TECHNOLOGY & BUSINESS REVIEW

Mechanical-Biological-Treatment : A Guide for Decision Makers Processes, Policies and Markets

The Summary Report

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Mechanical-Biological-Treatment : A Guide for Decision Makers

Processes, Policies & Markets

Summary Report

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We wish to place on record our gratitude to the many process developers, site operators and others who provided information for the preparation of this report. In particular we are grateful to the many individuals who facilitated our visits to reference plants to conduct site appraisals.

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Important Note

The inclusion of a supplier or proprietary process in this report does not constitute a recommendation as to its performance or suitability. Equally, non-inclusion does not imply that that process is not suitable for certain applications.

We welcome information to assist with the preparation of any future editions of this report. The opinions contained herein are offered to the reader as one viewpoint in the continuing debate about how MBT can contribute to a modern integrated waste management system. They are based upon the information that was available to us at the time of publication – and may subsequently change.

A wide ranging study of this type may contain inaccuracies and non-current information - for which we apologise in advance. We are always pleased to receive updated information or corrections about any of the processes reviewed for possible inclusion in future editions of the report.

This Review has been carried out on a completely independent basis. No payment has been or will be accepted from any process company for inclusion of any information or commentary contained herein. As an analyst active in this field, Juniper also provides confidential consulting services to many companies involved in this sector. We have procedures in place to avoid conflicts of interest, to protect confidential data and to provide 3rd parties with dispassionate, independent advice.

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SITA Environmental Trust

ABOUT SITA Environmental Trust

SITA Environmental Trust commissioned this report in 2004 to provide answers to the many outstanding questions about the future for MBT in the UK.

SITA Environmental Trust distributes funding through the Government's Landfill Tax Credit Scheme (LTCS). All the Trust's funding is donated by the waste management company, SITA UK.

SITA Environmental Trust:

- Is one of the largest distributors within the LTCS handling circa 10% of all funds in the Scheme
- Has allocated over £40M to more than 900 projects since 1997
- Has been a strong and focused investor in sustainable waste management projects
- Is planning to invest circa £30M over the next five years in community and environmental improvement projects across the UK

For more information about the Trust and details of other projects it has funded, please visit www.sitaenvtrust.org.uk

ASSURRE

ABOUT ASSURRE

ASSURRE (The Association for the Sustainable Use and Recovery of Resources in Europe), based in Brussels, is a partnership for action, which aims to play an important role in transforming Sustainable Resource Management from a concept into a practical process and to work for a better EU legislative framework through improved dialogue between all relevant actors and the EU institutions.

ASSURRE's approach is to:

- Raise the level of informed debate as regards the key issues of sustainable resource management and feed expertise into the EU institutions
- Uphold the vital link between EU policy formulation and implementation and ensure that experiences on the ground are fed back into the decision-making system.
- Commission Best Practice case studies and share lessons learned
- Track key issues and developments in technology and policy

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Format of the Report : electronic, downloadable pdf

This report consists of the **Summary Report**, **4 Annexes** and an **Executive Summary**.

All parts of the report can be downloaded free of charge from the SITA Environmental Trust (www.sitaenvtrust.org.uk), ASSURRE (www.assurre.org) or Juniper (www.juniper.co.uk) websites (please bear in mind the file size when downloading!). Alternatively a CD-ROM containing a complete set of files is available to order from Juniper at a nominal charge.

Section	Scope
The Summary Report	**Contains key findings about the role that MBT can play, assesses recycling and diversion performance, and reports on the issues and challenges that will affect its wider adoption**
Annexe A: Process Fundamentals	**Details the types of MBT system, related technologies and their key differences.**
Annexe B: Issues arising out of the Regulatory & Policy Framework	**Identifies and discusses the key EU and UK policy initiatives and regulations and assesses their impact on the uptake of MBT.**
Annexe C: An Assessment of the Viability of Markets for the Outputs	**Examines market constraints, technical obstacles and considers supply and demand issues related to fuel and soil improver applications**
Annexe D: Process Reviews	**Provides independent reviews of 27 commercial MBT processes and comparative analysis of these**
Executive Summary	**Summarises key conclusions**

1 Introduction

1.1. Mechanical-biological-treatment (MBT) technologies have attracted considerable interest in recent years. The hope is that such systems could reduce society's dependence upon landfill while at the same time avoiding the need for incineration. However, as interest in MBT has increased, conflicting views have emerged about its suitability for such a role. This report seeks to provide a **comprehensive, objective review of the capabilities and limitations of MBT** technologies in the context of evolving waste management requirements.

1.2. The project was funded by UK landfill tax credits disbursed by the SITA Environmental Trust (SET) and co-funded by ASSURRE (The Association for the Sustainable Use and Recovery of Resources in Europe). We are grateful for their support.

1.3. Because the primary funding was from UK tax credits, the report is written specifically with the aim of providing information to help UK Local Authorities make decisions about the extent to which MBT can help them meet mandatory EU and UK waste management policy targets. However, the majority of the issues discussed – as well as the Process Reviews - will be of direct relevance to a wide range of waste professionals in Europe and elsewhere.

Scope & Objectives

1.4. The aims of this report are:

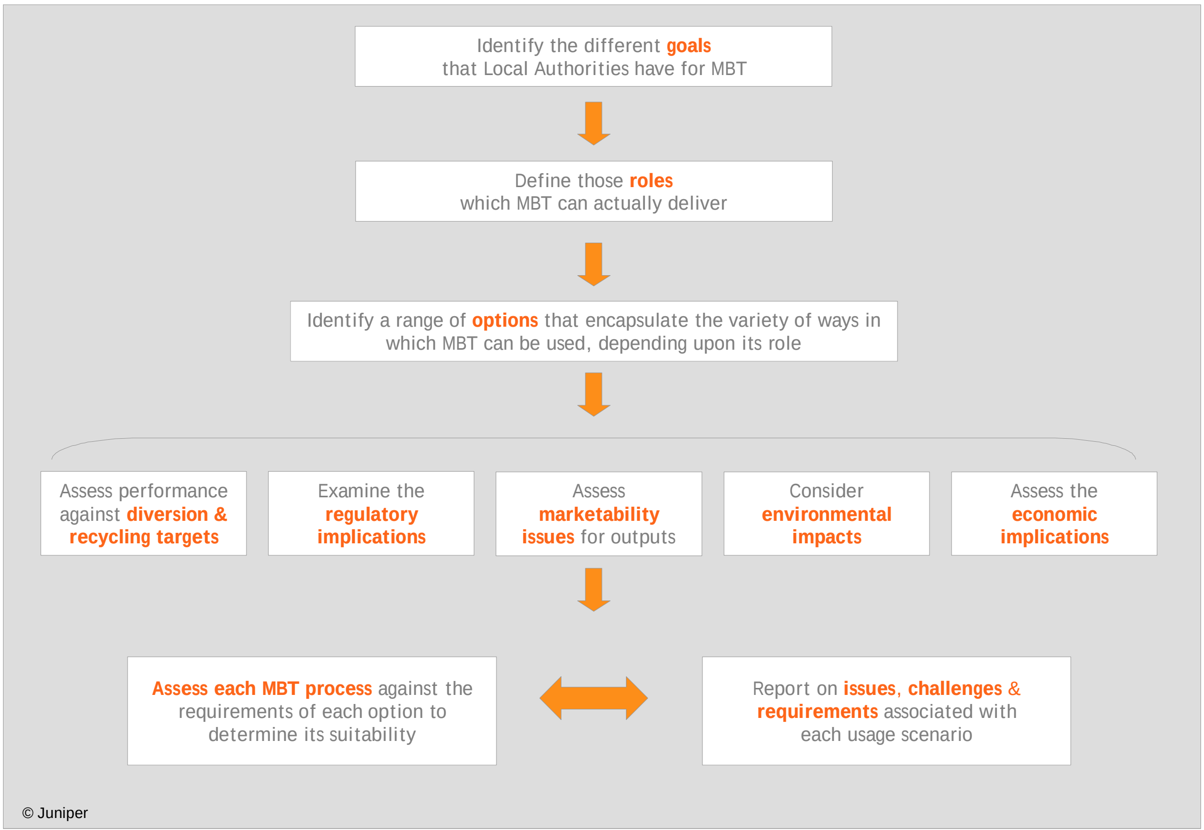
- to **assess the current status of MBT**, drawing upon international experience, site appraisals of reference facilities and a cross-comparison of technology options;
- to **identify issues, challenges and policy constraints** that will determine which type of MBT system is most suitable for an individual Local Authority in the context of the evolving regulatory and political framework in which policy decisions are being made;
- to **provide a suite of independent Reviews**, which have been prepared to a consistent set of criteria, and which assess the capabilities and suitability of the leading MBT processes from around the world;
- to **analyse the technical and commercial parameters** that determine the feasibility of using the output from MBT processes for **'fuel'** and **'soil'** applications.

1.5. There is no consensus about what constitutes an MBT process. Our over-riding objective has been to provide a comprehensive review that covers the range of technologies rather than focusing on a narrowly prescriptive definition of MBT. It was felt that the report should be focused on **integrated** MBT systems, rather than ad-hoc combinations of mechanical and biological elements, since this latter approach would have had to include consideration of the numerous composting plants that incorporate some mechanical screening to remove contaminants. The report only considers the processing of mixed MSW, not green waste or commercial/industrial waste applications.

MBT : Matching Roles to Processes

1.6. Much of the confusion about the capabilities of mechanical-biological-treatment of waste arises because MBT processes are being considered for a number of quite different roles. The varying **goals** of individual Local Authorities place different requirements on MBT processes and, not surprisingly, some commercial technologies are more compatible with one role than another. This can lead to apparently conflicting statements about the effectiveness of MBT systems. We have placed considerable emphasis within this report on addressing this confusion. The conceptual approach utilised is summarised in **Figure 1**.

Figure 1: Our approach to evaluating the effectiveness of MBT



1.7. The above analysis leads to a number of conclusions about key factors that can constrain or encourage the usage of MBT processes – which we are calling **Thematic Issues**. These may relate to policy matters, commercial parameters or technical issues (see **Figure 2**). Our analysis has been focused upon examining each of these Thematic Issues, which are topics frequently cited as either barriers to the adoption of MBT or reasons for MBT being a preferred solution; drawing conclusions about their significance and, where appropriate, providing recommendations.

Figure 2: The *Thematic Issues* related to the usage of MBT that are addressed in this report

- For what types of waste are MBT processes best suited?
- At what scale is MBT practical?
- Does the implementation of an MBT-led solution require changes relative to conventional waste management practices?
- How proven are MBT systems?
- Do MBT technologies complement or conflict with kerbside separation of waste?
- To what extent can MBT boost recycling performance?
- Is incineration a help or hindrance to an MBT-led approach?
- Can a UK Local Authority meet its statutory landfill diversion targets using an MBT system without the need for thermal waste processing?
- Are there fewer siting issues for MBT plants than incinerators?
- Are the differences between commercially available, proprietary MBT solutions significant in the context of a Local Authority decision?
- Are the various types of MBT system being promoted more suitable for different roles?
- Can MBT technologies deliver a 'zero waste' objective?
- To what extent is the output from an MBT process suitable for use as a soil improver rather than as a fuel or a residue for landfill?
- How viable is the use of the output as a co-fuel?
- Can the process produce a sufficiently consistent product to satisfy end-user concerns about fuel quality and fuel variability?
- Can the process produce a sufficiently stable residue to be acceptable as a landfilled material under EU regulations?
- Is deposition of the residual fraction in landfill consistent with the need to maximise resource recovery from waste?
- In the context of increasing landfill costs, would MBT + EfW be cheaper than MBT + landfill?

Source: Juniper analysis

Report Structure

1.8. This report seeks to provide a comprehensive review for decision makers. But we were also conscious that the type of information and the level of detail that each reader would want varied according to the topic. We have therefore decided to structure the report as a Summary Report (this document) which presents the principal topics and our conclusions, supported by a number of more detailed technical annexes.

1.9. The **Summary Report** is designed to be a self-contained document with cross-references to the relevant pages in the Annexes.

1.10. There are **4 annexes** in total and there is a Table on **page 6** of this report that summarises the contents of each. Details of how to obtain copies of them are also on this page.

1.11. A key part of this project is to provide an independent and objective review of the many MBT processes currently being marketed. Together these **Process Reviews** constitute the largest section of our report (**Annexe D**).

1.12. With any emerging technology, **Case Studies** are important. We have conducted **30 site visits** to appraise key reference plants in **Germany, Belgium, Italy, Spain, Austria, the Netherlands, Israel, Canada and the UK**. Our analysis of the performance of these plants has been included within the **Process Reviews** for the relevant supplier in **Annexe D**.

1.13. We also draw analogies from experience within other countries in considering usage options, regulatory aspects, marketability issues and policy initiatives.

2 What is MBT?

2.1. **Mechanical-Biological-Treatment (MBT) partially processes mixed household waste by mechanically removing some parts of the waste and by biologically treating others**, so that the residual fraction is smaller, more stable and more suitable for a number of possible uses.

2.2. **MBT is neither a single technology nor a complete solution** but is a term that has come to embrace the use of several types of biological and mechanical process elements that are combined in a wide variety of ways to meet a range of objectives. Thus, MBT systems vary greatly in their complexity and functionality.

2.3. This is the source of both its **flexibility** as a management option for MSW and the **confusion** about what is, and is not, an MBT system; and what it can, and cannot, be used for. Later in the report we will identify the various roles that MBT can play – here we clarify what MBT is, and isn't!

2.4. The aim of MBT as a waste management tool is to minimise the environmental impact associated with the end disposal of biodegradable wastes and to obtain additional value from the input waste by the recovery of recyclable materials, such as metal, glass, 'compost' and, in some cases, biogas and/or a waste-derived solid fuel fraction.

2.5. Since Mechanical-Biological-Treatment is a generic term for a large number of processes, many classification systems have been developed over the years to group sub-families of MBT and MBT-like processes. This has resulted in a bewildering array of acronyms and terms, such as MBT, BMT, MBS, MHT, bio-drying, MBA, MBV and MBP. Here we have only included a brief explanation of MBT and BMT (the two most widely used terms in the UK) and the reader is referred to **Annexe A** where these and other concepts are described in more detail. **Annexe A** also includes schematics for the most common types of configuration, brief descriptions of the core technologies used, and analysis of the key features of the main categories of MBT systems.

2.6. The '**M'** stands for '**Mechanical'** and refers to sorting, separation, size reduction and sieving technologies in varying configurations to achieve a mechanical separation of waste fractions into potentially useful products and/or streams suitable for biological processing.

2.7. The '**B**' stands for '**Biological**' and refers to an aerobic or anaerobic biological process which converts the biodegradable waste fraction into a compost-like output (CLO) and, in the case of processes incorporating AD (Anaerobic Digestion), biogas.

2.8. The '**T**' stands for '**Treatment**' and relates to the fact that process elements can be integrated to create an MBT process.

2.9. The '**B**' can be placed before the '**M**'. In this case the process is sometimes referred to as a **BMT** process. The most common variant of this is known as **'bio-drying'** where the up-front biological process partially dries the waste.

2.10. **In this report we will use the term MBT generically to describe all the types of integrated mechanical and biological processing of household waste**.

2.11. Until recently, MBT was little known in the UK and many other countries. But **MBT is already an established waste treatment method in some parts of Europe**, having evolved over the past 10 - 12 years.

2.12. The term was originally used to reflect an approach to waste management that eschewed thermal processing (i.e. to describe the use of any mechanical or biological techniques to reduce the amount of waste landfilled). Thus, in Germany and Austria, where the concept originated, the term MBT covered all mechanical systems (including MRFs) and biological systems (such as composting) that were used to reduce the amount of residual waste. Thus it included separate un-integrated biological and mechanical process elements. Over time, the use of the term MBT has largely come to mean an **integrated** system that uses both a mechanical and a biological element within one process.

2.13. We have used this latter definition, since, in our view, much of the confusion about MBT derives from using too broad a definition. For similar reasons we have not included **M**echanical **H**eat **T**reatment (**MHT**) technologies within the definition, despite their similarities with true MBT systems. MHT processes are discussed in **Annexe A**.

2.14. The first generation of MBT-type systems were very simple combinations of relatively low-tech mechanical sorting technologies with low-tech biological processes, such as windrow composting. More advanced concepts have since been developed and MBT processes are now being marketed as 'state-of-the-art' 'turnkey' solutions across Europe, together with more sophisticated approaches to environmental abatement than is used in first generation facilities.

2.15. It is important to note that some of these integrated MBT technologies produce a fuel as their primary output, which is then thermally processed by one method or another – and so the original perception that MBT does not involve Energy-from-Waste is not necessarily an accurate reflection of many of the configurations being most widely considered.

3 What are the reasons for the current interest in MBT?

Diverting waste from landfill

3.1. Faced with the need to meet statutory targets for recycling and diversion of biodegradable waste from landfill, UK Local Authorities have to make fundamental decisions that will change the way they manage waste. Similar challenges are faced by waste professionals in many other countries.

3.2. The majority of councils are currently focused on boosting recycling rates, but also recognise that they will have to go further to meet their landfill diversion targets. In essence, this means selecting a technology or technologies that will be used as the basis for moving away **from disposal towards treatment**.

3.3. In order to avoid landfill, the most obvious treatment option is incineration but, because of the negative image of this approach – and the consequent difficulty in implementing incineration-led strategies – most Local Authorities want to consider the possible use of alternative technologies, even if they then subsequently decide to adopt incineration.

3.4. Many of these alternatives, such as gasification and pyrolysis, are also thermal technologies (which can then raise similar concerns to those expressed about incineration). Moreover doubts have been expressed about the dependability and bankability of some of the more heavily promoted so-called Advanced Thermal Treatment technologies. Stand-alone gasifiers therefore seem less attractive than they did a few years ago. This has led to the search for proven, non-thermal alternatives. Much of the interest in MBT arises out of this search.

3.5. The publication in February 2003 of the Greenpeace report entitled "Cool Waste Management" included a recommendation to UK-based authorities to consider the merits of MBT. It stated that MBT could deliver up to 85% mass diversion of waste from landfill without the need for incineration. This, and associated coverage in the National Press, led to heightened interest in MBT technologies.

Can MBT fulfil the role it is being given?

3.6. In response to this interest, some specific MBT technologies were heavily promoted to UK Local Authorities during the latter part of 2003. At the same time **concerns about the practicality of adopting an MBT-led approach** were voiced. These doubts focused upon the fact that MBT is only an intermediate treatment technology and that therefore a viable end-use or disposal option is still needed for the outputs from MBT. Doubts have been expressed by both waste management companies and Local Authority officers about the viability of basing long-term waste disposal contracts on MBT when there are perceived commercial risks associated with managing the MBT outputs. Proponents of MBT dismiss such concerns, saying that they can easily be addressed. This report provides new analysis of this issue.

3.7. In our view, one reason for the difference of opinion about its suitability is that **MBT is being considered for a number of roles, only some of which it can achieve** (see **Figure 3**). It is therefore important to match the specific reasons for using MBT on a particular project with a process that is capable of delivering on those objectives. This is the subject of the next section.

Figure 3: Typical goals for MBT

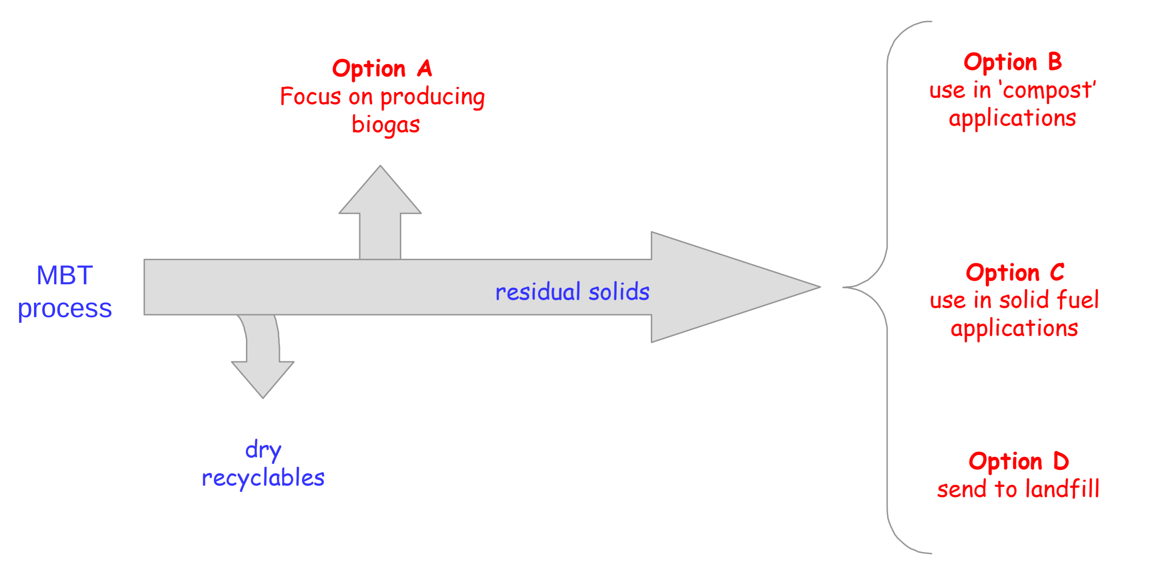
Goal	Extent to which this goal can be met by MBT	
Help to meet landfill diversion targets	**Yes, significantly**	Incorporating an MBT element into almost any waste strategy will boost landfill diversion, often significantly (see **Section 11)**
Boost recycling performance	**Yes, but ….**	A common misconception about MBT is that it produces lots of materials for recycling. In fact, when processing residual waste, MBT processes typically only recover 5-10% additional dry recyclables (though they are capable of recovering more). Notwithstanding this, because of the way recycling performance is calculated in the UK, MBT could boost reported recycling rates under UK BVPI targets by significantly greater percentages (see **Section 11**)
Reduce the need for incineration	**Yes, partly**	MBT processes only partially treat the waste, so an outlet has to be found for the residual fraction. Most UK LAs could meet their statutory diversion targets by using MBT + landfill, avoiding thermal treatment for those that are determined to do so, but this may have disadvantages, such as cost. Where MBT is used as a pre-treatment before thermal processing, the scale of EfW needed is usually halved.
Avoid the need for separate kerbside collection of dry recyclables and green waste	**Yes, but not in UK**	MBT can be used as an alternative approach to kerbside collection or MRF sorting; but, because of the requirements of the Household Waste Recycling Act, it is unlikely that this would be desirable in the UK.
Maximise the sustainability of waste management through recycling and recovery	**Yes, in some configurations.** **No, in others.**	Maximising the amount of recyclables generated by an MBT process increases cost, and so for commercial reasons, this may be limited at particular sites. If the solid output is sent to landfill, rather than being used as a fuel, resource recovery has not been maximised. The energy content could displace fossil fuels, mitigating climate change impacts.
Achieve an overall 'zero waste' goal	**No**	Despite claims from a wide range of policy makers, NGOs and process companies, MBT processes (like all other waste technologies) will produce a certain amount of secondary wastes that cannot be viably recycled or used as a fuel. As such, this is not a 'zero waste' solution.
Minimise waste processing costs	**Possibly, but not likely**	Although MBT processing costs are comparable to many other options, MBT is only a partial solution and so it is likely that the overall costs associated with an MBT-led solution will not be significantly lower than alternatives (see **Section 12**)
Reduce the impact of waste on the community	**Cannot generalise**	The visual impact, noise, emissions, vehicle movements, etc. associated with a project will vary. Some MBT processes will be better than others against specific criteria.
Make it easier to implement waste infrastructure in planning terms	**Slightly**	Waste strategies that avoid thermal processing tend to engender less public concern, regardless of their actual environmental and health impacts. This may lead to slightly less public opposition for an MBT-led approach.
Base waste policies on bankable robust technology solutions	**Yes, relative to other novel processes**	The technology risk associated with MBT is lower than many other novel approaches and there are several reasonably well proven systems available (see **Section 8**).

Source: Juniper analysis

4 Assessing MBT systems according to their outputs

4.1. Decision processes about MBT can be simplified by considering the four main options available for the outputs from the MBT process, regardless of its configuration. These four options are shown in **Figure 4**.

Figure 4: The four main options for MBT



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4.2. In **Figure 4** the MBT process can be designed to produce a primary output or, in several cases, more than one output, e.g. a soil improver and an RDF stream. It is also important to note that regardless of the primary objective with an MBT process of producing a **solid fuel**, **biogas**, and/or a **compost-like output** and/or a **bio-stabilised residue**, all MBT processes will produce other output streams. These may include:

- a range of **dry recyclables**, such as paper, metals and sometimes plastics;
- a variety of **reject streams** from the mechanical processing that are typically landfilled, and
- **wastewater** and **residues** from environmental abatement equipment, depending upon the particular design of the system and the requirements of the regulator.

Potential applications for the outputs from MBT processes

4.3. **Figure 5** lists some of the specific applications that have been proposed for the outputs from MBT processes.

Figure 5: Potential uses for MBT process outputs

Type of Use	Application
Compost-like output uses	On food crops
	For forestry
	On land used to grow energy crops
	To improve soil structure and moisture retention in arid areas of poor soil quality
	For pasture land
	Horticultural applications
	For use in domestic gardens
	Liquid fertiliser
	On verges & amenity land
	As landfill cap
	For landscaping during road construction and similar civil engineering projects
	On brownfield (contaminated land) sites
Solid fuel applications	Co-fuel for direct combustion in power plants
	Fuel for indirect combustion in power plants
	Co-fuel for cement kilns
	Co-fuel for industrial boilers
	Fuel for a dedicated incinerator
	Fuel for a dedicated gasifier
	Co-fuel for an existing incinerator
Biogas applications	Produce electricity (& heat)
	Blend with landfill gas &/or syngas from waste gasification
	Produce a transportable fuel
Disposal Options	Landfill daily cover
	Bio-stabilised residue suitable for depositing in landfills

Note: this report concludes that a number of these options are not practical (see Section 9 and Annexe C)

Source: Juniper analysis

4.4. As a part of this project, Juniper conducted a comprehensive appraisal of the viability of the potential uses identified in **Figure 5**. This work is reported in **Annexe C** and summarised in **Section 9**.

4.5. **In many of the proposals put forward by commercial companies for specific projects, the MBT system is actually configured to produce several outputs.** For example, the system may use anaerobic digestion to produce a limited amount of biogas and a partially digested humus which is then mechanically sorted into a number of fractions including:

- several dry recyclable streams such as ferrous and non-ferrous metals;
- a grit and glass fraction for use as an aggregate;

- some rigid plastic fractions for recycling;
- a 'fluff' fraction rich in plastic film and fibrous matter that is used as a fuel; and,
- some reject streams that are landfilled.

4.6. In some cases a de-contaminated bio-fraction is then matured aerobically for use as a soil conditioner. Thus, specific projects may pursue multiple objectives, depending upon the local context.

Assessing specific processes

4.7. Comparing the performance of commercial MBT systems and evaluating the extent to which they meet the objectives set is not an easy task and it is important to:

- carefully identify each output stream;
- assess its composition and, hence, its suitability for usage, as well as considering any potential environmental impacts;
- quantify the amount that will be produced;
- confirm that dependable market outlets exist for all 'recyclables' and that the economics of such usage have been assessed realistically; and,
- ensure there is a fit between the resultant recovered resources and the landfill diversion and recycling goals of the Authority.

4.8. **Realism is necessary in assessing whether an output is a recyclable or a secondary waste. If markets for recyclables are not viable this can have a significant impact on the economics of a plant (revenues are turned into disposal costs) and performance against diversion targets which, for UK Local Authorities, is likely to result in significant financial penalties**.

4.9. Our analysis aims to help Local Authorities evaluate this. For each of the proprietary processes that have been selected for detailed review, we have provided a Process Schematic that clearly identifies all of the output streams and classifies them either as recyclable materials, effluent streams, residue streams or outputs that can be further upgraded into useful resources. We have also included mass and energy balances and determined the percentage of recyclables and landfill diversion, where sufficient data was available.

4.10. The viability of the output options shown in **Figure 5** is considered in **Annexe C** in terms of:

- **usability and functionality**

  are there technical issues or changes in procedures that would need to be addressed before a usage option is feasible?

- **the balance of supply and demand**

  what quantity of material could be absorbed by an application relative to the total amount that could be produced by MBT plants?

⇨ **economics**

how do the overall costs associated with a use impact, favourably or unfavourably, upon the likelihood of it being adopted?

⇨ **regulatory & policy acceptability**

is an option constrained by regulatory requirements? Does Government policy encourage or discourage its development and are there any industry standards/codes that favour or restrict use?

⇨ **market appetite**

are potential users enthusiastic or reluctant to accept the MBT-derived material, relative to other alternatives?

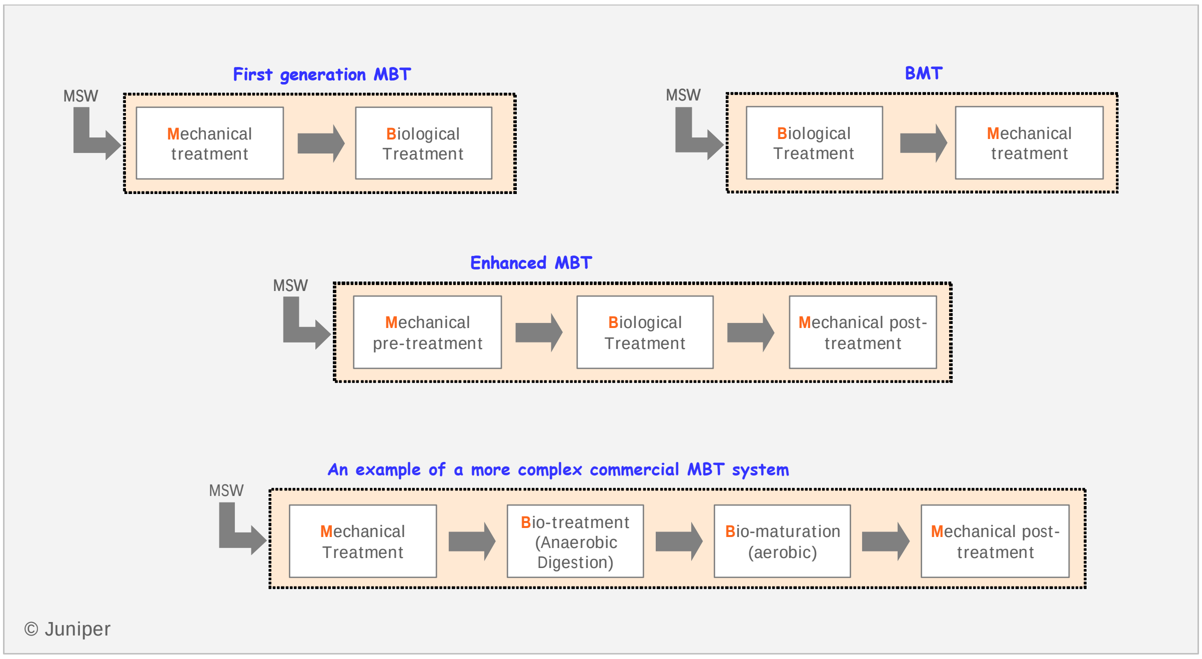
4.11. The conclusions from this analysis are discussed in **Section 9** and summarised in **Figure 21** on **page 48**.

5 The different ways of using MBT systems

5.1. We have already pointed to the number of combinations of process elements that are possible within an MBT-led solution – and the resultant flexibility this provides for fine-tuning a solution to meet the specific needs of a particular situation.

5.2. In practice commercially available systems may combine the '**M**' with the '**B**' in a variety of ways (see **Figure 6**). **Annexe A** explains these elements and the reasons for combining them in different ways, and the **Process Reviews** in **Annexe D** consider the specific proprietary approaches adopted by all the leading MBT suppliers.

Figure 6: Examples of generic MBT configurations



5.3. Whilst there are numerous possible combinations of mechanical and biological process elements, we have identified **8 generic options** which are broadly representative of the range of possibilities (see **Figure 7**). These eight will be used elsewhere in this report to determine the suitability of each type of configuration for the various roles ascribed to MBT and to report on their relative performance in terms of key parameters (such as landfill diversion and cost).

5.4. The generic options that we have selected are designed to reflect the ways in which MBT systems can be used to produce a variety of outputs; they are not 'configurations' in a process engineering sense: instead of focusing on whether the mechanical part of the MBT system is before or after the biological element, they focus on inputs and outputs and largely treat the **MBT system** as a **'black box'** with certain capabilities. Thus in **Figure 7** the schematics represent a mechanical *plus* a biological element in either order (hence the **+** sign in between these two elements in each schematic, rather than an ⇨).

5.5. The **eight configurations selected** for cross-comparison in this report include:

- **one scenario** that reflects the concept of using MBT to **pre-treat waste to reduce its volume and its biodegradability**. The resultant material is referred to as a **bio-stabilised residue**.
- **two scenarios** that seek to derive a **compost-like output**. Each reflects a different use for this material: as **a compost or a lower-grade soil improver**; in an optimal solution these differing goals should be reflected in differing ways of optimising the process.
- **one scenario** that reflects the general concept of producing a **refuse-derived fuel** (RDF) and another which focuses more specifically on using the **bio-drying**[1] variant of MBT with the aim of producing a fuel that is matched to end-market requirements (this latter type of RDF is known as a solid recovered fuel or **SRF**)[2].
- **one scenario** that reflects the concept of **integrating MBT with a dedicated thermal waste processing unit**, thus guaranteeing an outlet for the fuel fraction but at the same time **reducing the scale of thermal treatment** that is required.
- the **two final scenarios** relate to MBT systems that are based on **anaerobic digestion**. Both produce **biogas**. They differ in that one assumes the digestate is used as a soil improver while the other sends it to landfill, and so the processes should also be optimised differently.

5.6. These eight options (see **Figure 7**) are described in more detail in **Annexe A**, which also considers some of the advantages and disadvantages of the various approaches. The eight will be used in the later sections of this **Summary Report** as the basis for comparing MBT systems in terms of key parameters, including their economics and regulatory status as well as the varying performance against landfill diversion and BVPI targets.

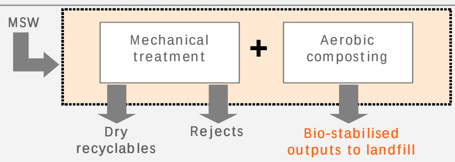
[1] explanations of RDF, 'bio-drying' and other terms used here can be found in **Annexe A**
[2] Fuel quality standards and the differences between SRF and RDF are reviewed in **Annexe C2**

Figure 7: The most significant options for MBT

Concept	Key elements of a generic solution

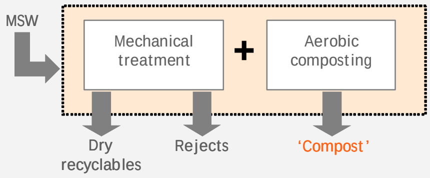
Stabilisation of waste for landfilling

the objective of this option is to lower the biodegradability of MSW, whilst also recovering some recyclables



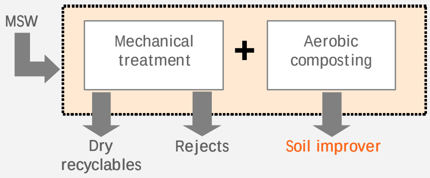
Make a 'compost' from MSW

this option aims to produce a material suitable for use as a compost. The resultant product quality issues are considered in this report



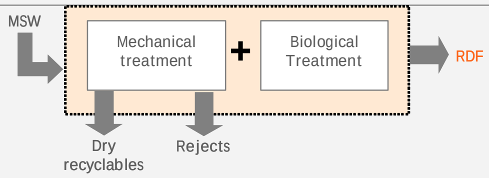
Make a lower grade soil improver from MSW

this option is similar to the previous one, but in this case the output is used for applications that have lower quality requirements



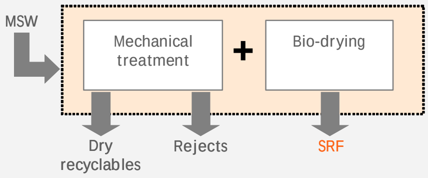
Make an RDF

this option reflects the generic approach of using the solid output from an MBT process as a fuel



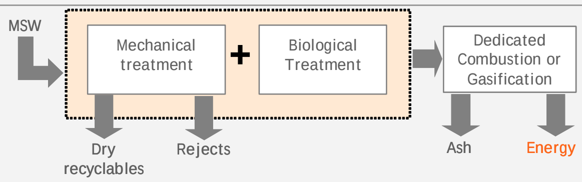
Produce a fuel using 'bio-drying'

the 'bio-drying' variant of MBT, promoted by some process companies, producing a defined specification fuel (SRF) has some specific advantages & disadvantages which this option aims to capture



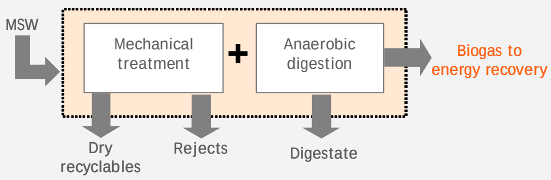
MBT to reduce the need for thermal treatment

MBT lessens the amount of residual waste, and so can reduce the scale of any associated thermal treatment capacity: this option reflects such an approach



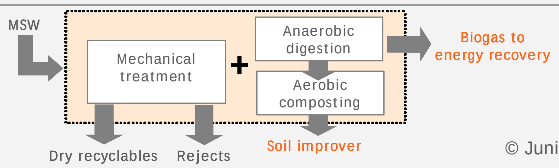
Produce biogas

if anaerobic digestion is used as one component of an MBT system, a bio-gas is produced. In this option the digestate is sent to landfill



Produce biogas + soil improver

many implementations produce both biogas and a soil improver, as represented in this option



Notes:
1. mechanical and biological elements can be in either order (see **paragraph 6.6**).
2. for simplicity input is shown as MSW (see **Section 7** for a discussion of possible inputs).
3. the terminology used in the Figure (e.g. bio-drying, SRF) is explained in **Annexe A**

6 Commercially available MBT systems

6.1. There is **no shortage of commercially viable MBT processes** that are suitable for a wide range of waste processing objectives at a variety of scales.

6.2. In this respect MBT systems are more developed – and hence more commercially viable for processing household waste - than gasification, pyrolysis, plasma, microwave and other novel systems that, like MBT, are being marketed as new (and 'better') approaches to waste management.

6.3. However, **the functionality, complexity, cost, environmental performance, standard of engineering and provenness of individual commercial systems vary widely**. The challenge for an individual Local Authority is to select the most appropriate configuration and, hence, proprietary processes for their particular requirement.

6.4. Many companies have recently decided to promote MBT solutions, some of whom have a limited track record within the relevant fields of expertise. As in any procurement exercise, it is important to shortlist suppliers carefully.

6.5. Of the many systems promoted a large proportion were considered either inappropriate for review or fell outside the Terms of Reference established for the Project and agreed by the Technical Advisory Committee (see **Annexe D3**). We selected **27 processes** for review, which are identified in **Figure 8**. **Process Reviews** for each of these individual processes, of varying length, are included in **Annexe D**.

Figure 8: The 27 processes selected for detailed review in this report

Company	Where process was developed	Company	Where process was developed
ArrowBio	*Israel*	Linde	*Austria*
Bedminster	*Sweden / USA*	Nehlsen	*Germany*
Biodegma	*Germany*	New Earth	*UK*
BTA	*Germany*	OWS Dranco	*Belgium*
Civic	*UK*	RosRoca	*Spain/Germany*
EcoDeco	*Italy*	Rumen	*Finland*
GRL	*Australia*	SBI-Friesland	*Netherlands / Finland*
Grontmij	*Netherlands / Finland*	SRS (Wright)	*Canada*
Haase	*Germany*	Sutco	*Germany*
Herhof	*Germany*	Valorga	*France*
Hese	*Germany*	VKW	*Austria*
Horstmann	*Germany*	Wastec	*UK*
Iska	*Switzerland/Germany*	Wehrle	*Switzerland/Germany*
Komptech	*Austria*		

Source: Juniper database

Which processes are most suitable for which application?

6.6. Since a wide range of different component processes can be integrated in a number of different ways - and the role for which MBT is being used varies from project-to-project - individual proprietary processes have been developed with particular outputs in mind. **Figure 9** groups the processes that are reviewed in **Annexe D** according to their functionality.

Figure 9: Leading integrated MBT systems classified by primary output

Make a solid fuel*	Make a soil improver	Produce biogas to generate electricity	Convert waste into a bio-stabilised output suitable for landfilling
Biodegma	ArrowBio	**Arrow-Bio**	**Biodegma**
Bedminster	**Bedminster**	**BTA**	Civic
EcoDeco	*Biodegma*	*GRL*	Haase
Herhof	Civic	**Grontmij**	**Horstmann**
Nehlsen	*GRL*	Haase	ISKA
Wehrle	Hese	Hese	Komptech
	Horstmann	ISKA	**Linde**
	Linde	**Linde**	**OWS**
	RosRoca	**OWS**	RosRoca
	Rumen	**RosRoca**	SRS
	SRS	**SBI**	**Sutco**
	Valorga	**Valorga**	**VKW**
	VKW	Wehrle	*Wehrle*
	Wastec		

* The companies listed here have processes that are designed to produce a bio-fuel (SRF). Several other companies have processes that produce a plastic reject stream that can be used as an RDF.

Bold entries relate to applications with relevant reference facilities.

Normal text entries have been demonstrated to a more limited extent (the particular nature of these limitations is explained in the individual Process Reviews within **Annexe D**).

Italics are used to indicate applications for which the company is marketing the technology but which are relatively un-demonstrated at the time of writing.

Systems that are not included within a particular column may also merit consideration for specific projects because they could be adapted to fulfil that purpose, however those modified processes would not be as commercially proven as others which had already been developed with that objective in mind. Thus the Table should be seen as a guide, at the time of writing, to the leading contenders for a particular application.

Some companies appear in more than one column, reflecting the fact that they promote their technologies in more than one configuration.

Source: Juniper database

7 For what type of waste is MBT best suited?

7.1. MBT processes are available to treat both 'black bag' MSW and 'source-separated' residual waste.

7.2. Most suppliers can configure their process for either type of feed.

7.3. For applications treating **'black bag'** waste the **'Mechanical'** part of the process would need to be more robust and flexible to extract, for treatment, the biodegradable content of the heterogeneous and seasonally changing waste input. A key role of the 'Mechanical' element of MBT is to prepare the input rather than extract recyclables (this is discussed in **Annexe A**).

7.4. In this context, the MBT systems that are arranged in a **configuration with the biological stage first**[1] may need to be larger to accommodate the recyclable materials still contained in the input waste stream as these processes recover the recyclables after the bio-treatment stage. Also, when treating 'black bag' waste in this configuration, there is the potential for blockages and damage in some types of biological treatment equipment.

7.5. For plants receiving **source-separated** residual waste, much of the easy-to-recycle materials will have already been recovered from the waste. This results in lower quantities of waste for treatment, but the waste will still contain quantities of metals, plastics, glass, paper and card. Because these remaining recyclables/contaminants are often of a small particle size, more complex 'Mechanical' elements are often required to extract a reasonably homogeneous bio-fraction.

7.6. Most of the German MBT plants treat the residual fraction from source-separated MSW - so-called **'grey bag'** waste - because the recycling infrastructure is much more advanced. This poses the question of whether German technologies may be less suited to UK 'black bag' waste. However, many of the German technologies have been implemented in Italy and Spain, where they have been designed to treat **unsegregated MSW**.

7.7. **Figure 10** lists a selection of reference plants that are processing different input waste streams.

7.8. The suitability of particular MBT processes for unsegregated and residual waste applications varies. For example, if an MBT process incorporates aggressive up-front mechanical elements (notably shredding) this can result in the co-mingling with the rest of the waste of undesirable contaminants, present within 'black-bag' waste, significantly constraining subsequent recycling. Thus, if batteries, fluorescent tubes or TVs are shredded, there is a real risk of heavy metal contamination of all output streams leading to quality concerns about the CLO and other recyclables. This, and similar issues, are often not considered sufficiently when designing or procuring MBT systems.

[1] this topic is discussed further in **Annexe A**

Figure 10: Key MBT reference plants categorised by type of input

Type of input waste	Reference plant	Main MBT supplier
Unsegregated MSW	Caivano, Italy	VKW
	Eco Parc 1, Barcelona, Spain[1]	Linde
	Eco Parc 2, Barcelona, Spain[1]	Horstmann + RosRoca + Valorga
	Istanbul, Turkey	VKW
	Madrid, Spain	Horstmann
	Sydney, Australia	GRL (ISKA[2])
	Tel Aviv, Israel	ArrowBio
	Thornley, UK	Civic
	Valladolid, Spain	Horstmann + Linde
Residual MSW	Bassum, Germany	OWS
	Cavaglia, Biella, Italy	Ecodeco
	Corteolona, Pavia, Italy	Ecodeco
	Dresden, Germany	Herhof
	Freisland, The Netherlands	SBI + Grontmij
	Groningen, The Netherlands	Grontmij
	Neuss, Germany	Sutco
	Venice, Italy	Herhof
MSW + sewage sludge	Edmonton, Canada	Bedminster

1 unsegregated and segregated MSW
2 the ISKA percolation process is a sub-element of GRL's integrated plant

Source: Juniper database

7.9. We are assuming in this report that, in a UK context, the predominant feedstock to an MBT plant will be a residual fraction because many Local Authorities have implemented varying degrees of kerbside collection services which includes metal, paper, plastics and in some cases garden waste. However, there may be cases when the MBT plant would be required to accept 'black bag' waste.

7.10. In principle, MBT could be applied to other types of waste (for example, mixtures of household and commercial waste). Such applications are outside the scope of this report.

7.11. **Conclusion: MBT solutions can be considered for either unsorted 'black bag' waste or the residual fraction from kerbside recycling schemes. There are relevant reference plants in Europe for both types of application.**

7.12. **The majority of European MBT suppliers have designed and constructed plants that operate on a waste input that has undergone a significant degree of source-separation because, particularly in countries like Germany, there is a considerable level of kerbside and source-separation infrastructure already in place. These proven systems (in Germany) have not yet proved their performance with UK 'black**

bag' waste and therefore technical and commercial risks remain until the 'first generation' plants have achieved sufficient demonstrated operational performance.

Figure 11: MBT processes categorised by type of input received

Unsegregated MSW			Source-separated MSW		
Operating reference(s)	**Demonstrated***	**Being marketed****	**Operating reference(s)**	**Demonstrated***	**Being Marketed****
Bedminster***	Arrow-Bio	Civic	Biodegma	ISKA	Rumen
Ecodeco	Civic	GRL	Ecodeco	Komptech	VKW
Horstmann	GRL	Haase	Grontmij		Wehrle
Linde	Hese	Herhof	Herhof		RosRoca
SRS	Wastec	Hese	Horstmann		Civic
VKW	Wehrle	ISKA	Linde		
BTA	Haase	Komptech	Nehlsen		
RosRoca		New Earth	OWS		
Valorga		OWS	SBI-Friesland		
		Sutco	Sutco		
		Wastec			
		Wehrle			

* These technologies have been demonstrated to a more limited extent (the particular nature of these limitations are explained in the individual Process Reviews within **Annexe D**).

** Applications for which the company is marketing the technology but which are relatively undemonstrated at the time of writing.

*** Plant co-processes unsegregated waste with sewage sludge

Source: Juniper database

8 How proven is MBT?

8.1. From an historical perspective, **MBT systems have been actively processing biodegradable waste fractions for more than ten years**: this is not a 'novel' technology in the strict sense of the word. But its usage has been concentrated in a few countries and the rest of the world, including the UK until very recently, has been relatively unfamiliar with these processes.

8.2. Between them, the 27 companies included in this report have **80**[1] **operational reference facilities**, which have a combined treatment capacity of more than **8.5 million Tonnes per year**[2].

8.3. In addition, these companies have announced a further **43 MBT projects**, some of which are currently under construction.

Figure 12: Worldwide MBT infrastructure

MBT infrastructure	
Operational MBT Facilities	80
Cumulative Installed Operating Capacity	c. 8,500,000 Tpa
The number of plants that are expected to be operating by 2006	123
Expected installed capacity by 2006	c.13,000,000 Tpa

Notes: Wholly based on the reference plants supplied by the 27 process companies reviewed in **Annexe D**
'Operational' includes plants in commissioning that had started to process waste on a commercial basis at the time of writing
Excludes facilities with an input capacity below 20,000 Tpa

Source: Juniper analysis

Supplier classification

8.4. We have categorised each of the 27 processes that were reviewed according to our standard classification system for provenness: **Figure 13** groups them according to their commercial status at the time of finalising this review (February 2005).

8.5. **Of the 27 companies reviewed, 15 have at least one commercial reference**. Overall, therefore, there are sufficient MBT suppliers with a track record to provide a solid industry base for the development of this waste management solution. However, when considering **specific configurations** of MBT system there may be **fewer suppliers with a valid reference plant**. Some companies have supplied fully integrated plants whereas others have focussed on supplying core elements.

[1] higher estimates available from others for the number of operational plants include facilities which are not classed as MBT processes in this report

[2] Plants with capacities below 20,000 Tpa have been excluded

Figure 13: Classification of the 27 MBT suppliers reviewed in this report

Status	Description	Process Supplier
Fully Commercial	Two or more commercial facilities that have both operated for more than one year	Bedminister, Biodegma, BTA, Ecodeco, Grontmij, Herhof, Horstmann, Linde, OWS, SRS, Valorga, VKW
Commercial	One commercial facility operating for a period greater than one year	Nehlsen, RosRoca, SBI Friesland, Sutco
Demonstrated	A full scale trial plant (or module) has been operated for a period of time	ArrowBio, Civic, Komptech
Market entrant	While the company has received at least one commercial order they have not yet completed commissioning their first plant	GRL, Haase, Hese, ISKA, Wehrle
Conceptual	Has promoted an MBT solution	New Earth, Rumen, Wastec

Source: Juniper database

An overview of the use of MBT worldwide

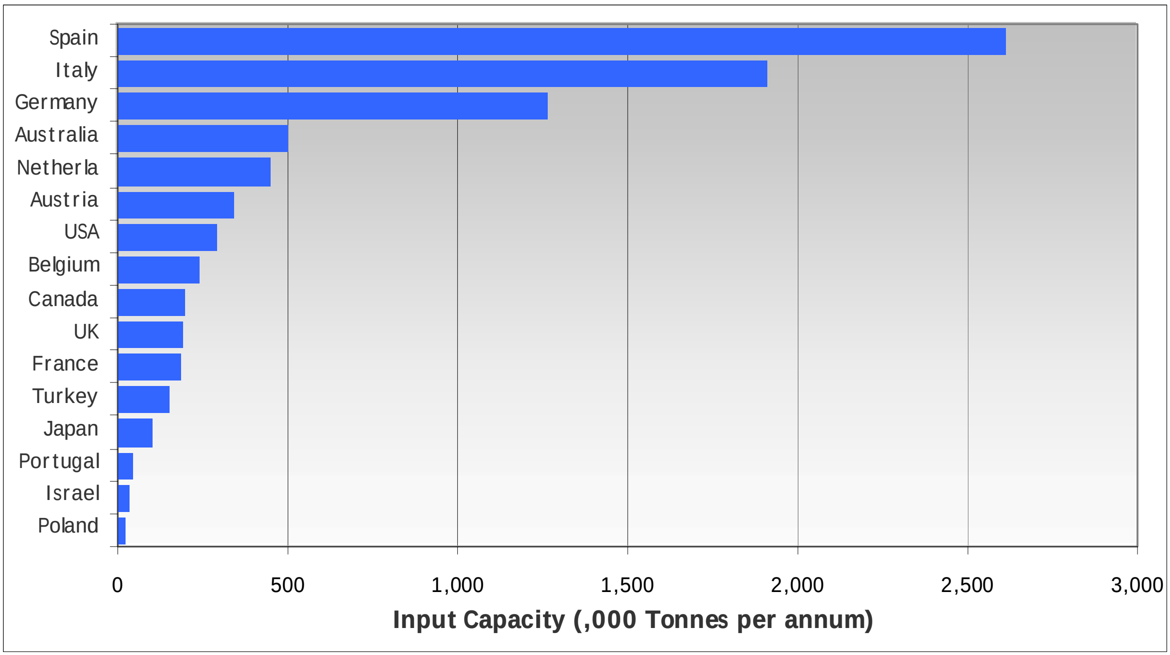
8.6. **Spain, Italy and Germany have by far the most substantial amount of experience with MBT**. The early development of MBT systems took place mainly in Germany and Austria - and it is in these countries where MBT has been considered as a viable waste management option for the longest period of time.

8.7. More recently, MBT has attracted much wider interest. **Figure 14** illustrates the broad array of countries which have at least one commercial MBT facility. This includes the plants in commissioning that are treating waste on a commercial basis.

8.8. The fact that the majority of the operational experience with MBT has been gained outside the UK implies differences in feedstock, operational practices, regulatory requirements and market conditions, which raises concerns about the applicability of this track record. We address this in the context of particular proprietary systems within the individual Process Reviews in **Annexe D**. Overall **we regard the risk associated with adopting many of the leading MBT processes to be within reasonable limits**, assessable in the context of a procurement exercise for a specific project.

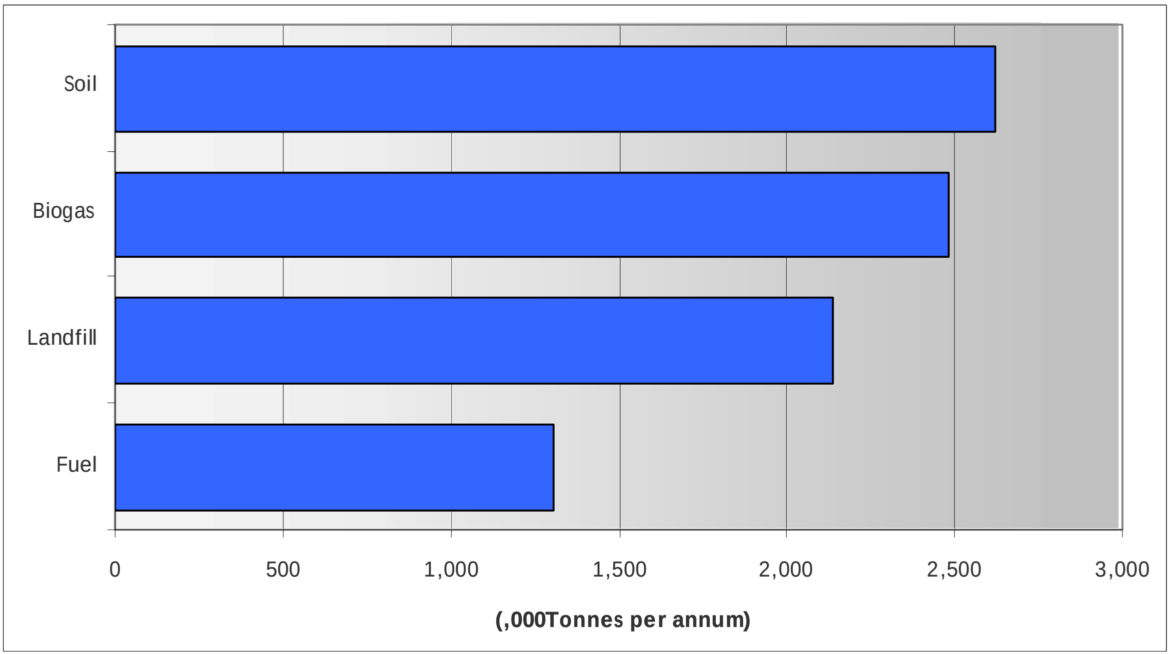
8.9. MBT has operated in a number of different configurations which has led to much confusion surrounding which waste management objectives MBT can, and cannot, fulfil. There is a perception amongst certain groups that MBT is primarily a route to producing a fuel. Others stress its ability to produce a compost-like output for a variety of soil applications (see **Section 9**). In this context it is interesting to note what has been the primary motivation for the facilities that are already in operation.

Figure 14: Installed capacity of operational[1] facilities[2] by location



Source: Juniper database

Figure 15: Capacity of operating[1] MBT plants[2] by primary output



Source: Juniper database

[1] Includes plants in commissioning that are treating waste on a commercial basis
[2] For the 27 processes reviewed

8.10. **Figure 15** shows the amount of installed capacity[1] according to the **primary output produced** (in many cases, an MBT plant will produce more than one marketable output). This shows that, contrary to the perception of many that MBT is predominantly about producing a fuel, this has actually been the least popular primary goal for MBT.

Figure 16: Take up of MBT internationally

Countries that already have several MBT facilities	
Germany	18+ facilities[2] with many more planned.
Austria	Already a relatively high diversion rate, with a large experience base using biological processes for the treatment of organic wastes. Several mixed waste composting plants (that are described as MBT facilities by others but fall outside the definition used in this report).
Italy	17 integrated facilities[2] and many smaller composting plants with some mechanical sorting.
Spain	Need to reduce landfilling coupled to a shortage of existing waste processing infrastructure. Strong preference for MBT in certain regions (vs incineration). Output is seen as helpful in drive to prevent desertification in arid regions.
Netherlands	Only three MBT facilities, but two of these are among the largest in the world. Broadly, has sufficient existing infrastructure, so smaller demand for MBT plants than, say Spain, Italy, Germany or UK.
Countries that are pursuing MBT	
UK	Strong need to divert BMW from landfill. MBT is seen as route to avoid incineration by many Local Authorities.
Australia	Interest in identifying technology-based sustainable waste management approaches. Anti-incineration and nervous of gasification following well-publicised issues locally.
Canada	Greater emphasis placed on managing residual waste in a sustainable way relative to other nations in the region. Some Provinces are strongly anti-incineration.
Examples of countries with progressive waste policies that are not pursuing MBT	
Sweden	Focus on recovering energy content from waste, using CHP/district heating. A ban on combustible waste landfilling is leading to increased incineration capacity
Switzerland, Denmark	Existing thermal treatment infrastructure is adequate for handling most of the country's residual waste arisings.
Examples of industrialised countries where MBT is still largely unknown	
USA	Low cost landfill precludes most other waste management solutions. Where novel technologies are being considered, the focus has been largely on thermal technologies.
Japan	Incineration and gasification are viewed as least risky options to maintain a high landfill diversion rate and maximised recycling.
Ireland	Will need to reduce waste going to landfill dramatically. Resistance to incineration.
Poland	Underdeveloped waste infrastructure with a need for increased diversion to meet EU obligations.
China	MBT projects already under serious consideration.

2 Of the type classified as MBT in this report. Other studies have reported higher numbers, using a different definition of an MBT plant

Source: industry comments

[1] this chart is based on the most significant operating MBT plants

Figure 17: The preferred MBT approach in different European countries

Country	Preferred outputs (based on existing references)	Influencing factors
Spain	Mainly soil applications and biogas	Improvement of arid land
Italy	Landfill or fuel	Avoidance of incineration, interest in co-firing RDF
Germany	Landfill or fuel	Ban on landfilling biodegradable waste, avoidance of incineration in some States.
United Kingdom	As yet unclear	LATs, BVPI and ROCs
The Netherlands	Biogas, with some RDF	Large incineration capacity

Source: Juniper analysis

At what scale is MBT practical?

8.11. **Commercial MBT plants have been built both at small scale (<50,000 Tpa) and large scale (>200,000 Tpa)**. No MBT facilities have yet been built at a scale comparable to the largest incineration facilities (500,000 Tpa to >1,000,000 Tpa).

8.12. The largest known operating MBT plant in the world is located on the outskirts of Madrid. The upfront mechanical treatment system of this plant has a capacity of 480,000 Tpa, although only about half of this throughput is treated by the subsequent biological stages (a large amount of the input waste is diverted to landfill as rejects, or recovered as recyclables).

Figure 18: The 10 largest plants in the world

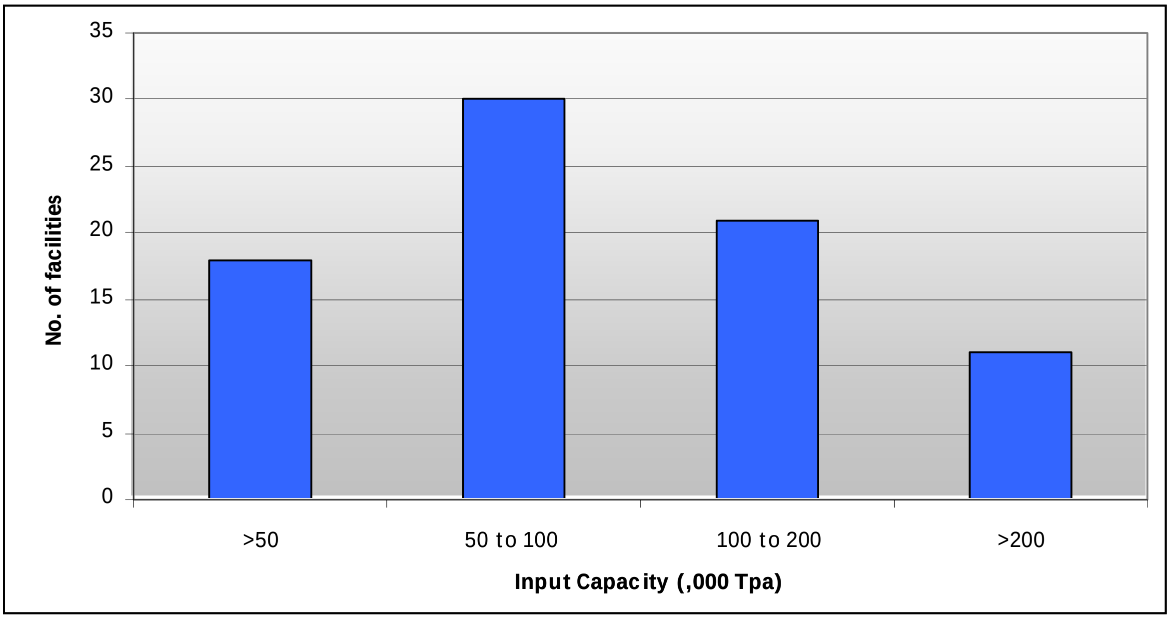
Facility	Input Capacity (Tpa)	Country	Core Technology	Main outputs
Madrid	480,000	Spain	Horstmann	Soil
Barcelona (Ecoparc I)	300,000	Spain	Linde	Biogas, Soil
Caivano	270,000	Italy	VKW	Landfill, SRF
Barcelona (Ecoparc II)	265,000	Spain	Horstmann + RosRoca + Valorga	Biogas, Soil
Groningen	230,000	The Netherlands	Grontmij	Biogas
Friesland	220,000	The Netherlands	SBI Friesland + Grontmij	Biogas
Léon	217,000	Spain	Horstmann + Haase	Soil, Biogas
Valladolid	210,000	Spain	Horstmann + Linde	Soil, Biogas
Cadiz	210,000	Spain	Valorga	Biogas
Neuss	206,000	Germany	Sutco[1]	Landfill

1 Sutco supplied the mechanical part of this RWE plant

Source: Juniper database

8.13. Despite the provenness of larger scale MBT plants, the majority of the facilities that have been built, or are under construction, by the suppliers considered in this report have been at a scale of less than 100,000 Tpa (see **Figure 19**).

Figure 19: Analysis of the scale of operating facilities reviewed for this study



Source: Juniper database

8.14. **Conclusion: MBT is far more proven in operation than the other novel processes which are being promoted as alternatives to landfill and conventional incineration. While experience in the UK is somewhat limited at present, we regard the technical risks associated with adopting many of the leading MBT processes as manageable.**

9 Finding viable market outlets

9.1. Concern about the **marketability of the outputs** from MBT processes is the **single most significant factor constraining their use at present**. Some proponents of these systems say such fears are groundless, whilst others feel they are sufficient to make it nigh on impossible to structure a contract between a risk-taking private entity and a public authority (whether under PFI or another mechanism).

9.2. In this context, a major part of this project has been evaluating how viable are the various applications for the solid outputs from an MBT process. This evaluation has been based on:

- analysis of how the outputs from existing MBT facilities are being used – and how these differ, in some instances, from the original intent when the plant was built;
- an assessment of the UK market for each application, including discussions with potential users of the output;
- a review of other studies within the literature.

9.3. The marketability issues vary, depending upon the type of output, and derive from a variety of technical, commercial and regulatory factors.

9.4. It might seem that **securing markets for the outputs is an issue for the contractor**, not the Local Authority. While it certainly is a vital aspect of an MBT project for the contractor, it is also **directly relevant to the Local Authority because it affects their performance against recycling and LATS targets**, the viability of the facility and the gate fee that is economically sustainable. For example:

- recovered **outputs that cannot find a use are likely to have to be landfilled**, adversely impacting upon performance against diversion targets and potentially leading to very significant financial penalties for the Local Authority;
- if markets for recyclables are not sustained, this could lead to the outputs being classified as residues and the end-use being counted as disposal, which would adversely affect performance against recycling targets;
- if the contractor's business model contains over-optimistic assumptions about the value of the outputs and these are not achieved, insufficient cashflow will be generated to meet the funding requirements for the Special Purpose Vehicle that owns the asset. This may lead to the bankruptcy of that company and, regardless of what insurance bonds, parent financial guarantees or escrow monies were available to the Local Authority; the Local Authority would then be left without a physical solution to the day-to-day need to process waste.

9.5. **Our analysis indicates that the challenges associated with using the output as a compost or a fuel are significant**. The longer term viability of MBT projects that do not take these issues into account is questionable.

9.6. **In the case of compost-like applications, the main issue is the quality of the material, especially the higher levels of contamination contained in the MBT output**

relative to other types of compost produced from separately collected green waste, which, as we shall see, limit the end-uses for this material.

9.7. **In the case of fuel applications, the key issue is that the MBT output is simply less attractive to users than other fuels for a mix of technical, economic, legal and regulatory reasons.**

9.8. There are clear policy implications that arise from our analysis - in terms of the UK's overall waste management objectives, its policy of diversifying fuel sources and encouraging more sustainable agricultural practices. For this reason we devote the whole of **Annexe C** to analysing this topic. Here we summarise those findings.

9.9. **Figure 20** summarises the key issues that were identified for each of the main categories of use

Figure 20: Issues associated with each type of usage option

Option	Key Issues
Produce a bio-stabilised output that is placed in landfill	Local landfill availability may be limited: using void space for MBT outputs may deplete a strategically important resource, given the difficulty of establishing new landfills Does not fully recover resources from waste Landfill disposal is likely to be more costly than usage options (especially when escalating rates of landfill tax are taken into account) Method of measuring bio-stabilisation in the UK, and hence performance against diversion targets, not yet finalised
Produce a compost	MBT derived 'composts' do not qualify for certification under PAS100 Higher level of visual and chemical contamination Market resistance to accepting this type of compost
Produce a lower-grade soil improver	Low or negative value of product in most applications Some applications have limited demand
Focus on biogas generation	Uncertain regulatory status of the emissions from the gas engines Market outlet required for the digestate, or would have to be landfilled
Produce a solid fuel for use in existing facilities	Reluctance on the part of the power industry and many industrial facilities to use waste derived fuels Concerns about possible problems of corrosion or erosion in co-combustion boiler tubes and other technical issues Potential changed regulatory status of co-combustion facility when burning wastes Impact on community relations for user ('burning waste') Limited capacity for waste-derived fuels within the cement industry Concerns about the long-term security of outlets, and hence 'bankability' of projects Insufficient fiscal incentives for waste co-combustion relative to biomass feeds and novel technologies
Use the fuel in a dedicated EfW	Likely to be more costly than just incinerating all the waste Possible delays in securing planning permission for EfW element may impact on BMW diversion rates

Source: Juniper analysis

9.10. The balance between the quantity of material that an end-market could possibly absorb and the availability of that material is a key factor for some applications (notably use as a fuel in cement kilns).

9.11. There are approximately 25 million Tpa of MSW arisings in the UK. If **50%** were processed by MBT plants and all were of the 'bio-drying' type then approximately **6 million Tpa of SRF** would be produced that required an end-use outlet. If only **10%** of the annual MSW arisings were converted to SRF there would still be **1.25 million Tpa** to co-combust. This simple calculation does not allow for annual waste growth, increases in recycling performance or an increase in EfW capacity in the UK. Whether there is sufficient capacity in the power industry, cement industry and in industrial boilers is addressed in **Annexe C**.

Using the solid output as a compost

9.12. Many MBT processes aim to produce a compost-like output (CLO). Opinions differ about the suitability of this material: can it be used as high grade compost on agricultural or horticultural land, or is its application restricted to lower grade applications such as remediating contaminated land? As part of this project we examined this[1] and concluded that **very little of the output from MBT processes in the UK will find applications as high grade compost**.

9.13. There are five main reasons for this. **Firstly**: users of composts react very negatively if they see any **visual contamination** within the product, from for example, plastic film. During our visits to reference plants, we examined the output and noted that at even low percentage rates (below the 1% limit specified by many process companies) non-biological material was clearly visible. Experience in a number of European countries, including the UK, has shown that products containing visible amounts of such 'foreign' material have great difficulty finding long-term markets as compost.

9.14. **Secondly**, users and regulators are also concerned about the possibility of environmental and health impacts that might be caused by soil contamination arising from the presence of **heavy metals** and other contaminants that were in the input waste. A study conducted for the EU Commission has shown that contamination levels are higher in the output from MBT plants than compost derived from source separated green waste[2]. In this context, we have concluded that most process companies and site operators would need to develop more comprehensive data about the quality of their product to address market concerns about product quality. In the absence of such data, it is not surprising if farmers are nervous about accepting this material.

9.15. **Thirdly**: the food industry is using its purchasing power to discourage the application of any compost that could contain **kitchen waste** on pastureland or land used for growing food crops. Thus, to maintain consumer confidence they may elect not to purchase

[1] the evaluation is reported in **Annexe C6**
[2] see **Figure C26** in **Annexe C**

product from land on which CLO from MBT plants had been used. This reinforces farmers' reluctance to consider using such material.

9.16. **Fourthly**, in the context of building user confidence, the UK industry's voluntary quality standard (known as **PAS100**) requires that compost products must be derived solely from green waste to be certified.

9.17. **Finally**, the **amount of green waste compost** will increase significantly as Local Authorities increase the centralised composting of garden waste to boost their performance against recycling targets.

9.18. **Conclusion: it will be difficult to place CLO from MBT plants into agricultural, horticultural or domestic applications within the UK.**

Lower-grade soil applications

9.19. Earlier in this report we listed a number of applications where quality issues may not be so critical (see **Figure 5** on **page 16**). In some of these a relatively small amount of CLO would be spread as a top dressing to a regular cycle (an example is its use as a mulch on land used to grow energy crops); in others it is used once as a top cover (e.g. to restore slag heaps and cap landfills) at higher spreading rates; while in others it would be mixed with the soil as part of remediation (brownfield regeneration) or landscaping (road construction).

9.20. It is obvious that the level of contamination that is acceptable in applications like landfill daily cover and brownfield regeneration is much higher than when the CLO is used as horticultural compost. In conducting our analysis of the viability of such applications we therefore considered a range of parameters, including the amount of material that could, in principle, be absorbed by each end-use, the underlying economics, market attitudes, environmental and regulatory constraints as well as the overall policy framework. Overall, **our conclusions about lower grade soil applications are somewhat more positive than those reported by others** and we believe that **some, but not all, of these applications could be viable outlets** for the output from MBT plants. We explain our reasoning for each of the main possible end-uses below.

9.21. In reaching this conclusion, one contributory factor has been that such applications count towards Local Authority LATS[1] targets provided that there is a functional improvement to soil quality, with demonstrable ecological benefit. The Environment Agency has recently made it clear[2], however, that it would not accept applications that are surrogate forms of disposal.

[1] LATS = Landfill Allowance Trading Scheme, discussed in **Section 11**

[2] Assessing the Diversion of Biodegradable Municipal Waste from Landfill by Mechanical Biological Treatment and other options, Environment Agency, November 2004

9.22. It is imperative that Government should develop quality standards for these types of low-grade soil applications, so that MBT plants can be designed accordingly, and confidence would be built into the market.

On land used to grow energy crops

9.23. It has been suggested by others that this application is more viable than agricultural uses because there are less issues associated with higher contaminant levels: any heavy metals taken-up by plants would not enter the food chain. However, **our analysis has concluded that the opportunities for use on energy crops are limited**.

9.24. There are two types of energy crops: those sown annually to produce transport fuels, like rape for bio-diesel; and those harvested annually from longer term plantings, such as willow coppice and miscanthus, as fuels for power plants.

9.25. In the former, the seed-to-oil processing infrastructure is common to both food and energy applications. For this reason, land-spreading of mixed waste composts on such crops would be subject to the same issues as other food crops. We understand from industry contacts that they would not embrace such usage.

9.26. In the latter case, the land under production is currently limited. Farmers wish to maintain the flexibility of switching such land back to food crops or grazing in the future, (not least because of the well-publicised failure of the ARBRE project[1]). While some might be willing to mulch coppice with MBT-derived material, they would expect to receive a fee for access to their land, analogous to that paid by water utilities for spreading sewage sludge.

Forestry applications

9.27. Unlike land used to grow energy crops, land used for commercial forestry or woodlands is not normally switched to agricultural use at a later date, so mitigating the issues related to possible contamination, discussed above.

9.28. Theoretically, the forestry sector could absorb large quantities of material (well in excess of the likely output from the UK's MBT plants); but the largest concentrations of woodland occur in relatively remote upland areas of low population density, so the accessible market is much smaller. Nevertheless, our estimates indicate that the sector has sufficient capacity to be a significant outlet (see **Figure C29**).

9.29. The most likely uses are: as part of the growing medium for saplings and as a mulch that would be applied whilst other forestry operations (planting, thinning and felling) were being conducted.

[1] Europe's first willow-coppice to gasification project

9.30. Even though studies elsewhere in Europe have shown silvicultural benefits from mulching, these are not generally seen by the UK industry as significant enough to justify the costs and logistic issues associated with spreading.

9.31. We have concluded that **the forestry sector will normally only accept MBT outputs if they are paid a fee for taking such material**. Paying someone to accept the material would be beneficial to the operator of an MBT plant if this avoids higher disposal costs. Local Authorities would also benefit financially if such usage helped them to avoid any Central Government fines under LATS.

On verges and amenity land

9.32. Our study has reached more positive conclusions about the possibilities for re-use in some specific applications within this category of use.

9.33. Like others, we believe **the potential for re-use in public spaces, like parks and sports-fields, is very limited** because of the contamination issue – instead, we would expect such applications to be an outlet for the Local Authority's green waste compost.

9.34. But **we believe that the potential for application to verges has been under-estimated**. Our calculations indicate that this could be a significant outlet, and one which does not share the same issues as other compost-like applications (visual and chemical contamination is far less of an issue here). According to our calculations, this use could absorb 25 – 100% of all the solid output from UK MBT plants, assuming a mulch is applied to the verges of trunk roads every five years. Since this land is in public ownership there are less economic issues associated with such use. Provided that the Environment Agency (or SEPA in Scotland) accepted that such applications did not constitute 'disposal' they would count towards both LATS and BVPI targets (as discussed in **Section 11**).

For landscaping in road construction and related applications

9.35. The output from MBT plants that are configured to produce a good quality soil improver could find a **significant use in embankments and landscaping around road construction sites, new-build industrial and commercial premises and other civil engineering projects** that are not related to sensitive applications, such as schools and housing. The MBT output would be blended with on-site soils to produce a grading material and a top soil.

9.36. Although projects frequently have sufficient top soil on-site and do not require additional material, construction contractors may be keen to accept MBT output if they are paid a small fee per tonne and can, therefore, export, other soils to other sites for a similar fee. In the competitive world of civil engineering such income streams could be attractive.

9.37. Our analysis indicates that significant tonnages of material could be used in this application, provided that the Environment Agency (or SEPA) approved the use, in terms of product quality and qualification for LATS, as discussed above.

On brownfield (contaminated land) sites

9.38. The UK is embarking on a programme of regeneration of brownfield sites to free up more land for development and reduce pressure on rural areas. We estimate that there are some 80,000 hectares of such land requiring remediation within the timeframe relevant to this study.

9.39. The issues related to contamination that constrain many other soil uses do not apply to this application. Moreover application rates per square metre are higher, since the material is blended with the site's soil to a depth of, say, one metre.

9.40. The economics associated with this application are also more favourable, since use of an MBT-derived soil improver avoids the need to import top-soil from off-site sources.

9.41. Moreover the use of the MBT derived product can be part of an agreed remediation plan with the Environment Agency, making waste licensing and LATS qualification aspects more straight forward and clear cut than with some other uses.

9.42. Juniper believes that **this is an attractive usage option that is capable of taking significant quantities of material**.

9.43. However, such uses are essentially transient in nature (in contrast, to some fuel applications where longer term contracts can be agreed with a counter-party), and so the operator of an MBT facility would need to have a backup outlet for when there was no market demand for this type of re-use.

For use in arid regions

9.44. In arid regions of the world, soil improvers that can enhance soil structure and moisture retentiveness are of considerable importance to maintaining the productivity of the land, addressing the risk of flash floods and halting the spread of desertification and salination of soils.

9.45. Although this has limited relevance in a UK context, it is of considerable significance for overall EU policy, given the importance of this issue in many Mediterranean regions[1]. It has been an important point within the discussions on the Soil Strategy (see **Annexe B2**). As a result, Member States from this area have a different perspective on the overall balance of benefits and risks (from an environmental perspective) associated with land-spreading of 'composts' derived from mixed waste. There is a feeling, notably within parts of Spain where MBT has attracted considerable interest, that the benefits

[1] it is also of great importance in some other parts of the world, such as some regions of Australia and the Middle East

outweigh the possible risks. Landspreading of MBT outputs is practised relatively widely in these regions.

9.46. Where communities face these challenges and the relevant regulatory authorities accept the arguments for land-spreading, this is likely to be a practical, economic outlet for CLO derived from MBT processes that is capable of absorbing all of the output from facilities.

As a liquid fertiliser

9.47. During the research for this report, we came across one instance, outside the EU, of the output being used in liquid form as a fertiliser[1]. At first sight, it seems attractive to use the output from processes that incorporate wet anaerobic digestion as their core technology in this way, since it avoids the need for de-watering and effluent stream management. However, because of the potential contamination and concerns about 'dilute and disperse' issues, EU regulators may be reluctant to grant a permit for such usage. In any case, our research has not identified attractive markets for such a product, derived from a mixed waste stream, so it has not been considered in detail (see **Annexe C** for more information).

Fuel applications

9.48. Although much of the industry has focused upon fuel usage over the last two years, **we have concluded that, under current market conditions, accepting the output from MBT plants as a fuel is likely to be unattractive to many end-users**.

9.49. Our review of the actual usages to which the outputs from MBT reference plants are put, indicates that relatively few produce a fuel. Anecdotally, there is a perception that many European plants are producing an SRF[2] that is used in co-firing applications within power plants – one frequently hears statements to this effect at conferences, for example – yet only a few process companies claim this as an outlet at their existing reference plants and it has proved difficult to validate this in some cases.

9.50. There are two types of outlet for a fuel produced within an MBT facility:

- ⇨ the product can be marketed as a fuel product for use by 3rd party customers;
- ⇨ the product can be utilised within a dedicated facility.

9.51. In the former case there are a range of technical, economic, commercial and regulatory factors that influence the viability of particular uses, which are considered in detail within **Annexe C**.

[1] in Israel

[2] SRF = Solid Recovered Fuel, a term used for a fuel made from waste to a defined specification. This is increasingly being used to differentiate the product from lower grade, more variable quality RDF (Refuse Derived Fuel). This topic is addressed in more detail in **Annexe C2**.

9.52. In the latter case the main issues relate to the economics and securing planning permission for an Energy-from-Waste facility.

How attractive are MBT outputs as a fuel?

9.53. MBT-derived fuels **compete** against other waste-derived fuels (such as tyres, solvents and packaging waste), conventional fossil hydrocarbons, imported biomass and energy crops for co-firing in a range of power applications and in cement manufacture. More generally this type of fuel competes with other forms of renewable power and nuclear energy in the context of meeting climate change goals.

9.54. They are **unattractive** fuels because:

- they are more **heterogeneous**, and hence have more **variable fuel properties**;
- **a facility that combusts or gasifies them will fall within the WID[1] regime**; involving a submission to the regulator, possible modifications to plant operation, higher levels of monitoring and regulatory reporting
- there are substantial **technical issues**[2] associated with co-firing that may exclude their use in certain types of facilities;
- even where use is possible, **the amount that can be tolerated without causing technical problems may be rather limited**, reducing the benefits of co-firing;
- by processing waste-derived fuels a facility is likely to encounter opposition, concerns from neighbours and a **worsening of community relations**;
- they contain **heavy metals**, which raises **environmental issues** that need to be addressed;
- their use may necessitate **additional capital investment** for fuel preparation and emissions control, the scale of which can be so large as to make their use unviable;
- their **qualification for ROCs is heavily constrained** [3] compared with some other co-firing options (under current rules) - refining the fuel to qualify requires challenging and costly processing for the MBT company;
- they can continue to **degrade if stored for prolonged periods** leading to odour and other problems.

9.55. They are an **attractive** fuel because:

- they are **cheap**, available at low, zero or negative cost, reducing input costs significantly for the power plant or cement kiln;
- **supply is dependable**, fuel can be ‘contracted long’ at stable cost lowering uncertainties of fuel costs for the power plant; they are not seasonal, as some bio-fuels, and not variable, as wind, solar, tidal and wave power are;

[1] WID = Waste Incineration Directive , see **Annexe B7** for a review of this topic
[2] see **Annexe C4**
[3] see **Annexe C2**

- they could be **available in reasonable quantities** locally;
- they have a **strategic value**, since they are available domestically within a country – reducing dependence on imported fuels;
- they **displace fossil hydrocarbon** fuels, mitigating net greenhouse gas emissions.

9.56. When competing with other waste–derived fuels, many of those, including hazardous wastes, command high **gate fees** compared to that which would be economically viable for an MBT plant, but SRF could be made available at much lower cost than 'clean' biomass, such as wood chip or coconut husk.

9.57. Some more sophisticated MBT plants can produce an SRF to a **very tight specification**, i.e. a "made-to-order" fuel, which is unlikely to be the case for industrial fuels, which would usually have to be processed by the kiln or power company themselves.

9.58. With regard to **calorific value (CV)**, SRF may be less attractive than some other waste-derived fuels, but more attractive than others with high biomass content.

Co-firing in power plants

9.59. There has been much debate about how viable markets for MBT-derived fuels are within the power industry.

9.60. The potential benefits for the power industry of using SRF are threefold:

- a reduction in fuel costs;
- the possibility of revenues from Emissions Trading;
- meeting their Renewables Obligations.

9.61. At present, these incentives are insufficient to persuade operators to co-fire SRF because of the significant technical challenges associated with its use: in essence **the risk/reward balance is not favourable for the power plant at the present time**.

9.62. In our view, the technical issues associated with this application have generally been understated and the relative development of this market within Continental European markets has been overstated.

9.63. **There is no example of large-scale SRF co-firing at any UK power plant and only isolated instances of usage within Germany and Italy**, from which very little information, reporting the results of sustained commercial usage, is available within the public domain. Without such validation the power industry is unlikely to have confidence in this application.

9.64. In **Annexe C** we identify some **20 different technical challenges** related to this application, ranging from possible damage to the boiler tubes, through increased risks of fire to the potential for the ash to be no longer acceptable for use as a construction material. Moreover there are significant issues associated with handling a controlled waste for the facility operator related to **the need to comply with the Waste**

Incineration Directive. Together **these factors limit the number of facilities that can consider co-firing and make the cost of modification to allow co-firing less economically attractive. They also limit the proportion of co-fuel that can be used to such a low level that the commercial benefit for the power plant operator is not worth considering**.

9.65. **Conclusion: we believe that unless Government changes the policy framework and provides financial incentives for co-firing SRF, little of this material will be used by the UK power industry.**

9.66. When considering co-firing in a power plant it is assumed that the SRF will either be blended with the coal in the mill or injected separately into the boiler. Juniper's research has identified a third possibility, which is already utilised in Scandinavia, that we believe merits further consideration: **indirect co-combustion**. In this approach the SRF is first gasified and the resultant syngas is used in the power plant. Such an approach avoids many of the technical challenges associated with direct firing – and may also qualify more easily for ROCs. This option is discussed in **Annexe C4**.

9.67. **If**, however, **the ROC rules were changed to allow ROCs for the biomass content of SRF**, without the current complex requirements, such as the need to increasingly switch away from waste-derived biomass to 'clean' biomass over time, **then the power industry would embrace SRF utilisation** and would invest in either indirect combustion or new feed methods to fire the SRF, especially because biomass that is suitable for firing in power plants and does not derive from waste, is becoming increasingly expensive across Europe. For this reason, SRF is potentially attractive as an alternative fuel that is available in reasonable quantities and at low or even negative cost.

9.68. In such circumstances, those MBT processes that are capable of producing an SRF that consistently meets a tight fuel quality specification would have a competitive advantage.

Use in cement kilns

9.69. Cement manufacture is a commodity business. Displacing costly fossil fuels with waste-derived fuels, which can command a **gate fee** (i.e. have a negative cost) can not only maintain the competitiveness of local cement manufacture relative to lower cost imports but also help **meet climate change obligations**. It also opens up **opportunities for emissions trading** that could be worth **£5 - 20 /tonne of SRF used**.

9.70. There are far **less technical issues** associated with utilising SRF in a cement kiln than a coal-fired power plant. There is also no ash residue, since the inorganics (mineral matter) form part of the cement product. Understandably, this end-use has been explored more actively by waste management companies within the UK.

9.71. All UK cement companies are either already using or are considering using waste-derived fuels within their operations. SRF is under serious consideration as a part of this mix. However, our analysis indicates that **the cement industry could use a maximum of 500,000 Tpa of SRF**, and the figure could be **as low as 125,000 Tpa**. This represents the output from c. 3 – 10 MBT plants, far short of the number envisaged by

Government and the regional planning boards. Access to much of this limited capacity has already been secured by specific waste management companies or Local Authorities in the context of particular MBT projects, leaving little, if any, available for new projects.

9.72. It should be noted that **SRF is still a less attractive fuel** for cement kilns than many other types of waste for the reasons already outlined. In this application its relatively modest CV is a key issue.

9.73. **Because of competition between waste-derived fuels for access to the limited capacity within the cement industry, operators of MBT facilities may have to pay relatively high gate fees to secure contracts with cement kilns**.

Other co-firing opportunities

Industrial boilers

9.74. Research by Juniper has identified over **250 facilities in the UK with large-scale boilers** that could potentially co-fire SRF. The majority of these produce process steam for use within industry.

9.75. The technical challenges associated with its use will limit SRF to facilities that need to upgrade their energy plant for other reasons. These plants are largely within the paper & pulp, rendering and chemicals sectors.

9.76. There are grounds for believing that, in the future, industry may become more interested in using SRF, mainly as a means of reducing fossil-fuel consumption as part of achieving their Climate Change obligations. If Government extends ROCs to this type of application, use of SRF could also become increasingly attractive economically.

9.77. **Conclusion: From our analysis we expect that in the short term few of the 250 facilities will seriously consider utilising SRF. At present, the risk/return balance is simply unattractive for industry.**

Within existing incinerators

9.78. A practical method for using SRF is to co-combust it with other wastes in existing incinerators. In some countries, notably Germany, there is spare capacity within incinerators, and so operators of these facilities are keen to obtain RDF-like materials as a means of maintaining throughput. Because of the economics of incineration, it is necessary for the incinerator operator to receive a gate fee for such fuels, but this can still be a competitive option for an MBT plant when compared with deposition of a bio-stabilised output in a landfill.

9.79. One advantage of using incinerators to combust the fuel fraction from MBT plants is that the incinerator is capable of handling all quality levels, thus avoiding the need to produce a more expensive SRF-type fuel.

9.80. **Conclusion: as there is likely to be a national shortage of incineration capacity because of the difficulty of obtaining planning permission for such facilities, we believe that it is unlikely that this outlet will be available for significant amounts of MBT outputs within the UK.**

Import/export of SRF

9.81. Within the EU, waste derived fuels may be shipped across national boundaries (the Basle Convention does not apply[1] and the Proximity Principle is non-binding). Some RDF has been shipped to German and Dutch incinerators (from Italy, for example), and brokers have offered to take RDF from regions lacking in waste treatment infrastructure (eg Ireland and Guernsey) for processing in other countries. In theory, therefore this is an option for an MBT facility; however we have not considered it further in this report.

Use in dedicated facilities

9.82. Given the uncertainties of many fuel and soil end-uses, one option is for the developer of an MBT facility to incorporate a dedicated thermal unit to handle the output from the plant. This could be on-site or off-site – for example, several MBT facilities could feed one centralised combustion unit.

9.83. The thermal unit could either use proven combustion technology (typically a fluid-bed unit of the type that is readily available from several world-class companies) or could use (less proven) gasification technology, opening up the possibility of ROC qualification.

9.84. The attributes of such an approach are:

- removes most market risk for the MBT project;
- reduces the scale of thermal waste processing (relative to a stand-alone incinerator);
- economics of combustion are likely to be worse than a stand-alone incinerator;
- economics with gasification are more complex and need case-by-case evaluation;
- technology risk using gasification is greater, potentially affecting the bankability of the project;
- likely to engender greater public concern, and possibly opposition, because of thermal element.

9.85. **We believe that this option will receive considerable attention from many UK Local Authorities, especially in the context of 3rd party processing risks (as discussed above).**

[1] The Basle Convention on the trans-frontier shipment of waste only prohibits the export of hazardous waste. MBT outputs, whilst still classed as waste, are not classified as hazardous.

Landfill as an outlet

9.86. There are three landfill options:

- use as daily cover;
- deposition of a bio-treated output in landfill;
- use as final cap for landfill restoration.

9.87. Each of these can be a practical means of disposal. The analysis we have conducted[1] indicates that there is substantial demand for both daily cover and top cover, even with the reduction in numbers of landfills that is occurring. Of course, landfill is not evenly distributed across the country and this approach may be more viable in some areas than others.

9.88. In Austria and Germany, MBT has been used essentially as a pre-treatment stage before landfill deposition. The driver has been the desire to meet the Landfill Directive by using bio-stabilisation rather than incineration. A significant body of research has been developed to demonstrate that MBT processes bio-degrade the organic fraction of waste to a sufficient level that it can be deposited into a landfill and meet the requirements of the Directive, as discussed in **Annex B3**.

9.89. There are two approaches possible if the output is used in or on a landfill:

- maximise the degree of bio-degradation within the MBT process to produce a fully bio-stabilised residue;
- carry out more limited bio-stabilisation, thus saving cost and potentially reducing land-take, but resulting in a bio-treated output which still has some level of bio-degradability.

9.90. The former approach is the one that has been adopted extensively on the Continent and is the one most often discussed. It maximises landfill diversion of bio-degradable materials.[2]

9.91. The latter approach would not be allowed in many countries but, according to recent statements by the Environment Agency[3], would be allowed in the UK. In Germany, for example, waste may not be landfilled unless it has reduced the residual biodegradability to a low, defined threshold limit, whereas in the UK waste may be landfilled, regardless of its biodegradability, but the extent to which it is biodegradable will count against a Local Authority's LATS targets (as discussed in **Section 11**).

[1] see **Annex C, Figure C29**

[2] There will be some further biodegradation after MBT but at a much reduced rate. Gas emissions are much reduced as is the amount of leachate production. It has been suggested in the report by the UK Government Strategy Unit that landfilling of bio-stabilised organic waste only generates 10% of the landfill gas and 10% of the leachate compared to generation rates for untreated wastes.

[3] Answers to questions at Environment Agency workshop on the Consultation Document for the assessment of the diversion of BMW by landfill pre-treatment methods, 10 December 2004, Birmingham; and at the CIWM Workshop on MBT, Peterborough, 20 January 2005.

9.92. Each approach has differing levels of attractiveness for the public sector and private sector partners. We return to this topic in our consideration of the relative attractiveness of the different MBT configurations in the final section of this report.

9.93. It should be noted that the level of residual bio-degradability has been shown to be significantly affected by the MBT processing method and residence time of the waste in the biological part of the overall process, so this is an important parameter in selecting an optimum solution for a particular project, given that, in general, reducing bio-degradability increases cost.

Conclusions

9.94. **Our research for this report indicates that, overall, MBT-derived fuels are less attractive than proponents of their use have implied; they are used far less widely than thought and there are many significant technical issues associated with their use.**

9.95. **Similarly, many options to use the output on land have significant issues associated with them.**

9.96. **In general, therefore, this report concludes that the identification of robust end-uses for the outputs from MBT facilities is a key issue for MBT projects.**

9.97. **Nevertheless we have identified a number of end-uses that, depending upon the local context, merit further consideration, including use in land remediation, spreading on road verges, as landfill daily cover, co-firing in cement kilns and combustion or gasification in a dedicated purpose-built EfW facility. The detailed evaluation of each end-use, reported in Annexe C, is summarised graphically in Figure 21.**

Figure 21: Summary of the viability of usage options for MBT outputs in a UK context

Use	Technical practicality	Supply / demand balance	Economics	Regulatory & policy acceptability	Market appetite
Co-fuel for cement kilns	✓	!	?	✓	! [1]
Co-fuel for direct co-combustion in power plants	!	✓	! [2]	?	! [2]
Fuel for indirect co-combustion in power plants	?	✓	! [2]	✓	! [2]
Co-fuel for industrial boilers	? [3]	!	? [2]	?	? [1,2]
Co-fuel for incinerator	✓	✗	?	✓	✓
Fuel for dedicated incinerator	✓	✓	?	✓	!
Fuel for dedicated gasifier	?	✓	?	✓	?
As an agricultural compost for food crops or pasture land	✓	✓	?	✗ [4]	!
As a soil improver for forestry	?	✓	?	?	!
As a soil improver for arid areas of poor soil quality [5]	✓	✗	✓	!	!
On land used to grow energy crops	✓	!	?	?	?
For horticultural applications	?	?	✓	✗ [4]	!
For use in domestic gardens	✓	?	✓	✗ [4]	!
As a liquid fertiliser	?	✓	✓	!	!
On verges & amenity land	✓	?	✓	✓ [6]	✓ [7]
As landfill cap	✓	?	✓	? [8]	? [8]
On brownfield sites	✓	✓	✓	✓	✓ [7]
Landfill daily cover	✓	✓	?	? [6]	✓
Bio-stabilised residue for depositing in landfills	✓	?	?	✓	✓

Notes:

1 : energy dependent manufacturers of commodities (such as cement, paper and chemical process companies) are keen to displace fossil fuel by waste derived fuels, but competition for MBT-derived fuel is intense from tyres, solvents , etc

2 : government is consulting on a modification to the ROC rules: if SRF was allowed to qualify this would have a significant favourable impact on the economics of this use, and hence also on the market appetite

3 : the degree of technical challenge will vary between industries, but there are some where these challenges should be manageable

4 : as a PAS100 certified compost

5 : this application is of interest in other regions of the world (see **Annexe C)**

6 : as a BS3882 soil improver

7 : assuming a fee is paid to the user

8 : may count as 'disposal' under LATS in the UK

9 : may be an issue related to continuity of demand

✗ potential 'stopper'

! factors that are a significant impediment

? factors that are less significant but which could constrain usage

✓ potentially constraining factors, but not sufficient to adversely impact the viability of market outlets

Source: Juniper analysis

10 Regulatory and policy issues

10.1. During the course of our analysis we identified a number of regulatory and policy issues, at both EU and UK level, that could affect the take-up of MBT. This section summarises those issues; their impact is considered in more detail within **Annexe B**[1].

10.2. **The policy framework for MBT is far less well defined than, for example, that for incineration**. This has two consequences:

- public authorities that are either considering the role that MBT could fulfil or assessing individual project proposals are not certain about some key policy parameters, listed below, against which judgements must be made;
- private sector contractors and those who finance the cost of new infrastructure could find that assumptions they made about the direction of policy, when deciding to go ahead with a project, were incorrect. They may therefore be understandably hesitant about proceeding or accepting project risks – and hence it may be difficult to reach 'contract closure' on some projects, which could delay urgently needed infrastructure.

At EU level

10.3. The uncertainties identified **at EU level** during the course of this study include:

- **Issues that were intended to be addressed by the draft Biowaste Directive**[2] **have not been finalised**

  It was originally intended that the Biowaste Directive would establish standards and protocols for the use on land of compost-like outputs derived from waste processing facilities. The lack of such definitions at EU-level has meant that slightly differing standards are being established in those individual Member States where interest in MBT is most active (Germany, Austria, Italy, Spain and the UK).

  This will lead to difficulties in harmonising protocols in future and could lead to issues for facilities already established, requiring extended transitional arrangements. The difficulties will increase as interest in MBT broadens to other Member States, not least the 10 accession countries.

  The Biowaste Directive has been withdrawn and it is unclear whether it will be revived in some form at a later date. It was meant to provide guidance on issues associated with the use of waste-derived materials on land and these issues have been added to the Terms of Reference of the Thematic Strategy for Soil Protection.

- **Delays in formulating the Soil Strategy**

  The Soil Strategy was expected to have been agreed by now and would have established guiding principles about the use on land of waste-derived materials, including CLO from MBT plants. Its absence increases the already significant uncertainties about which usage options are acceptable. This lack of policy clarity is unhelpful to the development of non-thermal options for residual waste processing.

[1] Issues that relate specifically to the utilisation of MBT outputs are also addressed in **Annexe C**, and in the context of individual processes, they are covered in **Annexe D**.

[2] Working documents were circulated by DG Environment in February 2001 and December 2003

⇨ **The BAT Reference (BREF) for Waste Treatment has still not been finalised**[1]

The absence of a finalised BREF increases the difficulty for local regulators in determining whether or not individual MBT projects are compliant with the IPPC[2] Directive, and increases the uncertainties for facility owners and operators relative to more established waste processing technologies.

⇨ **The regulatory status of biogas combustion in gas engines is uncertain**

Neither the draft BREF for Waste Treatment nor the draft BREF for Waste Incineration offer any clear guidance upon whether this activity will be subject to the requirements of the Waste Incineration Directive (WID).

⇨ **Standards for Solid Recovered Fuel (SRF) are still under development**

Until finalised, both as part of the BREF for Waste Treatment and via EC working group CEN/TC 343[3], there will be uncertainty over whether SRF produced by existing MBT plants was of a sufficiently acceptable quality to achieve compliance.

⇨ **SRF and CLO from MBT plants continue to be defined as "wastes"**

Recent decisions made by the European Court of Justice (ECJ) mean that MBT outputs are unlikely to gain "product" status in the near future, which inevitably constrains their marketability and hence, adversely affects the viability of some configurations of MBT.

⇨ **Some approaches to MBT appear to conflict with the goals of the Waste Framework Directive**

Sending the MBT output to landfill, rather than using it as a fuel, is favoured in some Member States and by some NGOs. As this output could be further 'valorised' by recovering its energy content, this option seems to be in conflict with the concept of maximising resource recovery from waste; as a consequence of which, only those wastes from which further resources cannot be recovered should be sent to landfill[4].

At UK level

10.4. In addition to the factors listed above, there are several other significant uncertainties at national level that could impede the adoption of MBT. These relate not just to waste policy but also energy policy and the ever-more complex array of fiscal and other economic market distorters. In the UK[5] these include:

⇨ **Guidance on how the biodegradability of MBT outputs should be assessed has not yet been issued**

Both the testing protocol to determine the biodegradability of MBT outputs and the status of their different uses under LATS[6] have yet to be determined. This is critical

[1] currently in draft form and due for formal publication in December 2005
[2] Integrated Pollution Prevention and Control
[3] this standard is scheduled for adoption by 2008
[4] as exemplified by the French concept of "dechets ultime" (similar principles are applied in several other EU countries, e.g. The Netherlands and Denmark)
[5] there are similar, but different, issues in other countries which are outside the scope of this report
[6] Landfill Allowance Trading Scheme

to an assessment of how MBT would perform against landfill diversion targets from 5 April 2005; a key issue for Local Authorities. This topic is discussed in **Section 11**.

⇨ **Guidance on how MBT outputs count towards BVPI[1] targets remains uncertain**

MBT is a new technology in the UK, and so DEFRA has not yet published specific, detailed guidance on how it fits into the BVPI framework (see in **Section 11)**.

⇨ **Outputs from MBT plants cannot easily be marketed as "compost"**

The voluntary PAS 100 standard, developed by the Composting Association, has been widely adopted, and clearly excludes any material that is derived from mixed waste, whatever its inherent quality. There have been arguments made for a quality-based, rather than source-based, specification. This topic is discussed further in **Annexe C6**.

⇨ **Quality standards for low-grade soil applications**

It is imperative that Government develop quality standards for these types of soil applications, so that MBT plants can be designed accordingly, and confidence is built into the market.

⇨ **Compliance with ABPR[2] requires more detailed procedures in the UK**

Many MBT processes, which are ABPR compliant in other Member States, would require modifications to gain an operating licence from the State Veterinary Service in the UK. This could involve re-engineering of the process, including changing the operating parameters and modifying plant design, leading to increased costs.

⇨ **The status of MBT plants under PPC remains uncertain**

The eventual publication of the BREF for Waste Treatment means that existing guidance developed by DEFRA and the Environment Agency may soon be superseded so that MBT facilities may be subject to different regulatory requirements.

⇨ **The Renewable Obligation (RO) is currently under review**

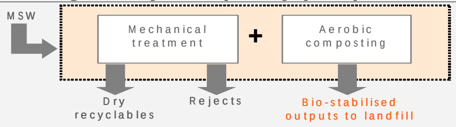
As part of efforts to join energy policy with wider waste management goals, the RO may be amended[3]. The Terms of Reference for the Review indicate that some types of fuel outputs from MBT and similar plants may become eligible for Renewable Obligation Certificates (ROCs), whilst others may not. The precise terms of qualification remain unclear at this time. Given that this may result in a significant financial incentive for qualifying facilities, there is a risk that projects that are finalised in advance of the conclusion of the review may subsequently be uncompetitive. This uncertainty encourages the private sector to delay investment, which is not consistent with Government policy that aims to encourage rapid development of new waste processing infrastructure to meet waste diversion targets.

10.5. In **Section 5**, we introduced **8 generic configurations** which are broadly representative of the range of possibilities for MBT plants. **Figure 22** summarises the potential effects of the key regulatory and policy drivers on these configurations[4,5].

[1] Best Value Performance Indicators
[2] Animal By-Products Regulations
[3] as stated in the Terms of Reference for the 2005/6 review of the RO, DTI, 2004
[4] This analysis is from a UK perspective – there will be differences between countries, because of the varying policy framework.
[5] **Figure 22** aims to highlight differences between configurations, and so regulatory constraints that are common to configurations such as the PPC permitting and Waste Management Licensing have been omitted.

Figure 22: The 8 MBT options: Key differences from a regulatory and policy perspective

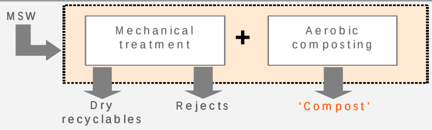
Stabilisation of waste for landfilling



Key Policy Drivers

- Uncertain performance against BMW diversion targets until Guidance is issued (as discussed in next section)
- May be considered to conflict with the central waste policy objective of maximising resource recovery from waste, despite the enthusiasm of some NGOs for this option, since a fraction is landfilled which could be used as a fuel

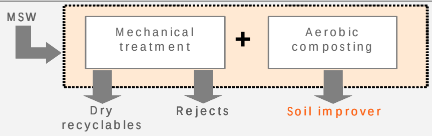
Make a compost from MSW



Key Policy Drivers

- Proposed EC Biowaste Directive (now withdrawn) proposed that compost-like output from MBT plants should not be considered as a 'compost'; a distinction which may be included in a future Soil Directive
- Output does not meet voluntary BSI PAS100 quality standard for compost, so markets may be constrained
- Processes of this type must meet ABPR requirements, which, in this case, include a mandatory three week gap between spreading and grazing if output is applied to pastureland

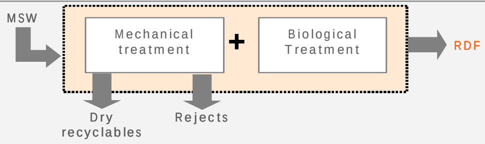
Make a lower grade soil improver from MSW



Key Policy Drivers

- Quality and usage standards for some applications are not clearly defined
- Some applications, such as landfill daily cover, will be classed as disposal (as discussed in the next section)
- The draft Biowaste Directive suggested that outputs from MBT plants could be used as a soil improver, a provision which may, or may not, be included in a future Soil Directive
- Processes operating in this configuration must meet ABPR requirements

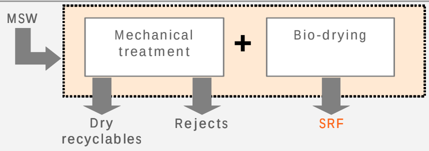
Make an RDF



Key Policy Drivers

- The variable quality of the RDF may cause difficulties – for users of this fuel - in meeting regulatory emission limits
- Revisions to the Substitute Fuels Protocol in 2005 mean that cement kilns can more readily burn RDF

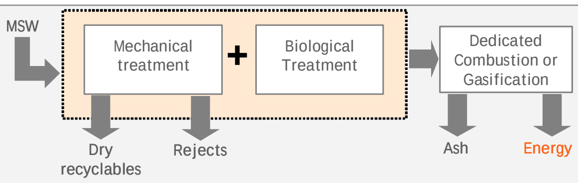
Produce a fuel using 'bio-drying'



Key Policy Drivers

- Indications are that following the 2005/6 review of the RO some grades of SRF are more likely to qualify (partially) for ROCs than less well controlled RDF

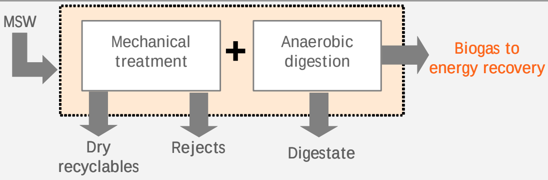
MBT to reduce the need for thermal treatment



Key Policy Drivers

- Plant must operate within the constraints of the WID, and may therefore be perceived as an incinerator
- If gasification is used, electrical output qualifies for ROCs according to the % biomass content of the waste input to the gasifier

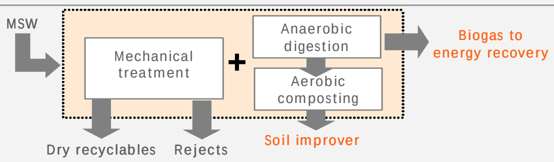
Produce biogas



Key Policy Drivers

- All the electrical output qualifies for ROCs
- As the digestate is likely to be sent to landfill, this configuration does not maximise resource recovery
- Process must meet ABPR requirements

Produce biogas + soil improver



Key Policy Drivers

- As above, except that the configuration does maximise resource recovery, provided the soil improver finds a use

Source: Juniper analysis

11 Can MBT help meet BVPI & BMW diversion targets?

11.1. Assessing the extent to which an MBT-led waste strategy may contribute towards landfill diversion and recycling targets is not straightforward. This is partly because some key regulatory instruments have not yet been put in place (at the time of writing) and partly because the performance of a particular Local Authority's MBT project against these targets depends upon a number of project specific parameters, which may not have been fully defined during the early stages of developing a waste management strategy. These uncertainties include:

- **Government and EU definitions** of what counts as landfill diversion or 'recycling'; and hence….
- differences between the **actual amounts** of recycling or diversion and the calculated performance against statutory targets;
- the **composition** of the input MSW;
- the type of **MBT configuration** adopted;
- the extent to which waste is **pre-sorted** (through separate kerbside collection, for example);
- the **recovery performance** of continental based MBT systems when processing UK 'black bag' or 'grey bag' waste is not demonstrated;
- the **fate of the outputs** from the MBT process;
- the particular properties of **the proprietary MBT process** selected.

11.2. In this section, we will provide:

- an explanation of the **key parameters** that determine the extent to which MBT contributes towards achieving the targets;
- a pro-forma **methodology for calculating performance** against BVPI targets that can be adapted to a particular local situation;
- estimates of the **typical diversion and BVPI rates for each of the eight representative MBT configurations** discussed in this report;
- a simple **Decision Tree** and a quick-reference checklist for assessing which outputs count against each target;
- illustrative **case studies**;
- **conclusions**.

11.3. The Waste and Emissions Trading Act 2003 places the responsibility for diverting biodegradable municipal waste on waste disposal authorities. Local Authority landfill diversion targets were therefore devised by the UK Governments to ensure that the UK, as a whole, meets the obligation to reduce the amount of biodegradable municipal waste (BMW) sent to landfill that is specified in the EU Landfill Directive. Meeting these targets will be facilitated by the Landfill Allowance Trading Scheme (LATS), which was brought into law by the 2003 Waste and Emissions Trading (WET) Act.

11.4. Waste Strategy 2000 (DEFRA) sets targets for recycling and composting of household waste for England (25% by 2005, 30% by 2010 and 33% by 2015) and Wales (15% by 2004, 40% by 2010); whilst for Scotland, the Scottish Executive has set targets of 25% by 2006, 38% by 2010 and 55% by 2020.

11.5. Composting and recycling targets for England, Scotland and Wales are not mandatory at national level, yet they have been translated into 'Best Value Performance Indicators' (BVPIs) for Local Authorities, which include a series of financial incentives for compliance. BVPIs for waste are viewed as complementary to the Landfill Regulations in that the amount of waste recycled or recovered helps to meet landfill diversion targets.

11.6. The detail of these policies and regulations is not discussed in this report - here we focus on the implications for MBT.

11.7. Both the method for determining BMW diversion, defined by DEFRA for the LATS, and the system of measuring BVPI performance (managed by both DEFRA and the ODPM) are complex instruments; and their implications for the use of MBT by UK Local Authorities are far-reaching and sometimes somewhat surprising. Thus the goal of this section is to provide information and guidance for Local Authorities to help them assess how the use of MBT impacts on performance against these targets.

Which activities count towards BVPI targets?

11.8. Our analysis of the performance of MBT plants located in other EU Member States indicates that the mass of dry recyclables recovered from MBT processes, as they are likely to be used in the UK, is somewhat limited. However, paradoxically, their **contribution towards achieving BVPI targets can be significant**, and greater than most industry insiders have anticipated.

11.9. This is because there can be a significant difference between:

- ⇨ The amount of recyclables in the input waste;
- ⇨ the amount of materials actually recycled from within an MBT process; and,
- ⇨ the performance reported as 'the recycling rate' for that same recycling activity under BVPI methodology.

We explain the reasons for this within this section of our report.

11.10. Since **the headline "recycling rate" is the sum of both recycling (BV 82a) and composting (BV 82b)**, it is necessary to consider both of these to assess the overall performance of MBT.

BV 82a (recycling)

11.11. The contribution of MBT to "pure" recycling from dry recyclables, like glass and metal, will be modest. This is because the input waste in most UK Local Authorities is likely to be a **'grey bag'** residual waste fraction that has already been through some kind of separation; in the household, at the kerbside, in 'bring' facilities or within a MRF (materials recycling facility) – and which may already have removed a large percentage of such materials from the input to the MBT plant.

11.12. A realistic guide figure for the recovery of dry recyclables within a typical MBT plant processing the residual fraction of household waste, in the way that they are likely to be configured in the UK, is 3-15 weight%. The higher levels of recovery can be achieved if the most sophisticated mechanical sorting and extraction processes are included. The eight MBT configurations introduced in **Figure 7** can produce varying levels of dry recyclables depending on the primary output of the process.

11.13. The Waste & Resources Action Programme (WRAP) has developed voluntary standards for both glass and plastics in the UK, but recovered materials from MBT facilities are not required to meet any quality specification to qualify for BV 82a as **qualification is based on acceptance by the market**. The recovery of these materials is discussed in **Annexe A**.

11.14. Acceptance by third party reprocessors depends upon both the wider market demand for their products and on their internal quality standards. In the case of recycled green glass, for example, there is currently insufficient demand to match supply in the UK market.

11.15. In the case of aluminium, the material derived from most MBT plants is usually contaminated with putrescibles. Moreover, it also contains other non-ferrous metals, such as copper, which makes it less attractive or even unacceptable to aluminium reprocessors.

11.16. **It is important for Local Authorities and their contractors to ensure that markets with their associated quality requirements are available for the dry recyclables. If all such recycled materials have to be landfilled the contributions to BV 82a targets will be zero.**

BV 82b (composting)

11.17. The position of the residual bio-treated output (normally the largest fraction) is less straightforward. **The extent to which this material counts towards performance against recycling targets depends largely upon the use to which it is put.**

11.18. **Use as a fuel** does not qualify for inclusion, though it does contribute towards performance against the less significant BV 82c.

11.19. A range of potential **land applications may qualify** under BV 82b, from final landfill cap through soil improvers to landscaping material for golf courses. However there seems to be an element of uncertainty about this. The Environment Agency, in a

Consultation document on BMW Diversion from MBT facilities[1] ("BMW Consultation"), stated that land uses must **"demonstrate agricultural benefit or ecological improvement"** to constitute a "genuine recovery operation"; otherwise they will be deemed "disposal" with regard to the Landfill Allowance Trading Scheme (LATS). No guidance currently exists to determine how this relates to qualification for BV 82b, but DEFRA has confirmed that use as **daily landfill cover does not count towards BV 82b**, since it is considered **a "disposal" option**[2]. This implies that other land uses that are defined as 'disposal' (i.e. ones that **do not demonstrate agricultural benefit or ecological improvement) may also not qualify**.

11.20. The output also needs to be recognised as meeting soil quality standards, as expressed in BS3882[3], to qualify under BV 82b. It must meet the definition of having been 'sent for composting' that is given in a DEFRA Consultation Response[4], which states that the process must result in;

- "A final 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 BS 3882,"

11.21. In the case of an MBT plant, DEFRA has decided that the performance against BV 82b shall be derived by subtracting the weight of the outputs that are landfilled from the weight of the input to the biological element of the MBT plant.

11.22. This seems a simple, straightforward approach but, in preparing this analysis, we realised that it results in much higher reported recycling rates than one would expect. In particular, one consequence of this methodology is that the **moisture and carbon dioxide lost within an MBT process count as 'recycling' under BV 82b, if the CLO is used beneficially and the application is deemed to be "recovery"**. DEFRA officials have confirmed[2] that our interpretation of the Guidance is correct, which some might find surprising since it is not immediately apparent why the evaporation of water should count as recycling. This method of calculation is the main reason why MBT processes can give a higher contribution towards BVPI targets than generally appreciated.

11.23. Another example of the surprising implications of the DEFRA methodology is that all 'losses' within the facility would also boost BV 82b performance by reducing any net mass sent to landfill. In the extreme, this could include liquid run-off from stored material, gaseous emissions and wind-blown debris - though no doubt the permitting authorities might have separate concerns about excessive levels of any of these!

11.24. **Figure 23** provides a quantitative methodology of how the BVPI performance of an MBT plant could be calculated (the numbers are illustrative of the methodology rather than a specific process). The calculation illustrates how moisture loss and biogas production count alongside compost and dry recyclables (both of which are assumed to find end-use markets) towards an overall derived contribution towards the key BVPI targets.

[1] Assessing the Diversion of Biodegradable Municipal Waste from Landfill by Mechanical Biological Treatment and other options, Environment Agency, November 2004

[2] Personal Communication, DEFRA, August 2004

[3] BS3882 and other topics related to compost standards are discussed in **Annexe B3**

[4] Response to the Consultation on the role of AD of MSW within the BVP Standards, DEFRA, March 2004

11.25. **Figure 24** provides estimates of the possible contributions of the eight generic MBT configurations to BVPI recycling targets. From our review and knowledge of the proprietary MBT processes considered in this report we have deduced the likely contributions to BV 82a and BV 82b. The numbers presented are indicative of the **range of likely outcomes** and **should not be considered definitive numbers**.

11.26. The tonnage of material that can qualify for BV 82b is essentially that which enters the biological process stage of the MBT plant and thus can be regarded as 'sent for recycling'[1].

11.27. The materials that do not qualify towards BV 82b include:

- rejects removed by the mechanical front-end of the process and sent for landfill;
- rejects removed in the post-refining stage of the process and sent to landfill;
- and the dry recyclables removed by the mechanical part of the process, which count under BV 82a.

11.28. It is assumed that the **CLO is beneficially used** and as we have discussed, if this is the case, then the **moisture loss and any biogas produced from an AD process counts towards recycling**.

11.29. The percentage of rejects we have assumed for the generic MBT processes have been based upon typical ranges determined from our review of the proprietary processes.

11.30. The amounts of dry recyclables recovered vary because of differences in the quantities present in the input waste and the degree of recovery required by customer objectives.

11.31. The sum of (dry recyclables + reject streams) is a reflection of the amount of 'contaminants' that need to be removed from the waste in order to achieve the required quality of compost or soil improver. Our estimates for recyclables and rejects have been derived from our understanding of the qualities of the outputs from MBT reference plants across Europe.

11.32. From the eight MBT configurations introduced in **Figure 7** only three of the eight options (make a 'compost'; make a soil improver and make biogas and a soil improver) can contribute to BV 82b. It is **important to stress** that for the purposes of **Figure 24** it is **assumed that 100% of the CLO is accepted by end-use markets**.

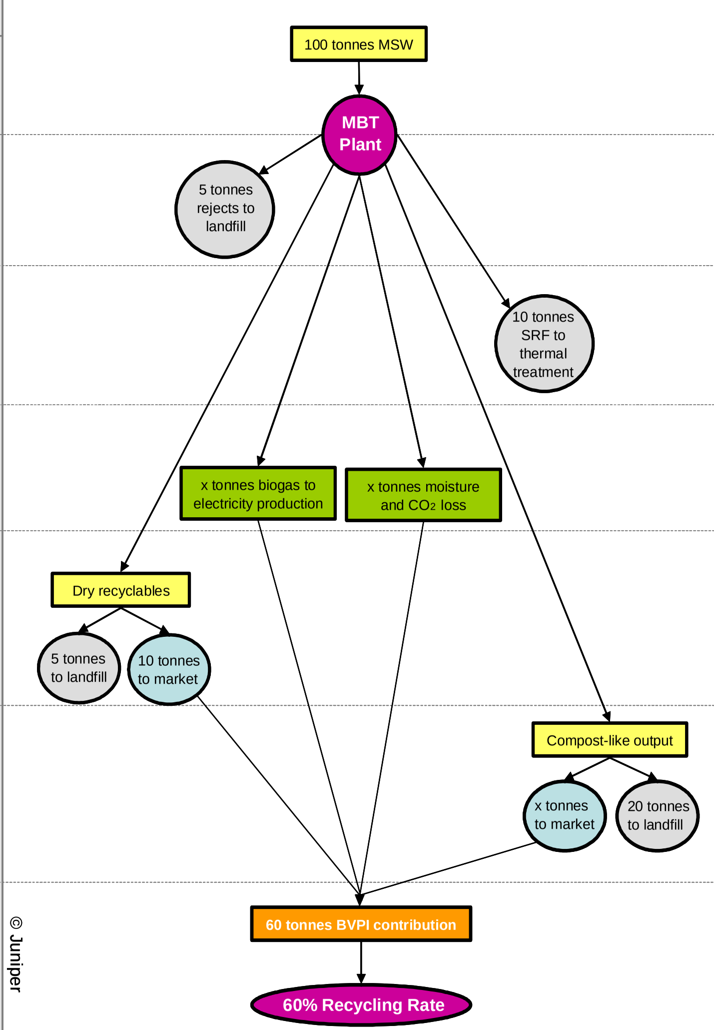
11.33. **Figure 24 shows that the contribution towards recycling targets varies enormously. It is heavily dependent upon the type of MBT process selected, the way it is implemented and the end-use for the output.**

11.34. **Reported recycling rates (BV 82a + BV 82b) could be as low as 3% or as high as 85% (expressed as a percentage, by weight, of the input to the MBT plant (see Figure 24).**

[1] *ibid*

Figure 23: Illustrative calculation of contribution towards BVPI targets by an MBT Plant

Steps to calculating BVPI contributions	Illustrative calculations
1 Assume an MBT plant receives 100 tonnes of black bag MSW.	**1** 100t of input waste
2 The MBT plant initially removes a reject fraction that would contain a mix of biodegradables and inerts. This must be weighed prior to landfill.	**2** 100t (input MSW) *minus* 5t (rejects) = 95t potentially qualifying towards BVPI targets
3 The process produces solid recovered fuel (SRF) which is sent for thermal treatment. This counts towards BV 82c ("recovery"), but not towards recycling targets (BV82a or BV 82b).	**3** 95t *minus* 10t (SRF qualifying as BV 82c) = 85t potentially qualifying as BV 82a or BV 82b
4 During processing, moisture, carbon dioxide and biogas are given off as part of the biological degradation.	**4** To calculate performance against BVPI targets, these outputs do not require quantification, although their equivalent tonnage effectively counts towards BV 82b in stage 6.
5 Dry recyclables (e.g. metals and glass) are another output produced by the facility. These may go to a market - and so be included in BV 82a targets - or be landfilled. Both streams should be weighed prior to departure from the plant.	**5** 85t *minus* 5t (dry recyclate landfilled) *minus* 10t (dry recyclate qualifying as BV 82a) = 70t potentially qualifying as BV 82b
6 Finally, the MBT facility may produce a compost-like output. To be included under BV 82b this must be used on land and be defined as a "recovery" operation. However, it is only necessary to weigh the excluded tonnage which is sent to landfill.	**6** 70t *minus* 20t (compost-like output landfilled) = 50t qualifying for BV 82b (of which x tonnes is the moisture, CO_2 or biogas shown in stage 4 above)
7 The total tonnage qualifying for performance against BVPI targets can now be deduced, along with the overall recycling rate achieved by the MBT plant.	**7** 50t (BV 82b) + 10t (BV 82a from step 5) = 60t recycling BVPIs (60t / 100t) x 100% = 60% recycling rate

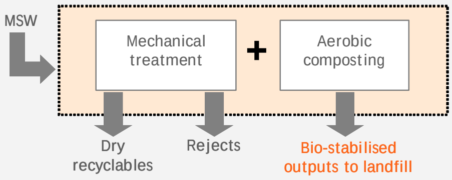


Source: Juniper Analysis

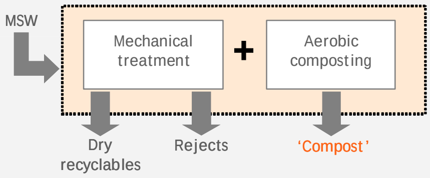
Figure 24: The 8 MBT options: Likely range of performance against BVPI targets

Configuration goal	Contribution to BV 82a	Contribution to BV 82b	Total Contribution
Stabilisation of waste for landfilling	3 - 15	0	3 - 15
Make a compost from MSW	10 - 15	55 - 60	65 - 75
Make a lower grade soil improver from MSW	7 - 15	68 - 70	75 - 85
Make an RDF	3 - 7	0	3 - 7
Produce a fuel using bio-drying	3 - 7	0	3 - 7
MBT to reduce the need for thermal treatment	3 - 7	0	3 - 7
Producing biogas with digestate to landfill	3 - 15	0	3 - 15

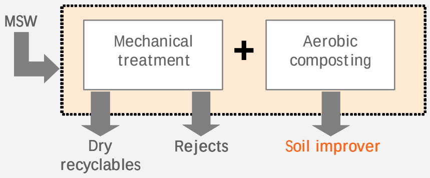
Stabilisation of waste for landfilling



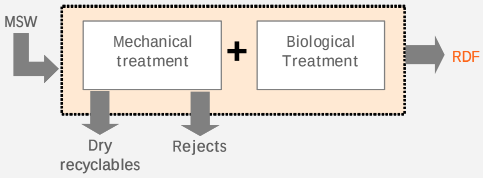
Make a compost from MSW



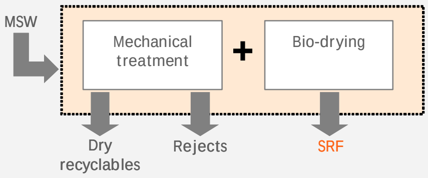
Make a lower grade soil improver from MSW



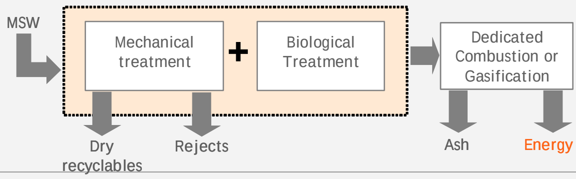
Make an RDF



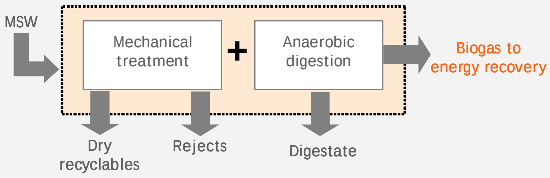
Produce a fuel using bio-drying

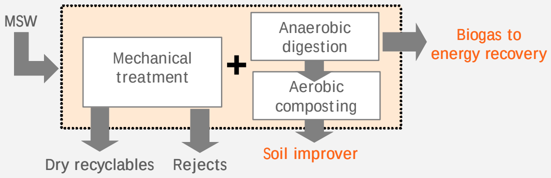


MBT to reduce the need for thermal treatment



Producing biogas with digestate to landfill



Producing biogas and a soil improver 	7 - 15	53 - 55	60 - 70

1. All figures are expressed as a % of the input
2. Each BV 82b range reflects both that the output is accepted by a market and that the activity is deemed a "recovery" operation. Should this be the case, both gas and moisture loss count towards performance.
3. If a market cannot be found for the output (i.e. it would be landfilled), or the activity is deemed a "disposal" operation by the Environment Agency, the contribution to BV 82b would be zero.

Source: Juniper analysis

11.35. **The numbers in Figure 24 are the likely performance of commercial plants built in the UK, taking into account plant economics and customer objectives. They do not represent the range of performance that could be achieved by the underlying technologies in other circumstances.**

What activities count towards BMW diversion?

11.36. **When an MBT output is used as a fuel it always counts as BMW diversion, but when the output is used on land or sent to a landfill the position is far more complex**.

11.37. As mentioned above, a consultation process[1] ("BMW Consultation") is currently underway in the UK on two key issues for Local Authorities:

- when a bio-treated MBT output is sent to landfill or used on the land, what is the impact on performance against LATS targets?
- how is this contribution calculated?[2]

11.38. At the time of writing (February 2005), feedback on the consultation is being received by the Environment Agency, with the response and associated guidance due to be published in March / April 2005; although this may be delayed if it is deemed that further research is required.

11.39. The following analysis, therefore, represents our current understanding of the ongoing BMW Consultation and our interpretation of the possible implications in terms of calculating BMW diversion. These may, of course, be subsequently altered when the Environment Agency and DEFRA have finalised their position. We have not summarised the detail of the Consultation Document in this report, but instead focus on analysing its potential implications for the adoption of MBT-based solutions.

11.40. With regard to **landfilled outputs**, the UK has chosen to adopt a different approach from some other EU Member States: the Environment Agency, on behalf of DEFRA, has decided to use what Juniper is calling a **"proportionality approach"**: the extent to

[1] Assessing the diversion of biodegradable municipal waste from landfill by mechanical biological treatment and other options, Environment Agency, November 2004

[2] The varying test methods being proposed are addressed in **Annexe B4**

which the biodegradability of input waste is reduced will be deemed to be the amount of BMW diversion.

11.41. This differs from the approach adopted in Germany, Austria and Italy, where **a threshold limit** is set, above which residues may not be landfilled and below which they are deemed to have a sufficiently low level of bio-degradability hence can be landfilled without being regarded as bio-degradable waste within the meaning of the Landfill Directive. If this system were adopted in the UK, following the Consultation process and a bio-treated output from an MBT process was sent to landfill, it would either count as 0% or 100% towards LATS targets.

11.42. Instead, under the "proportionality approach" outlined in the Consultation document, any reduction in the biodegradability, however small, would result in a pro-rata reduction in the amount of BMW that was counted against the LATS targets. Thus, for example, **a 10% reduction in biodegradability will mean a similar reduction in the amount of BMW counted as having been landfilled under LATS**.

11.43. Since all MBT processes will reduce the biodegradability of waste to some extent, there will always be a contribution towards BMW diversion targets. In fact, as we shall explain, if the methodology outlined by the Environment Agency in their explanations[1] is adopted, **the contribution from some types of MBT system could be far higher than is generally appreciated**. Our analysis, summarised below, indicates that most **MBT technologies will usually deliver high levels of performance against UK BMW diversion targets – even if all the bio-treated outputs from the plant are sent to landfill** (see Illustratative Case Study 1 later in this section).

11.44. Another consequence of the approach is that there would be **no requirement to fully bio-stabilise MBT outputs prior to landfilling them in the UK**[1].

11.45. It should be noted, however, that the total weight of MBT outputs landfilled would be subject to **landfill tax**, whatever the reduction in biodegradability, though not if these were used as **daily landfill cover**. Conversely, we understand that if the bio-treated output is used as daily cover, it will be subject to the same calculation for LATS contribution as if placed directly in landfill; under the "proportionality approach"[2].

11.46. The full implications of using the "proportionality approach" depend upon both the **testing method**[3] used to determine "biodegradability" and the workings of the mass balance approach that is currently under development by the Environment Agency. Currently, it appears likely that this will be based on measuring the LOI[4] of both the input and output streams, and performing a detailed mass balance so that **only the reduction in "readily available carbon" is taken into account**. Other "biogenic" and "fossil" forms of carbon - which are not broken down either during the biological stage of MBT processes - would not be measured, thus benefiting the reported performance of

[1] Presentations by T Coleman at Environment Agency workshop, December 2004 and at CIWM workshop, January 2005
[2] Personal Communication, Environment Agency, October 2004
[3] Discussed in more detail in **Annexe B3**
[4] LOI = loss on ignition

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MBT facilities. This has a very significant beneficial impact on reported diversion rates (this topic is discussed in more detail in **Annexe B3**).

11.47. If a biological test (such as DRI or SRI) is used instead of LOI there should be very little effect on the reported rates of diversion – indeed, in theory, the result should be the same since the test methodology should only reflect the underlying change in biodegradability. This equivalence would be achieved through normalisation between test methods, as explained by the Environment Agency during the consultation process.

11.48. During the Consultation Process some people have questioned how an LOI test can differentiate between biodegradable carbon and other carbon. By conducting an LOI measurement on each of the relevant streams, as the Environment Agency has proposed, it is possible to measure, by subtraction, the reduction in the biodegradable carbon. This is a more rigorous methodology than biological testing, which means that the protocol is less open to challenge or abuse, but by requiring a mass balance it is a lengthier and possibly more cumbersome methodology. Since there has been opposition to both the mass balance protocol and the use of the LOI test, it may be that this approach might not actually be adopted once the Consultation process is finalised. It is also unclear what the implications would be if the UK adopts a different methodology to that finally agreed throughout the rest of the EU.

11.49. With regard to other uses of MBT outputs, the BMW diversion rate of an MBT plant largely depends upon **market acceptance**, i.e. ensuring there are market outlets for the material, whether this is for use as a fuel or for use on land. If markets fail, and the output has to be sent to landfill, the reported diversion rates would be affected to the extent that the output had residual biodegradability, i.e. well matured compost-like output that failed to find a market would have less adverse impact on a Local Authority's performance against diversion targets than SRF from a bio-drying process, with its higher residual biodegradability.

11.50. Even if MBT outputs find a market for **use on land**, their status under LATS remains uncertain. This is because the BMW Consultation states that such uses **must be defined as a "recovery" operation by the Environment Agency to be considered diversion.**

11.51. Should this not be achieved, either via a Waste Management Licence or by exemption from the Waste Management Licensing Regulations, use on land is likely to be considered "disposal" and thus be treated in the same way as sending the material directly to landfill, i.e. under the "proportionality approach"[1].

11.52. Thus, in cases where there is a significant risk that outputs intended for use on land may either have to be sent to landfill because of market volatilities or may be defined as "disposal", it would be **preferable for Local Authorities to select MBT processes that give relatively high levels of reduction in biodegradability to minimise the impact on performance against diversion targets.**

[1] see **Annexe C6**

11.53. It is also important to note that **performance is likely to be based upon an "actual measurement"** and so BMW diversion rates can only be calculated with certainty once a facility is operational, unless none of the bio-outputs count as disposal. (In this context, commercial processes that can provide biodegradability data from relevant reference sites to prospective customers would be at an advantage in competitive tenders).

11.54. How BMW diversion will be calculated is far from clear. The current consultation exercise will provide the necessary guidance but, at the time of writing, this process had not been completed. The non-clarity is caused by uncertainties with respect to the following parameters:

- Whether calculations are made on a 'wet' basis taking into consideration the moisture loss during the biological stage of an MBT process or on a 'dry' basis when the moisture loss is not included;
- The issue of whether the BMW calculation is based just on the fraction of the biodegradable carbon that is said to be 'readily biodegradable carbon' (i.e. excluding the biogenic carbon that would not degrade in a landfill over a relevant timescale), as proposed by the Environment Agency[1] during the Consultation process; or, instead, is based on the total amount of biodegradable carbon (as discussed in **Annexe B3**);
- The reduction in biodegradability resulting from the various treatment times of the composting process used in actual plants throughout Europe;
- The testing protocol for measurement of the residual biodegradability (LOI, DRI, SRI, BMP)[2];
- The sampling methodology;
- Use of a *de minimis* limit or a strict proportionality approach[3].

11.55. If the UK does go ahead with a 'proportionality approach' based around a mass balance evaluation utilising an LOI test, there is a risk that this methodology may differ so much from that subsequently adopted at EU level that MBT facilities, which have already come into operation in the interim period within the UK, may not achieve the same level of performance against Government targets when a different basis of measurement is used. Whilst this is a risk for projects under development at the present time, it is likely that Government would need to agree special transitional arrangements in such cases.

11.56. Another potential issue for the proportionality approach is that future revisions to the Landfill Directive could require biowaste not to be landfilled – as currently is the case within a growing range of EU Member States (such as The Netherlands, Austria, Germany and Denmark). It has been pointed out that under such a system the proportionality approach would have little validity, but, in our view, this is a somewhat spurious argument. The proportionality approach has only arisen as a result of the need for a proportional measure to underpin the LATS concept of meeting targets.

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[1] Presentations by T Coleman at Environment Agency workshop, December 2004 and at CIWM workshop, January 2005

[2] see **Annexe B3**

[3] T. Coleman, *op. cit.*

Were the EU to adopt an outright ban, LATS trading and target setting would be largely irrelevant. In the context of recent EU enlargement and the resultant challenge faced by the relatively poor new Member States to update their waste management practices, it would be impractical to strengthen the Landfill Directive in the manner discussed above within the foreseeable future.

11.57. Notwithstanding the above uncertainties, we feel that it is still useful to the reader of this report to provide **indicative estimates** for the likely BMW diversion potential of the eight generic MBT configurations. The results of this analysis are shown as ranges in **Figure 25.** The calculations assume that the waste being treated has a composition typical of household waste according to UK government publications.

11.58. The estimates of the BMW reduction that could be expected from an MBT process are based on data derived from the literature, discussions with operators of actual MBT plants which we have visited and discussions with other experts active in this field. The levels of reject streams expected from the generic MBT configurations are based on the data provided by the process companies and the quality of the primary output required. We have made estimates of the biodegradable content of those reject streams.

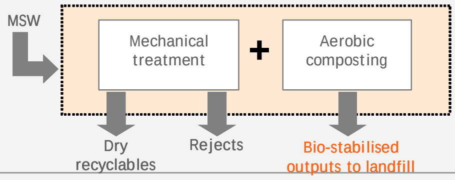
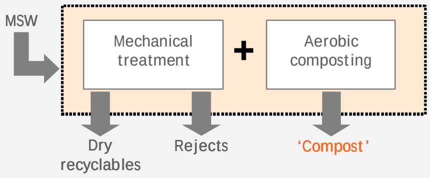
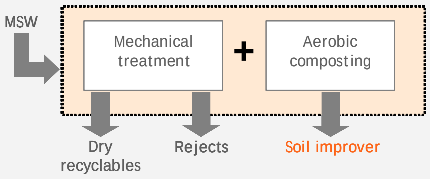
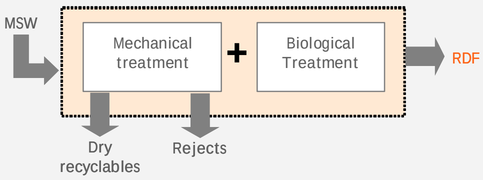
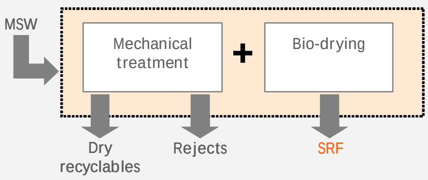
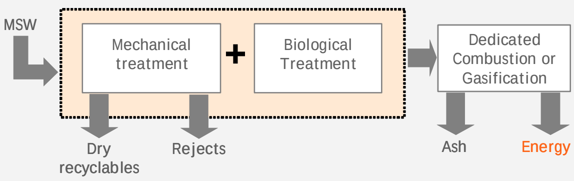
11.59. **Figure 25** presents estimated ranges for BMW diversion according to two scenarios:

- ⇨ the primary output from the MBT process finds an end-use market;
- ⇨ the market fails and the primary output has to be disposed of in a landfill.

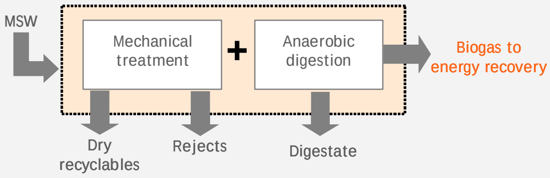
11.60. **From Figure 25 it can be seen that, regardless of the uncertainties associated with the current Consultation process the BMW diversion performance of MBT systems varies significantly. Even within one type the reported rate may vary widely. But configurations are available that achieve diversion rates in excess of 90%.**

11.61. It should be stressed that the **actual mass diversion** provided by MBT facilities may be very different than the diversion performance reported under LATS. This is because the system being established by the Environment Agency and DEFRA aims to measure the reduction in the amount of biodegradable waste sent to landfill (i.e. compliance with the provisions of the Landfill Directive). This is not the same as measuring the diversion of waste from landfill (i.e. the success in reducing dependence on landfill, and so moving up the waste hierarchy). Actual mass diversion is more important for the many Local Authorities that have access to a limited stock of local landfill void space. For these Authorities, **reducing the total amount of waste deposited in landfill, regardless of its biodegradability, is the critical parameter since this extends the life of the landfill stock** (estimates of the mass diversion for the eight generic options are provided in **Annexe A**).

Figure 25: The 8 MBT options: Outline guide to likely BMW diversion performance

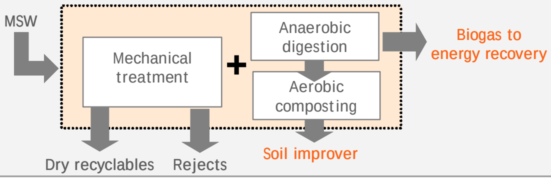
Configuration goal	Estimated performance range against BMW diversion targets (%) when the output finds a market	Estimated performance range against BMW diversion targets (%) when the market fails and the output has to be landfilled
Stabilisation of output for landfilling  	24 - c. 90	Not Applicable
Make a compost from MSW  	82 - c. 90	34 - 83
Make a soil improver from MSW  	87 - 92	6 - 79
Make an RDF  	90 - 95	6 - 70
Produce a fuel using bio-drying  	85 - 92	6 - 68
MBT to reduce the need for thermal treatment  	85 - 92	Not Applicable

Producing biogas with digestate to landfill



14 - 61	Not Applicable

Producing biogas and a soil improver



79 - 85	28 - 79

1 Calculations represent the amount of waste received by the MBT facility and not the total MSW arisings in a particular area

2 The range in the option – stabilisation of output for landfilling - assumes differences in the composting times and varying levels of rejects. The high end of the range assumes achievement of 95% BMW reduction as demonstrated by several German MBT plants.

3 The option with a dedicated combustor/gasifier assumes that the SRF is used as a fuel because the availability of a dedicated EfW facility would reasonably eliminate any potential market risk. The range reflects varying degrees of recycling, drying and degradation (and thus reject levels) that are achievable by an MBT system operated within this configuration.

Source: Juniper analysis

Summary & Illustrative Case Studies

11.62. To aid the reader, we have compiled both a simple **Decision Tree** (**Figure 27**) and a **checklist** (**Figure 26**) of which outputs (and activities) count towards BMW diversion and BVPI targets.

11.63. In addition to the above summary tools, we have prepared **three hypothetical case studies to illustrate the implications on performance against diversion and recycling targets of changing circumstances**. As the BMW Consultation process is still ongoing at the time of writing, the results of our analysis are shown as a range, reflecting the diversity of possible outcomes of the Consultation exercise; once the Environment Agency has published formal Guidance, the reader will need to take into account the particulars of the test protocols and qualification criteria contained in that Guidance.

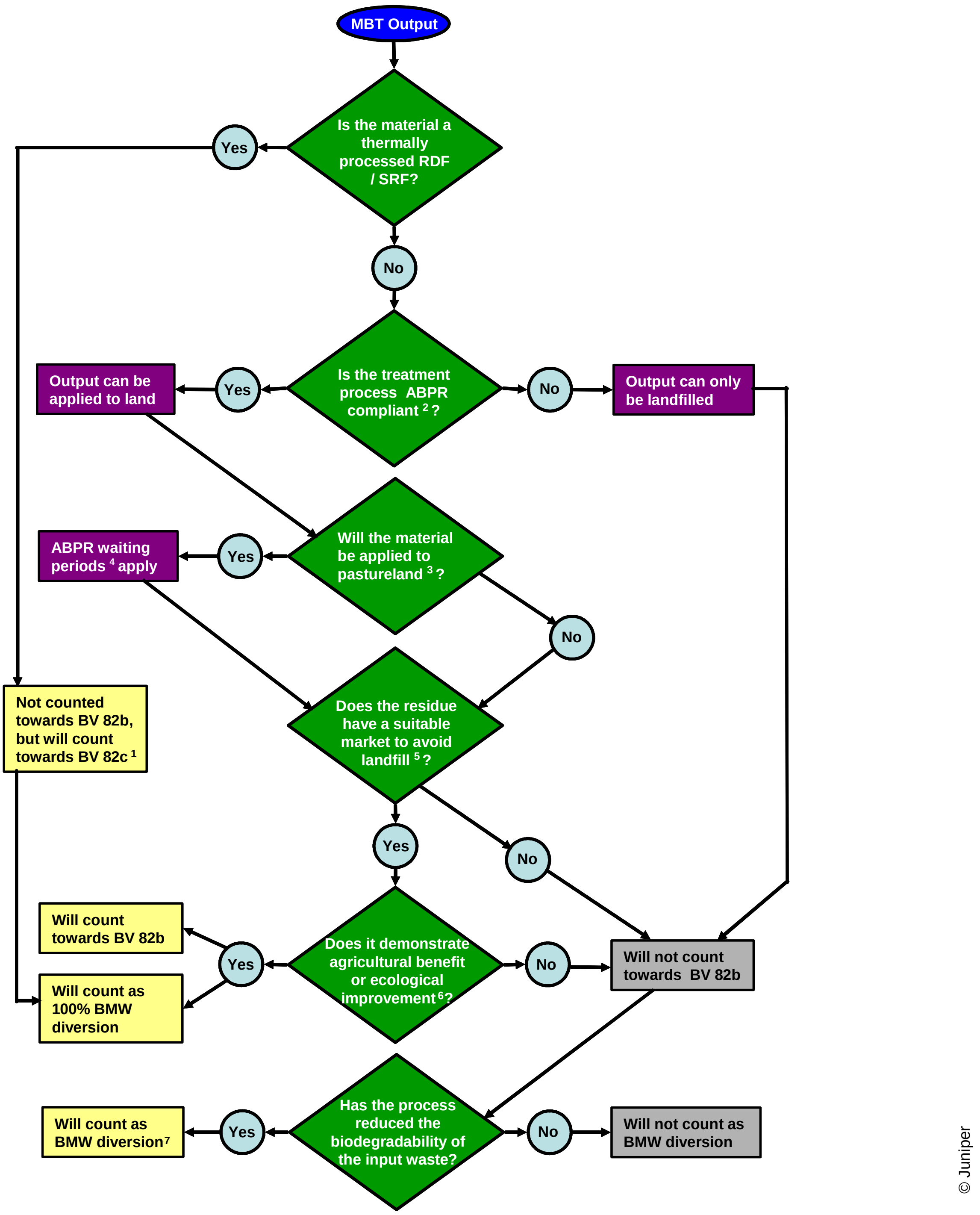
Figure 26: Contribution of activities towards BMW diversion and BVPI targets

Output[1]	BV 82a	BV 82b	BV 82c	BMW diversion
Dry recyclables	✓			
SRF/RDF to thermal treatment			✓	✓
Biogas for energy production		✓[2]	✓[6]	✓
"Stabilised" output to landfill				✓[3]
Soil Improver used….				
…on amenity land		✓[4]		✓
…in land remediation		✓[4]		✓
…as final landfill cap		✓[4]		✓
…as landfill daily cover				✓[3]
Process losses				
Front-end rejects to landfill				
Net moisture loss		✓[2]		✓[5]
CO_2 driven off in bio-reactor		✓[2]		✓
Other unaccounted losses		✓[2]		✓

1 assumes output finds a market and that the process is ABPR compliant
2 counts indirectly (see explanation in **11.22**)
3 in proportion to the reduction in biodegradability of the input waste
4 assumes the activity can demonstrate "ecological improvement". If not, overall contribution to targets is as for landfill daily cover
5 it is proposed that only the moisture associated with "readily biodegradable" carbon will count (so at the time of writing it is not clear how this would be determined)
6 if does not qualify under BV 82b

Source: Juniper analysis

Figure 27: Decision Tree for determining qualification under BVPI and LATS



Notes
1. BV 82c is used to measure the "recovery" of value from waste, which includes the use of thermal treatment
2. Process must conform with the temperature and residence requirements contained in the UK ABPR (see Annexe B4)
3. Land on which animals are grazed or land on which crops to feed animals are grown (see Annexe B2)
4. There must be a 3 week waiting period between spreading and grazing (extended to 2 months for pigs)
5. "Landfill" includes use as daily landfill cover, but not use as final landfill cap / restoration material
6. This must be determined with reference to the Waste Management Licensing Regulations (see Annexe C6)
7. In the UK, the "proportionality" approach means landfilled outputs will count as BMW diversion only to the extent to which the biodegradability of the input waste has been reduced (see Annexe B3)

Illustrative Case Study 1

Assume that a particular Local Authority, which is far from achieving both its landfill diversion and BVPI targets, decides to use MBT to help address both these issues. It lets a contract to a private sector company for the construction and operation of a 100,000 Tpa MBT plant, using mechanical separation followed by anaerobic digestion and a composting stage. The plant generates electricity from the biogas produced. The contractor enters into three commercial agreements with third parties to take the outputs from the plant. The first is with a forestry company to use the output as a soil improver for planting programmes (defined in this case as a "recovery" operation); but their demand is variable and because there is no guaranteed off-take, contracts are re-negotiated annually. The contractor therefore has another contract with a local landfill operator, who agrees to take the balance as daily landfill cover. The final agreement is with an approved aggregate and metals recycling company to take all the glass, non-ferrous and ferrous metals from the process.

The amount sent to the forestry application is not directly relevant to calculating the contributions towards BVPI and BMW diversion targets; instead the performance is measured in terms of the amount sent to landfill (including daily cover use). Assume that, during the first year of operation, this latter amount is 20,000 tonnes (and also assume for simplicity that the plant operates at full capacity, generating 35,000 tonnes of rejects in the mechanical processing elements that are sent directly to landfill and 10,000 tonnes of dry recyclables).

100 kTpa	input MSW	of which 68 kTpa is BMW that is 100% "biodegradable"
35 kTpa	rejects landfilled	= c. 9 to 12 kTpa of BMW
20 kTpa	output used as daily cover	= c. 1.2 to 13 kTpa of BMW
10 kTpa	glass and metals sent for recycling (assumed zero BMW)	

BMW diversion = 68 – (9 to 12) – (1.2 to 13) = 57.8 to 43 kTpa ≡ 63 to 85%
BVPI rate = 100 – 20 - 35 = 45% (35% BV 82b, 10% BV 82a)

Then assume that in the 2nd year of operation, the forestry application decides to start using a competing material. As a result, all of the digestate has to be sent to landfill in the second year of operation (meaning the plant is now deemed a "disposal" facility). As the operator does not have to maintain the quality of the output, he decides to remove only those recyclables which are profitable to recover (halving the rate to 5%). The plant now achieves the following contributions to BVPIs and BMW diversion:

100 kTpa	input MSW	of which 68 kTpa is BMW that is 100% "biodegradable"
35 kTpa	rejects landfilled	= c. 9 to 12kTpa of BMW
50 kTpa	output used as daily cover	= c. 3 to 32.5 KTpa of BMW
5 kTpa	glass and metals sent for recycling	

BMW diversion = 68 – (9 to 12) – (3 to 32.5) = 56 to 23.5 kTpa ≡ 34.5 to 82%
BVPI rate = 5% BV 82a

This Case Study illustrates how:

- **straightforward MBT systems can achieve very high performance against targets when operating to specification;**
- **when markets disappear, causing all of the bio-fraction to be sent to landfill, BMW diversion rates may remain surprisingly good, but BVPI performance will drop significantly.**

Illustrative Case Study 2

Assume that another Local Authority is near to meeting its BVPI targets via extensive collection of dry recyclables, but is far from achieving its landfill diversion targets. To meet this latter goal, it lets a contract to a private sector company for the construction and operation of a 100,000 tonne MBT plant, using mechanical separation followed by bio-drying to produce a solid recovered fuel (SRF). The contractor enters into a single, five year commercial agreement with a cement company to utilise the SRF as co-fuel in its kilns. A reject stream, which contains an oversized biodegradable fraction, is sent to landfill.

The amount sent to the cement company is not directly relevant to calculating the contributions towards BMW diversion targets; instead the performance is measured in terms of the amount of BMW sent to landfill in the reject stream. In the process of producing a specified, quality SRF, the contractor also removes 7% of dry recyclables. Assume that, during the first year of operation, the reject stream is 25,000 Tpa.

100 kTpa	input MSW	of which 68 kTpa is BMW that is 100% "biodegradable"
25 kTpa	rejects landfilled	= c. 6 to 9 kTpa of BMW
7 kTpa	glass and metals sent for recycling (assumed zero BMW)	

BMW diversion = 68 – (6 to 9) = 59 to 62 kTpa ≡ 87 to 91%
BVPI rate = 7% BV 82a

Then assume that in the 6th year of operation, the cement company decides to start using a competing co-fuel, and thus does not renew the contract to take SRF from the MBT plant. As a result, all of the SRF has to be sent to landfill whilst alternative market outlets are being explored. As the plant no longer has to produce its output to a quality standard laid down by the customer, the contractor decides to only remove metals as dry recyclables. The MBT plant now achieves the following contributions to BVPI and BMW diversion targets:

100 kTpa	input MSW	of which 68 kTpa is BMW that is 100% "biodegradable"
25 kTpa	rejects landfilled	= c. 6 to 9 kTpa of BMW
45 kTpa	SRF output to landfill	= c. 11.7 to 38.2 KTpa of BMW
3 kTpa	metals sent for recycling	

BMW diversion = 68 – (6 to 9) – (11.7 to 38.2) = 50.3 to 20.8 kTpa ≡ 30.5 to 74%
BVPI rate = 3% BV 82a

This Case Study illustrates how:

- ⇨ **The BMW diversion performance of MBT systems that use bio-drying technologies to produce an SRF is very sensitive to changes in market acceptance.**
- ⇨ **The range of possible diversion performance, where markets fail, is much bigger for this type of MBT system and is also very dependent on the operating parameters of the process but could still be acceptable for some Local Authorities.**
- ⇨ **It would therefore be prudent for Local Authorities and Contractors to have contingency plans for outputs from MBT plants of this type.**

Illustrative Case Study 3

Assume that another Local Authority is operating a centralised green waste composting plant, which results in it meeting both its BVPI targets and its 2010 BMW diversion target. But to meet the stricter 2013 and 2020 diversion targets, it decides to use MBT and lets a contract to a private sector company for the construction and operation of a 100,000 Tpa MBT plant for MSW, using mechanical separation followed by composting. The plant generates 20,000 Tpa of rejects in the mechanical processing elements that are sent directly to landfill and 5,000 Tpa dry recyclables). 50,000 Tpa of the bio-output is used as landfill daily cover thereby avoiding the purchase of topsoil and this activity is considered "disposal" by the Environment Agency.

The plant now achieves the following contributions to BVPI and BMW diversion targets:

100 kTpa	input MSW	of which 68 kTpa is BMW that is 100% "biodegradable"
20 kTpa	rejects landfilled	= c. 5 to 7 kTpa of BMW
50 kTpa	output used as daily cover	= c. 7 to 35 kTpa of BMW
5 kTpa	glass and metals sent for recycling (assumed zero BMW)	

BMW diversion = 68 – (5 to 7) – (7 to 35) = 26 to 56 kTpa ≡ 38 to 82%

BVPI rate = 5% BV 82a

Then assume that in the 4th year of operation the Local Authority contractor enters into a commercial agreement with a land remediation company to use some of the output in a remediation project and this company gains a waste management license, but the activity is defined by the Environment Agency as a "disposal" operation. Both the tonnage of output sent to the land remediation company and that left over which is sent to landfill are relevant to calculating the contributions towards BVPI and BMW diversion targets. Let us assume that the former amounts to 30,000 Tpa and the latter to 20,000 Tpa. The BVPI and BMW performance is now:

100 kTpa	input MSW	of which 68 kTpa is BMW that is 100% "biodegradable"
20 kTpa	rejects landfilled	= c. 5 to 7 kTpa of BMW
30 kTpa	sent to remediation projects	= c. 4.2 to 21 kTpa of BMW
20 kTpa	bio-treated output to landfill	= c. 2.8 to 14 kTpa of BMW
5 kTpa	glass and metals sent for recycling	

BMW diversion = 68 – (5 to 7) – (4.2 to 21)- (2.8 to 14) = 26 to 56 kTpa ≡ 38 to 82%

BVPI rate = 5% BV 82a

This Case Study illustrates how:

- **Using outputs on land does not necessarily deliver better performance than sending them direct to landfill or using them as daily landfill cover;**
- **Although use as daily landfill cover only achieves the same BMW diversion performance, this option saves on payment of landfill costs (gate fees) and tax and avoids the need to purchase topsoil.**

Conclusions

11.64. The reported **BVPI rates will be higher than has generally been appreciated** until now, because of the way performance against those targets is calculated.

11.65. We have estimated that **the combined BV82a (recycling) and BV82b (composting) rate could be as high as 82%**[1], depending upon the type of configuration selected, **but could be less than 10%** for other types of MBT system.

11.66. There is currently no firm consensus within Europe on how to measure whether an MBT output is sufficiently bio-stabilised not to count as biodegradable waste within the meaning of the Landfill Directive. This element of policy uncertainty can impact on the 'deliverability' of MBT solutions.

11.67. **MBT has the potential to deliver high rates of BMW diversion.** The precise performance cannot be stated with certainty at the time of writing, since there is an ongoing consultation process being undertaken by the Environment Agency on how diversion rates will be measured and calculated.

11.68. Based on the methodology outlined by the Environment Agency during the Consultation Process we have estimated that **some types of MBT configuration could achieve diversion rates of more than 90%**[1]**, assuming long-term end-use markets are guaranteed**

11.69. If these estimates are confirmed, after the Guidance on the methodology is published, then there may be **far-reaching consequences for UK waste management**.

11.70. From the many discussions that we have had in connection with this study – and other interviews conducted by Juniper with a cross-section of UK Waste Disposal Authorities -it is clear that the most important driver for considering MBT is a political desire by LA members to avoid the use of incineration. Until now it has been thought that it would not be possible to meet statutory targets (particularly the 2020 Landfill Diversion targets) without using incineration to some degree. Our study indicates that this is not necessarily the case for every Local Authority and that large numbers of new EfW plants may not be necessary.

11.71. Each Waste Disposal Authority has different 2020 targets to meet and the difficulty of achieving these will vary. Hence the diversion that the residual waste processing facility or facilities needs to achieve also varies from Authority to Authority. It depends in particular upon three parameters:

- ⇨ the rate of growth in the amount of MSW between 1995 and 2020;
- ⇨ the amount of recycling;
- ⇨ the type of recycling (and hence the BMW diversion)[2].

[1] as a percentage of the input to the MBT plant, will be lower as a percentage of the total MSW waste stream
[2] if much of the BMW, such as paper is removed by up-front recycling, the challenge for the residual waste processing plant is somewhat smaller, whereas if the main dry recyclables recovered are non-putrescible (metals, glass and plastics) then the challenge is greater.

11.72. Thus it is not possible to generalise about the degree of BMW diversion that an MBT plant, used alone, needs to achieve in order for a Local Authority to be able to meet its 2020 targets. Modelling conducted by Juniper indicates that the amount of BMW diversion that most Local Authorities will need from such a standalone MBT plant (taking into account growth in waste arisings and an increase in up-front recycling activities) varies between 45% and 80%[1]. Comparing this range of required diversion with the calculations for the range of possible diversion rates achievable by the eight generic MBT options in our report indicates a substantial overlap. So, in principle, all of the 8 generic options might allow most Local Authorities to meet their 2020 targets, when used in conjunction with normal upfront recycling activities but without the need for another type of waste treatment.

11.73. **The possibility that some forms of MBT, in conjunction with kerbside recycling, could deliver 2020 targets for many Local Authorities opens up a route that, politically, many will wish to explore further**.

11.74. Of course, in exploring this option, some Local Authorities will find that, in their particular circumstances, they need to combine mechanical-biological processes with thermal ones and others may find that contractors cannot identify sufficiently robust outlets for the bio-treated output (especially in the context of declining landfill void space and a possible glut of output from the many MBT plants that could potentially be built) whilst others will find that the costs of MBT are less attractive than incineration in their particular circumstances. Notwithstanding the reluctance of many councillors to consider incineration, this may be the best solution for a Local Authority on a balance of parameters including cost, environmental performance and risk, not least because waste companies may not be willing to tender an MBT—led approach if they believe that the risks associated with finding outlets for the bio-treated solids are excessive.

11.75. Moreover, it should be stressed that, once the Guidance on calculating rates of BMW diversion from MBT is finalised, the methodology could result in lower rates of diversion than those we have calculated and, hence, far more Local Authorities would then need to use some form of thermal waste processing.

11.76. **Even if the output is sent to landfill, our calculations of the likely impact of the proposed measurement method indicate that Local Authorities will achieve a very significant proportion of their targets using an MBT system. Combined with an increase in recycling, this approach may be sufficient for many to meet their targets, avoiding fuel applications, which are politically undesirable for some Authorities.**

11.77. There is a widespread feeling that non-thermal infrastructure can be implemented more rapidly than incineration, because of opposition from some quarters to incineration projects and the consequent delays within the planning system.

11.78. However, it is far from clear that this would be the case. For example, a MRF (normally regarded as a less controversial form of waste processing infrastructure) was denied

[1] We modelled a range of scenarios in which waste grew by 1 to 3% per annum between 2005 and 2020, upfront recycling rates increased from a low of 15% up to 50% between the same dates. The analysis also modelled the impact of selecting various types of waste, with different BMW content, for upfront recycling.

planning permission by West Sussex County Council (acting as the Planning Authority) early in 2005 despite the support of the same Council acting as the Waste Disposal Authority. In this context it is not certain that MBT infrastructure could be put in place any quicker or easier than alternatives.

11.79. Nevertheless, **the possibility of being able to meet UK diversion targets without the need for a large number of incinerators would be politically attractive to many** and, for this reason, we expect there to be considerable interest not only in the minutiae of how the diversion performance of MBT is measured, as discussed in this section of our report, but also in the conclusions we have reached about, for example, the viability of markets for the outputs, the degree to which MBT can be regarded as a proven technology and its overall economics.

12 Assessing the economics of MBT

Comparing costs

12.2. The **range of possible costs for an MBT plant will be far wider than for other types of waste process** – because of the inherent flexibility of MBT.

12.3. To give just two examples: both the capital and operating costs of a particular facility will depend upon the amount of recycling that the client wishes to include (and hence the complexity of the 'M' part of the process); and they will depend on the degree of refinement (maturation, removal of contaminants) required for the bio-treated output. Thus, even two facilities that use the same company's process, at the same capacity, within the same country may have very different capital and operating costs.

12.4. Cost data for reference plants derive from facilities operating in different countries, processing different input waste to produce differing qualities of output, under differing economic conditions. Making choices between systems on the basis of that information is more likely to lead to false conclusions than to aid the decision maker!

12.5. 'Illustrative' numbers provided by process companies – that are normalised by them in some way to UK circumstances - should also be treated with caution, since they may have varying underlying assumptions, and may be commercial projections rather than costed analyses. We therefore caution against relying on **'headline costs'** when opting for one approach or another.

12.6. We have concluded that inclusion of graphs within this report that compare capital and operating costs for different proprietary MBT systems is inappropriate because such analysis may be taken out of context and used to make decisions that derive from a false premise[1].

12.7. In our view, the only meaningful cross-comparison that can be made is one prepared from information provided by process companies against a set of project-specific criteria in response to an RFP[2].

Is MBT expensive?

12.8. Notwithstanding our comments above, it is still possible to reach certain general conclusions about the economics of MBT and the extent to which these vary depending upon which type of MBT is chosen.

[1] Despite the dangers of comparing 'headline' cost numbers, we recognise that many process companies do provide such information in, for example, conference presentations; and that readers of a comparative study of this nature do wish to view summary tables of this type of indicative information – for this reason we have provided such a Table in **Annexe D2**.

[2] RFP = Request For Proposal

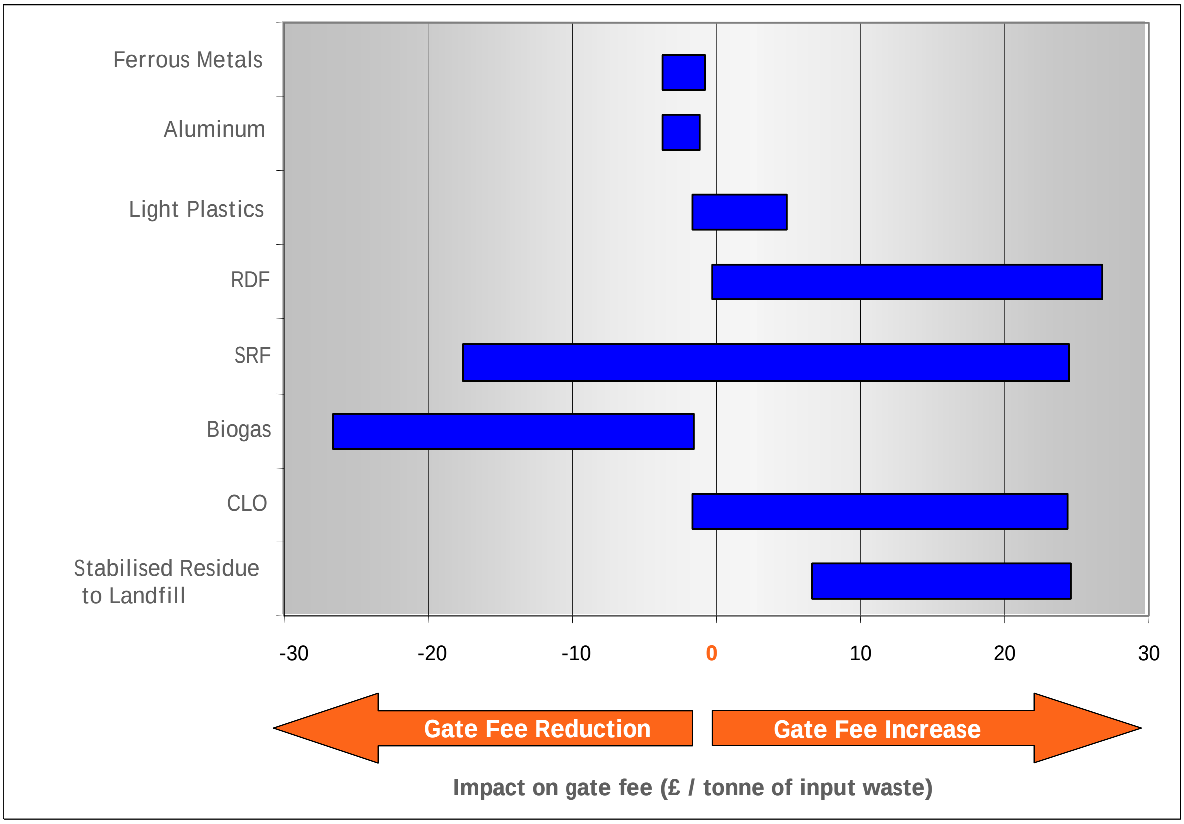
12.9. MBT is widely perceived as being a more expensive approach to the management of residual waste than other processes, in particular moving grate incineration. Our analysis indicates that this is only partially true.

12.10. **Capital costs vary widely, but are generally much lower than for incineration**.

12.11. The **operating costs for an MBT plant are normally higher than those for an incinerator** (per tonne of input waste), but our analysis indicates that there are some situations where this is not the case.

12.12. The analysis we have conducted during the preparation of this report indicates that **the economics of MBT hinge upon what happens to the output**: the direct processing costs and capital cost are less important in determining the break-even point for a particular MBT facility than is the type of application(s) envisaged for the bio-treated output and the viability of that end-use. This is illustrated by **Figure 28**, which shows the range of 'values' – both positive and negative – that could be associated with the various outputs from an MBT plant. In the case of SRF, our analysis indicates that the break-even gate fee could vary by as much as £40/tonne, depending upon the fate of the SRF.

Figure 28: The potential impact of MBT outputs on a facility's gate fee



Source: Juniper analysis

12.13. According to our research, a reasonable guide to the operational costs, excluding output costs or revenues, is £30-65 per tonne of input (including amortised capital cost and debt servicing, but excluding profit margin). Taking into account the types of values associated with the outputs that are shown in **Figure 28**, **net operating costs for some types of MBT plant could be very competitive** with alternatives (for example a facility that recovers significant amounts of biogas for ROC-qualifying electricity and manages to find outlets for its digestate as a 'free issue'[1] soil improver) while **other types of MBT plant would be more expensive**. For example, an aerobic composting plant that produced a bio-stabilised output for deposition in landfill would have a net energy cost, rather than substantial revenues, and a significant disposal cost (gate fee and landfill tax) for the bio-treated output.

12.14. **The overall economics of MBT will be increasingly dominated by policy-led market distorters**: taxes to discourage and incentives to encourage change; tradable permits and credits; and fines for not meeting targets or obligations.

12.15. The biggest of these at present is LATS fines (@ £150/tonne), which might be incurred if, for example, SRF had to be landfilled because there was no market outlet for this fuel. Elsewhere in this report[2], we have highlighted the considerable economic benefits that could be associated with SRF utilisation in the future: these values relate not just to the energy but also to the avoidance of costs that may be associated with fossil fuel utilisation (for example, by using SRF, an industrial user might avoid the need to buy carbon credits that would otherwise be required to meet a Climate Change Obligation (CCO) limit on fossil fuel utilisation). This is an embryonic, rapidly evolving market context, in which values and market mechanisms remain uncertain. In particular, there is much uncertainty about the extent to which MSW-derived fuels (as distinct from 'green waste'-derived fuels) will satisfy future qualification criteria for fossil fuel displacement, in the context of qualifying for ROCs and CCO.

12.16. Throughout this study we have highlighted the issues associated with ensuring viable market outlets for the output of an MBT plant. The whole of **Annexe C** addresses this topic. There, as part of our analysis of each of the main utilisation options for the bio-treated output, we considered the economics of each application and the economic impact if an output can be used in the way envisaged. The cost implications associated with market risk (the uncertainty of ensuring stable, viable outlets for the bio-treated output) are so large for many types of MBT that they become the dominant issue for such projects. Where facilities are financed by the private sector in return for long-term contracts, as in the UK, the private sector partner is expected to shoulder that market risk. Some companies feel that those risks are too high; others structure their bids to 'cost-in' this high risk, while others feel that the risks are over-stated. Waste Disposal Authorities are nervous that this large financial impact could result in the bankruptcy of their counterparty – hence the desire of all parties to assess how real are the market risks, which has been a core part of this study. We have concluded that **the economic risks are significant for some configurations of MBT but are low to negligible for others**. **Figure 30** highlights which of the eight generic configurations have especially high or low economic risks.

12.17. In some of the eight generic configurations, MBT is being used as pre-treatment prior to thermal processing or disposal in landfill. Some people have commented that this seems an unnecessary intermediate step of little value and one which just increases the overall cost

[1] zero cost to either party
[2] see **Annexe C2**

of waste management. This logic has some validity but there are circumstances when pre-processing will save money, e.g. where either thermal waste processing capacity is constrained (likely in the UK) or landfill disposal costs, including tax, exceed processing costs (increasingly the case in many countries, and likely to be so in the relatively near future in the UK) it can be economically attractive to have such intermediate treatment. **Figure 29** provides a guide to when pre-processing could be financially attractive. It shows that using MBT prior to conventional large-scale moving grate incineration is rarely likely to be economically advantageous, but that where project costs for thermal processing are higher than usual it could be worth considering. By contrast, given the likely trend in landfill costs, MBT pre-processing is likely to lower overall costs for that approach over the total life of the project. It should be stressed that this is only a guide – the actual situation will vary from project-to-project.

12.18. It is also worth pointing out that in those circumstances where MBT pre-processing is financially beneficial, other simpler approaches may be even better. In particular, if the output is going to be used as a fuel, some types of MHT (mechanical heat treatment) may be lower in cost and achieve similar or better results. Simple pre-processing using a MRF may also be adequate – depending upon the type of use envisaged for the fuel.

Figure 29: Indicative guideline on when pre-processing is economically attractive

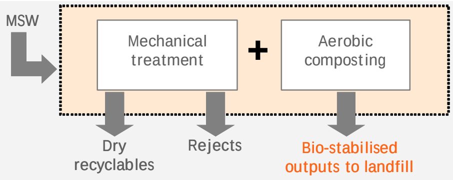
		Does pre-processing using MBT lower overall waste processing costs?					
£/tonne of input		Cost of alternative					
		25	35	45	55	65	75
Net MBT Treatment Cost	15	NO	YES	YES	YES	YES	YES
	20	NO	NO	YES	YES	YES	YES
	25	NO	NO	NO	YES	YES	YES
	30	NO	NO	NO	NO	YES	YES
	35	NO	NO	NO	NO	NO	YES
	40	NO	NO	NO	NO	NO	NO
	45	NO	NO	NO	NO	NO	NO

Note: assumes that the MBT output requiring additional treatment / disposal is 50% of the input
Source: Juniper analysis

12.19. **Conclusion: MBT can be a cost effective solution. However, both the costs and the economic risk vary significantly, depending upon the type of MBT solution chosen and the fate of the bio-treated output.**

Figure 30: The 8 MBT options: key economic differentiators

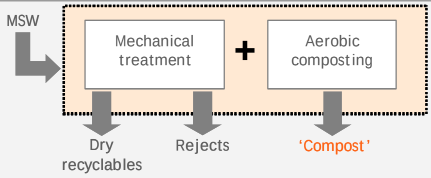
Stabilisation of waste for landfilling



Key Economic Differentiators

- Negligible secondary revenues, significant disposal costs.
- Very low economic risk.
- Depending upon the degree of stabilisation, may require purchase of LATS credits to avoid financial penalties.

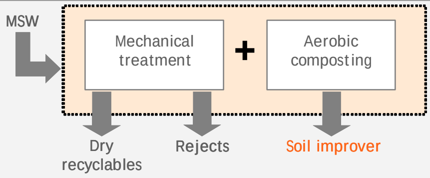
Make a compost from MSW



Key Economic Differentiators

- Low probability of significant revenues from sales of the compost.
- High investment cost because of land-take associated with prolonged maturation.
- Significant risk to plant economics from possibility that compost would have to be landfilled.

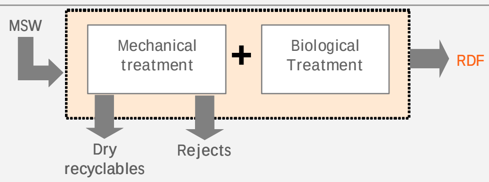
Make a lower grade soil improver from MSW



Key Economic Differentiators

- Slightly lower cost than previous configuration.
- No significant revenues, other than gate fee and some end-users may require a financial incentive to take the sol improver.
- Economic risk varies, depending upon the proposed use for the soil improver (as discussed in **Annexe C6**).

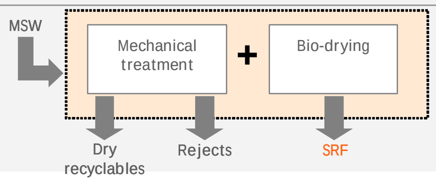
Make an RDF



Key Economic Differentiators

- Low cost (simple process).
- Secondary revenues will be low to negligible because of low value of RDF, which does not qualify for ROCs and is unlikely to do so in future. Operator may even have to pay the end-user to take the RDF.
- Significant 'downside' risk to plant economics, because of volatility associated with securing markets for the RDF, and consequent risk that it may have to be landfilled (see **Annexe C**).

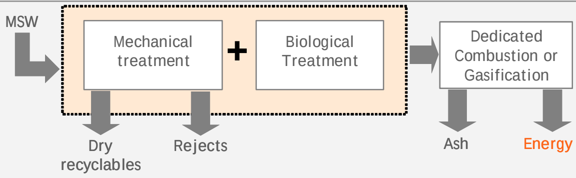
Produce a fuel using 'bio-drying'



Key Economic Differentiators

- Some types of SRF may qualify for ROCs in future and allow fuel users to bank carbon credits or avoid buying them, in which case SRF may command a significant value, with consequent upside revenue potential for the facility, but this is unclear at present. In the meantime SRF has little economic value.
- If SRF cannot find a market, plant economics are adversely impacted to a significant extent.

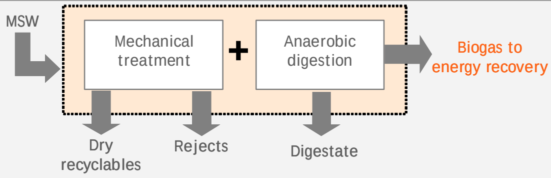
MBT to reduce the need for thermal treatment



Key Economic Differentiators

- The construction of a dedicated combustor / gasifier dramatically increases capital cost but lowers the market risk of the project.
- The economics are significantly enhanced if the electricity produced is eligible for ROCs, which is the case (partially) if gasification is used, but project economics are riskier because this technology is less proven.
- Can achieve the greatest BMW diversion, opening up the possibility of selling landfill credits.

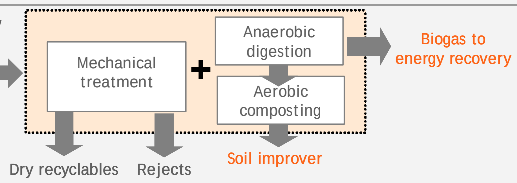
Produce biogas



Key Economic Differentiators

- Electricity output qualifies for ROCs making a significant and reliable contribution to the cashflow of a project.
- Digestate must be landfilled at a considerable cost, may require purchase of LATS credits.

Produce biogas + soil improver



Key Economic Differentiators

- Attractive economically because of significant revenues from biogas and absence of secondary disposal costs.
- Moderate-to-low risk, depending upon the end-use envisaged for the soil improver.
- Higher capital cost than some other options.

Source: Juniper analysis

13 Conclusions

13.1. Our analysis indicates that **MBT is a potentially attractive option for UK Local Authorities** to consider as part of an integrated approach to diverting biodegradable waste from landfill and boosting recycling rates. Our study has confirmed that the viability of many of the possible management options for the bio-treated outputs are still an issue – but not necessarily for all of them. Whilst the utilisation of SRF or compost remains problematic, our study has concluded that other, lesser-known options, merit further consideration for the U.K.

13.2. This study's findings could also have **politically significant implications for the UK** as a whole, namely:

- ⇨ Government could find that the achievement of the UK's obligations under the EU Landfill Directive might be more easily delivered using MBT than had previously been appreciated;
- ⇨ There could be less need for large numbers of EfW plants than had previously been thought.

13.3. But, for this to happen, **greater policy certainty is needed** in key issues, including:

- ⇨ the regulation of re-use of bio-treated outputs in remediation projects and low-grade soil improver applications;
- ⇨ the measurement and calculation of BMW diversion performance;
- ⇨ policy on fossil-fuel substitution by waste-derived fuels, plus qualification for ROCs and related fiscal incentives.

Summary of findings on the thematic issues identified in this report

13.4. At the start of this project we identified a number of key questions[1] that are being asked about MBT and its capabilities. Throughout this report we have addressed these in the context of discussion on the relevant topic. Here we summarise those findings.

Q For what types of waste are MBT processes best suited?

13.5. MBT systems are proven on both unsorted MSW ('black bag' waste) and the residual fraction of household waste ('grey bag' waste). Nevertheless, it is important to ensure that the actual process used is correctly optimised to the composition and type of waste that it will process.

[1] these *Thematic Issues* are listed in **Figure 2** on page **9**

Q At what scale is MBT practical?

13.6. The 80 reference plants considered in this report vary in size between 20 - 480 kTpa in nameplate capacity. One advantage of MBT is that it is more readily scalable than some other waste treatment options, by installing multiple modules at a facility.

Q Does the implementation of an MBT-led solution require changes relative to conventional waste management practices?

13.7. No. MBT can be incorporated into most waste management strategies and reference plants are operating in a wide range of circumstances.

Q How proven are MBT systems?

13.8. Overall, MBT is more proven than other novel technologies, but less proven than conventional incineration. The 27 companies reviewed have some 80 reference plants, however, given the variety of ways in which MBT can be configured, specific concepts may have a very limited track record.

Q Do MBT technologies complement or conflict with kerbside separation of waste?

13.9. MBT does not conflict with source separation, since it is effective on the residual fraction.

13.10. In countries which do not mandate separate collection and where there is no pre-existing recycling infrastructure, some MBT configurations can be a cost-effective method of both boosting recycling and reducing the residual waste fraction – for this reason they could be a very attractive method of updating the waste management practices of many countries, including the 10 EU Accession States. We believe this latter aspect has not received sufficient attention as yet.

Q To what extent can MBT boost recycling performance?

13.11. MBT systems can be configured to recover a significant proportion of the dry recyclables within the input. However, because they normally handle the residual fraction of household waste (after the majority of such materials have already been recovered), they typically recover 3-15% additional dry recyclables.

13.12. Those MBT systems that produce a bio-treated output that is used as a soil improver or 'compost' will report significantly better performance against BVPI targets than other types of MBT: 60-85% versus 3-15% typically, assuming the usage is deemed to be 'recovery' by the Environment Agency.

Q Is incineration a help or hindrance to an MBT-led approach?

13.13. Neither. An incinerator could be used to process the fuel fraction from an MBT plant, thus boosting the total amount of waste processed – equally this report has shown that MBT can function effectively without a combustion unit, assuming the outputs can find an end-use.

Q **Can a UK Local Authority meet its statutory landfill diversion targets using an MBT system without the need for thermal waste processing?**

13.14. Probably yes, depending upon which configuration of MBT process is used and the availability of viable outlets for the bio-treated solids, since our analysis estimates that BMW diversion rates of 24 to c. 90% are potentially achievable and most Local Authorities will require between 45 and 80% diversion from the MBT element.

Q **Are there less siting issues for MBT plants than incinerators?**

13.15. To some extent. There are siting issues with all waste management facilities, but since MBT plants can be housed in low profile buildings and do not require a tall chimney, there may be less.

Q **Are each of the various types of MBT system being promoted more suitable for different roles?**

13.16. Yes. The functionality of MBT processes varies widely as does their suitability for any particular role. Our analysis indicates that it is over-simplistic to just focus on the commonly cited categories (MBT vs BMT, for example) in considering which systems are most useful for which application. The type of MBT system has to be matched carefully to the waste management objectives of each specific project.

Q **Are the differences between commercially available, proprietary MBT solutions significant in the context of a Local Authority decision?**

13.17. Yes. The performance of MBT systems differ significantly. It is therefore vital for each Local Authority to select the most appropriate configuration to meet their particular circumstances and goals, and then to only select those proprietary systems that can best meet those goals.

Q **Can MBT technologies deliver a ‘zero waste’ objective?**

13.18. No. Like all waste management processes, MBT systems produce reject streams that require disposal to landfill. If the primary output cannot find an end-use market then this stream would also need to be landfilled.

Q **To what extent is the output from an MBT process suitable for use as a soil improver rather than as a fuel or a residue for landfill?**

13.19. We have identified several specific end-uses for a soil improver which are potentially viable options.

Q **How viable is the use of the output as a co-fuel?**

13.20. We have identified several technical challenges which are a significant impediment to the use of MBT ‘fuel’ outputs in co-combustion applications, under the current policy framework. We have also concluded that indirect co-combustion and using an integrated stand-alone combustor or gasification process are alternatives that merit consideration.

Q **Can the process produce a sufficiently consistent product to satisfy end-user concerns about fuel quality and fuel variability?**

13.21. Probably. However, there is little current data and evidence in the public domain to suggest that tightly specified SRF composition can be achieved in a consistent fashion.

Q **Can the process produce a sufficiently stable residue to be acceptable as a landfilled material under EU regulations?**

13.22. Yes. Provided the residence time is sufficient many MBT processes, particularly in Germany, can achieve the necessary degree of bio-stabilisation to comply with the requirements of the EU Landfill Directive. This type of material is being landfilled and the Umweltbundesamt are confident that the level of bio-stabilisation is satisfactory.

Q **Is deposition of the residual fraction in landfill consistent with the need to maximise resource recovery from waste?**

13.23. No, since the bio-treated output can be used as a resource.

Q **In the context of increasing landfill costs, would MBT + EfW be cheaper than MBT + landfill?**

13.24. Capital costs vary widely, but are generally lower than for incineration. The operating costs for an MBT plant are normally higher than those for an incinerator (per tonne of input waste), but our analysis indicates that there are some situations where this is not the case. In the context of escalating landfill costs, MBT + EfW is likely to be cheaper than MBT + landfill within five years in many areas of the UK.

Positive implications, challenges and uncertainties

13.25. MBT is not a single concept but, instead, is a family of possible process elements that can be combined in many different ways. The study has shown that the performance of these different configurations varies very widely and each has a complex mix of advantages and disadvantages. We have concluded that no one approach is a 'best solution', but, rather, that some types of system will be appropriate for a particular project, while others will be unsuitable. Our analysis indicates that **MBT is a potentially attractive option to several of the stakeholders** but raises issues for others.

13.26. MBT can be considered as the core element of an integrated approach to diverting biodegradable waste from landfill and boosting recycling rates because:

- ⇨ MBT is likely to deliver **higher levels of performance against diversion targets**[1] than has been generally appreciated prior to this study;

[1] subject to finalisation of the Environment Agency Guidance on measuring BMW diversion

- the use of **MBT technologies might engender less concerns about health and environmental issues** within the community[1], potentially easing the acceptance of such facilities;
- in this context, MBT may be somewhat **easier to implement, in planning terms**;
- the combination of potentially faster planning approval and a slightly faster construction time means that, on average, **lead-times for MBT infrastructure may be relatively short**;
- since it seems that MBT could deliver good diversion performance faster, **many UK Local Authorities could find it easier to meet their diversion targets** than had been thought;
- although MBT only provides a modest boost to the amount of dry recyclables recovered, **some, but not all, MBT configurations could provide high levels of performance against BVPI targets**;
- the types of MBT process that have been recently **under most active consideration in the UK are focused on producing an SRF.** Process designs that focus on the other three primary goals (biogas, soil improver and bio-stabilised residues to landfill) have received far less consideration. We have identified that these options do in fact offer opportunities to manage the outputs from an MBT process and should be given further detailed consideration.
- in summary, there are **multiple ways in which MBT could be deployed that may be both commercially viable and attractive to the public sector waste disposal authority**. Which of these is chosen will depend upon the results of a case-by-case detailed evaluation. Some maximise resource recovery, but they are not necessarily those that maximise performance against diversion targets. Others **may lower market risk and offer commercial opportunities for 'upside' on the plant**, through emissions trading and similar economic incentives. **These are the options which are likely to appeal to private sector project developers.**

... but there are **still significant challenges** ...

- **MBT** has a **low technology risk** but a **high market risk** (**EfW** has a **low technology risk** and a **low market risk**);
- MBT processes produce a number of outputs, all of which **require an end-use market to count towards landfill diversion targets**;
- **doubts have been expressed about the viability of many of the possible outlets for the output from an MBT process**. This study has shown that such concerns are well-founded for the majority of applications; indeed we have concluded that the issues for some end-uses have been previously underestimated.
- **there are very large variations in performance against both LATS and BVPI targets between different types of MBT process**;

[1] it should be noted that perceptions may differ from underlying realities. It is public concerns about incineration, rather than actual health or environmental impacts of new facilities, that is constraining its use.

- the very flexibility of an MBT-led approach (with the almost bewildering number of various process elements, configured in a variety of ways, produce varying qualities and quantities of outputs, which are targeted at many different end-uses) can lead to **confusion** amongst non-specialists and, hence, a **risk that solutions will be chosen that are inappropriate for a specific project**;
- **there is little data available about the possible health impacts** that might be associated with MBT. This may raise **concerns at the planning and PPC Authorisation** stages of a project, which could cause potentially significant delays to implementation;
- most MBT processes have **not yet** been **demonstrated on UK wastes** and this may lead to extended commissioning and 'debugging' for the first UK plants, or in some cases operational issues requiring technical modifications;
- concerns have been raised within the industry that the attractiveness of MBT could, of itself, lead to **an issue of capacity**: insufficient numbers of process companies, specialist personnel (engineers, project managers, consultants and other advisers), and insufficient capital and project-finance to deliver so much infrastructure so rapidly;
- **policy direction at EU-level is not clear**, at the time of writing:
  - the abandonment, at least for the time being, of the Biowaste Directive;
  - the delays in agreeing a Soil Strategy;
  - the on-going deliberations on the Waste Management BREF; and,
  - the CEN TC 343 on waste-derived fuel standards;

  together mean that the **EU regulatory and policy framework for both fuel applications and land applications of the outputs is extremely uncertain**;
- this study has also identified some **uncertainties in UK policy**, notably in relation to ROCs and the calculation of landfill diversion.

13.27. When considered together these policy uncertainties may affect the ease with which terms can be agreed and contracts concluded between a public sector client and a private sector contractor, **delaying the implementation of infrastructure**.

13.28. **Notwithstanding the issues identified, we believe that the balance of the findings from this study makes MBT a more, not less, attractive option for UK Local Authorities**.

13.29. Interest will not be confined to the UK. Our analysis has indicated that **MBT is of widespread interest within some countries in Europe and elsewhere**, but short-term demand will be greater in the UK than anywhere else.

13.30. We have also concluded that MBT will be of significant value to municipalities in many other countries including: Ireland, Greece, Italy, Canada, China, Taiwan, Australia and the Middle East, but the particular type of MBT system that is most appropriate will vary from country-to-country.

13.31. Finally, we believe that MBT is an attractive option for countries which currently lack waste management infrastructure, such as most of the ten Accession States, because some MBT processes could be a low cost method of both boosting recycling and diverting waste from landfill into beneficial applications. More conventional solutions using kerbside collection or MRFs and incineration are likely to be more capital intensive.

Of the many ways that MBT can be configured, which are best?

13.32. Our study indicates that some approaches to using MBT are likely to be more attractive than others, but which is best will vary from country-to-country and project-to-project within a country.

Attractive options

13.33. The scenarios which appear currently to be **more attractive** in a UK context are:

⇨ **make as much biogas as possible**;

- increases revenues from electricity sales;
- potential for favourable economic distorters (ROCs, carbon credits);
- has very high BMW diversion potential;
- lessens plant footprint.

⇨ **close-coupled MBT / gasification of the SRF fraction**;

- removes market risk associated with third party use of a fuel;
- maximises revenue potential from electricity; and,
- qualifies for ROCs.

By using an MBT output as the input to the gasifier the technical issues associated with handling raw MSW in a gasifier are significantly reduced (see **Section 9**).

⇨ **make a land remediation material using a 'fast composting' type of MBT process**;

- significantly reduces capital and operating cost associated with the relatively long treatment times to fully bio-stabilise the output;
- the application for the CLO is potentially more viable than many others;
- can achieve high levels of performance against recycling and diversion targets (discussed further in **Section 9** and **Annexe C6**).

⇨ **make an SRF that is shipped to a power plant for gasification and co-combustion of the syngas in the coal-fired boiler**;

By first gasifying the fuel, power plant applications potentially are more viable as the thermal conversion of the waste-derived fuel is carried out independently of the utility boiler. It also avoids the need to prepare a tightly specified SRF. This would be an attractive route if the economic market distorters develop as expected (this option is discussed further in **Annexe C4**).

13.34. A number of other options are of interest where the local situation allows. For example, where a **cement works** or a **large industrial facility** would be interested in using a fuel fraction, **production of SRF could be attractive**; or where there is a **specific market for a soil improver** – such as with a local **forestry company** or a **civil engineering contractor**.

Less attractive options

13.35. Scenarios that are **less attractive** in a UK context include

⇨ **making a compost for compost applications**;

- o long maturation periods and the need to remove contamination increases cost and land-take; but,
- o is unlikely to provide any certain economic benefit, because of the difficulties in marketing the output as a compost.

⇨ **making an RDF/SRF for direct co-combustion in a power plant**;

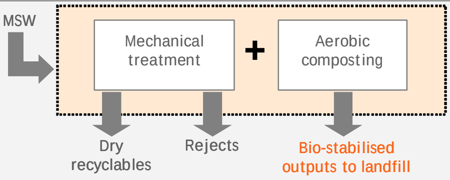
significant technical challenges associated with its use and lack of market enthusiasm for the product (unless the UK government changes ROC rules, as is being considered).

⇨ **making a bio-stabilised residue that goes to landfill**;

cost of disposal and use of scarce void space (in many regions) combined with the low BVPI and uncertain diversion performance relative to other options makes this less attractive.

Figure 31: The 8 MBT options: Summary of our conclusions on their attractiveness in a UK context

Stabilisation of waste for landfilling



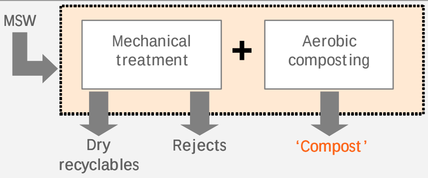
+ve attributes

- Can be implemented relatively easily and quickly.
- No market risk associated with the end-use of the output.
- Low risk route to meeting 2013 LATS targets.

-ve attributes

- High ongoing costs because of disposal costs (gate fees and landfill tax).
- Void space is a limited, strategically important resource in many regions. This approach does not reduce significantly its utilisation.
- Landfilling a resource capable of further utilisation (as a fuel or soil improver) is inconsistent with sustainability objectives, despite the enthusiasm of some NGOs for this option.

Make a compost from MSW



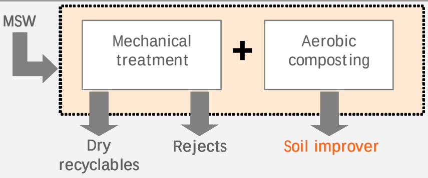
+ve attributes

- Results in very high performance against LATS and BVPI targets *if* the compost can find a market.

-ve attributes

- Compost would not meet PAS100 standard …
- would be difficult to market…
- so, could end up having to be landfilled.
- Requires long maturation of output resulting in higher costs and high land-take with little likelihood of increased plant revenues.
- Greater levels of rejects sent to landfill vs other options.

Make a lower grade soil improver from MSW



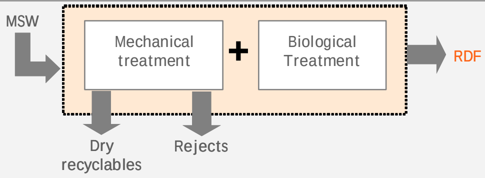
+ve attributes

- Output is more likely to find markets than in the previous option, e.g. land remediation, on verges and as landfill daily cover.
- Simpler, 'fast composting' types of MBT process may be adequate for this option …
- so, may be a low capital cost solution.
- Results in very high performance against BVPI targets if the output finds an end-use that is not classified as 'disposal' by the Environment Agency.

-ve attributes

- Would need to meet UK ABPR even though output is not used as an agricultural compost.
- Needs long maturation of output if used as daily cover to maximise diversion rate, resulting in higher costs and greater land-take.

Make an RDF



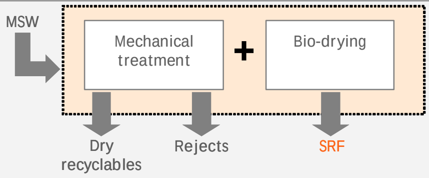
+ve attributes

- Simple, low technical risk, low cost process to implement.
- Results in very high performance against LATS targets *if* the RDF can find a use.

-ve attributes

- High market risk associated with 3rd party use of the fuel because…
- RDF is unattractive relative to other fuels from a technical perspective and incentives are currently insufficient to offset this disadvantage.
- Variable quality of RDF (relative to SRF) limits applications mainly to cement kilns and incinerators and capacity in these outlets is very limited.
- Poor performance against recycling targets.

Produce a fuel using 'bio-drying'



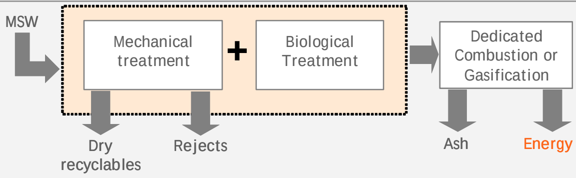
+ve attributes

- Reduced market risk relative to processes that make RDF, provided SRF can consistently meet customer specifications.
- Results in very high performance against LATS targets if the SRF can find a use.

-ve attributes

- Uncertainty of finding markets for the output because…
- SRF is unattractive relative to other co-fuels from a technical perspective and incentives are insufficient to offset this disadvantage.
- Poor performance against recycling targets.

MBT to reduce the need for thermal treatment



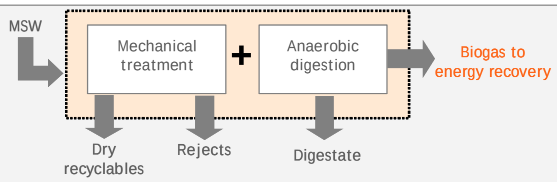
+ve attributes

- Minimal market risk.
- Very high performance against LATS targets.
- Maximises resource recovery within the system boundaries.
- Economically attractive despite higher capital costs because of…
- avoided disposal costs and …
- good potential for secondary revenue generation now and, possibly even more so, in the future (LATS, ROCs, emissions trading) and …
- opportunities for partnership with energy customer ('over-the-fence' sales) to maximise sustainability and economic benefit (through helping meet partner's Climate Change obligations).

-ve attributes

- Technology risk associated with some variants.
- Options that are more economically attractive have a higher technology risk.
- Involves a thermal processing unit, which may engender concerns related to incineration …
- thus, delaying or preventing project implementation through opposition during planning process.
- Only modest performance against recycling targets.

Produce biogas



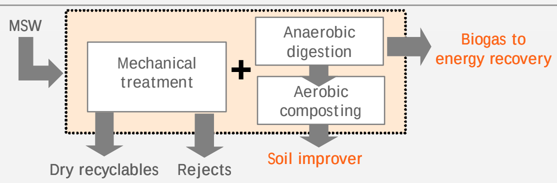
+ve attributes

- Biogas output is economically attractive because it combines …
- minimal market risk (electricity to grid) with qualification for ROCs and other government incentives.
- Small footprint plant.
- Closed system – much lower bio-aerosol risk.
- Reasonably well proven relative to other 'advanced conversion technologies'.
- Very high performance against LATS targets if Environment Agency confirms that ligno-cellulosic carbon does not count against BMW diversion[1].

-ve attributes

- Uncertainties, at the time of writing, associated with LATS performance of this configuration.
- Does not maximise resource recovery.
- Uncertainties over the regulatory position of gas engine emissions.
- Detectable odours at many reference plants.

Produce biogas + soil improver



+ve attributes

- As above, plus …
- preferable to above option if sure of an outlet for the soil improver, because avoids disposal costs for digestate.
- Is also preferable to the aerobic route (3rd option above) because of the revenues and economic benefits associated with biogas production outlined above.
- Potentially has an even higher performance against LATS targets.
- Some variants of this approach give the maximum resource recovery combined with economic benefits, making such configurations potentially the optimum approach.

-ve attributes

- Market risk associated with the use of the output.
- Uncertainties associated with LATS performance if the output is used as landfill daily cover.
- Recycling performance varies depending upon whether the soil improver is used in an application that is classed as 'recovery' or 'disposal' by the Environment Agency.
- Odour and gas engine emissions (as above).
- Greater cost and land-take than the configuration above.
- If the soil improver cannot find a market then the biogas does not count towards recycling targets (unlike in the AD option above).

Source: Juniper analysis

[1] see Section 11

Specialist Support for the Waste Management Sector

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