial area. Frog Island mainly serves the two Boroughs of Havering, Barking & Dagenham. The facility incorporates three bio-MRFs, a MRF, visitor and education centre together with reception / administration building.
- **Jenkins Lane** was originally a transfer station and CA site within the ownership of ELWA and which has been in operation for over 20 years. The facility, which is located adjacent to the A13 and to the south-west of Barking, mainly serves the two Boroughs of Newham and Redbridge. The site has been redeveloped to incorporate three bio-MRFs, a MRF, Reuse and Recycling Centre (RRC) and Visitor and Education centre.

The Bio-MRF system has been pioneered by Ecodeco, incorporating Biocubi® and ITS® (Intelligent Transfer Station) technology. There are seven major reference plants operating in Italy and a further plant has been commissioned in the UK near Dumfries.

The process starts with delivery of mixed waste to an enclosed facility, where it is shredded and dried for around 12 – 15 days. As micro-organisms digest the organic waste, air is drawn from the main process room, into the waste and is continuously extracted through floor vents beneath the aerobic fermentation area. The temperature rises to 50 - 60°C and this drives out moisture, reducing waste mass by around 25%. The heating value of the stabilised waste is between 15MJ/Kg and 18MJ/Kg, which represents and increase in energy content of between 50% and 100% compared to wet MSW.

Process emissions to air are solely water vapour and a small amount of CO_2. The plant is fitted with roof-mounted bio-filters, through which all vented air passes and which suppress any odours.

Stabilised waste undergoes further separation; steel and aluminium are extracted for recycling, glass and stones are removed for construction aggregate. Compostable material is also removed. Around 45% of the original input remains and is suitable for use as a 'secondary fuel' for conversion into energy or can be landfilled.

1.7. Biffa Leicester

In delivering the contract for Leicester City Council the successful bidder, Biffa Leicester, proposed to build a series of processing facilities to process 120,000 tonnes mixed waste which included the following technologies:

- Ball Mill;
- Trommel Screen;
- Overband Magnets;

- Ballistic Separator;
- Eddy current separator;
- Anaerobic Digestion

The mixed waste is fed into the ball mill which reduces the size of the waste which is then separated into two fractions by size, one sub 40mm and one 40-80mm fraction.

The larger fraction is passed through a magnet to remove ferrous metals and is the separated using the ballistic separator to produce a light floc material (paper plastics and glass) to be used as a refuse derived fuel and a heavier material from which non-ferrous metal is removed using an eddy current separator and the residue is sent to landfill.

The smaller fraction is passed through a magnet to remove ferrous metals and the rest of the material is sent to anaerobic digestion (AD).

The main waste sites are at Wanlip (AD at Severn Trent Water), Bursom (The ball mill and separators) and landfill at Welford and Wilnecote.

The Wanlip site along with the landfills were already designated and used as waste sites. The ball mill facility was placed on one of 2 sites that had been identified in the waste local plan for Leicestershire, Leicester and Rutland as suitable for waste management activities and owned by the City Council. The chosen site for the ball mill, although earmarked for waste management, is in close proximity to residential areas, approximately 250 metres.

3. Appendix Selected Examples of EfW Plants in the UK

Incinerator Plant	Scale	Energy recovery	Established	Website for further information
Edmonton	500,000tpa	Electricity, 32MW	1975	www.londonwaste.co.uk
SELCHP	420,000tpa	Electricity, 32MW	1994	www.selchp.com
Tyseley Birmingham	350,000tpa	Electricity, 25MW	1996	www.onyxgroup.co.uk
Cleveland	245,000tpa	Electricity, 20MW	1998	www.sita.co.uk
Coventry	240,000tpa	Electricity, 17.7MW & Heat	1975	www.cswdc.co.uk
Stoke	200,000tpa	Electricity, 12.5MW	1997	www.mes-e.co.uk
Marchwood	165,000tpa	Electricity, 14MW	2004	www.onyxgroup.co.uk
Portsmouth	165,000tpa	Electricity, 14MW	2005	www.onyxgroup.co.uk
Nottingham	150,000tpa	Electricity & Heat (max 20MW heat)	1973	www.wrg.co.uk
Sheffield	225,000tpa	Electricity, 19MW (max) & 39Heat (max)	2006	www.onyxsheffield.co.uk
Dundee	120,000tpa	Electricity, 8.3MW	2000	www.bbcel.co.uk
Wolverhampton	105,000tpa	Electricity, 7MW	1998	www.mes-e.co.uk
Dudley	90,000tpa	Electricity, 7MW	1998	www.mes-e.co.uk
Chineham	90,000tpa	Electricity, 7MW	2003	www.onyxgroup.co.uk
Kirklees	136,000tpa	Electricity, 9W	2002	www.sita.co.uk
Douglas (Isle of Man)	60,000tpa	Electricity, 6MW	2004	www.sita.co.im
North East Lincolnshire	56,000tpa	Electricity, 3MW & Heat, 3MW	2004	www.groupe-tiru.com
Shetland	23,000tpa	Heat	2000	www.shetland.gov.uk
Isles of Scilly	3,700tpa	No energy recovery	1987	www.scilly.gov.uk

1.8. Marchwood Incinerator, Hampshire
It has been designed to serve the needs of the south west of the county and exports 14MW of electricity to the local grid, enough to power 14,000 homes. The incinerator has been operating since 2004 and is clad in a 36 meter high aluminium dome. The plant uses water from the Solent for cooling purposes, avoiding the need for condensers which would otherwise protrude from the dome.

1.9. Sheffield Incinerator
The EfW facility in Sheffield generates electricity for the National Grid and heat for the city's district energy network to include the international sports centre, flats, the Lyceum theatre and Weston Park hospital. In 2005 this system prevented 15,108 tonnes of CO_2 from being released from buildings across the city. An electromagnetic overband separator removes metal from the ash so that it can be delivered to a local company for recycling.

1.10. Dudley Incinerator
This plant has been in operation since 1995 taking 90,000 tpa and generating 7MW of electricity. Special effort has been made in terms of the flue gas treatment with the use of dry urea. It is injected in to the combustion chamber to reduce nitrous oxides. Refuse collection vehicles discharge into the storage pit, from which the waste is carried to the feed hopper. There are two streams each utilizing a Martin Stoker Grate. The Martin reverse acting grate deals with all types of waste without the need for pre-sorting.