DESCRIPTIONS OF WASTE TECHNOLOGIES – MBT

WA Waste Authority - Strategic Waste Infrastructure Planning

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WA WASTE AUTHORITY

STRATEGIC WASTE INFRASTRUCTURE PLANNING

Concise Descriptions of Modern Waste Technologies

Mechanical-Biological Treatment FINAL REPORT

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1 SUMMARY

Hyder Consulting has been commissioned by the Western Australia Department of Environment Regulation (DER) on behalf of the Waste Authority to provide a concise description of best practice Mechanical-Biological Treatment (MBT) technologies as a means of modern waste treatment and resource recovery.

This report summarises a number of key parameters relating to this technology that have been requested by DER. It is one of a series of reports reviewing various waste treatment and disposal technologies that may be applied in the Perth Metro and Peel Region. The information is presented in a concise, standardised table format in Section 7 and Section 8 that, when merged with the information on other waste technologies will allow a comparison of key parameters across the technology types and inform the development of the *Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region*.

The purpose of the project is to provide sufficient information on each technology type to allow a comparison with other waste technologies and help to assess the potential for each option to play a role in the future Perth and Peel waste infrastructure mix. The project is intended to inform Government planning and strategic decisions.

MBT is a well-established and generally proven family of waste technologies that can potentially make a significant contribution to resource recovery and landfill diversion objectives as well as abatement of carbon emissions from the disposal of biodegradable waste. It is not a total waste solution in itself and will not result in zero waste to landfill. MBT should be considered as part of a broader integrated waste management system and it should complement rather than replace existing waste management systems such as source separation of dry recyclables and garden organics.

An MBT facility combines established mechanical waste separation systems with a biological treatment process, selected and integrated in a manner that suits the particular goals of the project. It is a very flexible approach that can be designed for a variety of outcomes and situations, but its viability will often depend heavily on the availability of sustainable markets for each of the outputs.

Although there are numerous different MBT technology variations and system configurations, for the current project, Hyder has focussed on three main categories of MBT processes for detailed analysis. The key differentiator is the type of ‘biological’ treatment applied to the organic fraction, as follows:

1 MBT with composting of the organics in a tunnel-type process

2 MBT with composting of the organics in a compost hall process

3 MBT with processing of the organics by anaerobic digestion

The information presented in this report is a combination of details gained through consultation with the operators of the case study facilities and information arising from a review of relevant and available literature on the topic. Additional general information has been included based on Hyder’s industry knowledge and experience.

On the basis of selection criteria agreed with DER, Hyder selected the following MBT facilities to use as case studies.

Type	Site Name / Operator	Location
Aerobic (Tunnel Composting)	Kemps Creek SAWT Facility, SITA	Sydney, NSW
Aerobic (Hall Composting)	Eastern Creek, GRL	Sydney, NSW
Anaerobic Digestion	Leicester MBT, Biffa	Leicester, UK

This report presents key details of each reference facility based on information provided by the operators. In some cases, information was not provided due to commercial concerns. The facility information has been summarised in a table as requested by DER to enable quick comparison with other waste management technologies. Section 8 contains a ‘Study Synopsis’ table for MBT which summarises the parameters across the different MBT variations.

2 INTRODUCTION

Following release of the *Western Australian Waste Strategy*, the Western Australian Waste Authority (WAWA) and Department of Environment and Conservation (DER) have established the Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region. Working Group, with the aim of developing a plan for the future waste disposal and recycling infrastructure needs of the Perth metropolitan and Peel regions. The Working Group will guide the development of a *Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region.*

The WA Waste Strategy sets out challenging recovery targets for each of the major waste streams: municipal solid waste (MSW), commercial and industrial waste (C&I) and construction and demolition waste (C&D), for both the Perth Metro and Peel regions. One of the key objectives of the Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region is to identify the waste technology options and infrastructure mix that will help Western Australia to achieve those targets.

Hyder Consulting has been commissioned by DER on behalf of the Waste Authority to provide a concise description of best practice Mechanical-Biological Treatment (MBT) technologies as a means of modern waste treatment and resource recovery. This report summarises a number of key parameters relating to this technology that have been requested by DER. It is one of a series of reports reviewing various waste treatment and disposal technologies that may be applied in the Perth Metro and Peel Region. The information is presented in a concise, standardised table format in Section 7 and Section 8 that, when merged with the information on other waste technologies will allow a comparison of key parameters across the technology types and inform the development of the Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region.

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1 MBT with composting of the organics in a tunnel-type process

2 MBT with composting of the organics in a compost hall process

3 MBT with processing of the organics by anaerobic digestion

2.1 PURPOSE

The purpose of the project is to provide sufficient information on each technology type to allow a comparison with other waste technologies and help to assess the potential for each option to play a role in the future Perth and Peel waste infrastructure mix. The project is intended to inform Government planning and strategic decisions.

3 PROJECT METHODOLOGY

The information presented in this report is a combination of

(a) Details gained through case studies of representative reference facilities identified by Hyder in consultation with DER; and

(b) Information arising from a review of relevant and available literature on the topic.

Additional general information has been included based on Hyder's industry knowledge and experience.

3.1 CASE STUDIES

Information was gathered for the case studies through direct interviews and consultations with the current operators of the selected existing facilities and Hyder acknowledges their valuable contribution to the project.

To identify appropriate reference sites to use as case studies in the current project, Hyder has focussed on facilities that:

- Use of proven, mature and best practice technology;
- Have been operational for at least 12 months;
- Have been operating successfully to a high standard with no known major issues or fundamental failures;
- Are generally large capacity, on a scale that would be appropriate for the Perth Metro and Peel regions;
- Have established sustainable markets for any outputs and products from the process; and
- The operators have agreed to take part in the project and provide information;

As far as possible, Hyder has given preference to Australian facilities (where they exist), so that the costs, regulatory drivers and environmental standards are likely to be consistent with the Western Australian context. However, in some cases and for particular technologies, Australian case studies were not available and it has been necessary to examine international facilities.

These generic criteria have been applied consistently across all waste technologies studied by Hyder (not only MBT) in the broader series of waste technology reports.

To facilitate the provision of information by operators, DER provided an introductory letter to each selected operator to introduce the project, explain Hyder's role and provide assurance as to the protection of commercially sensitive information.

3.2 LITERATURE REVIEW

To supplement the information obtained through the case studies and provide a broader view of typical facilities, Hyder has conducted a limited review of available literature on MBT technologies and representative reference facilities. Literature in this case includes:

- Published industry reports;
- Journal articles;
- Company websites; and
- Waste and recycling surveys and data reports.

Information obtained from published literature sources has been identified as such and references provided (see Section 9).

3.3 KEY PARAMETERS AND INFORMATION

The table below summarises the key parameters and information specified by DER. The same parameter list will be applied to each waste technology category in order to allow information to be presented in a standardised table format and therefore allow comparison across technologies.

Where relevant and representative information was obtained for the case study facilities, this is presented in the summary table (see Section 7 and 8). Where information was not available or there was a benefit in providing additional background, the table has been supplemented with information obtained through the literature review.

Ref	Information Parameter	Description
1	Process description	A high level description of the process (or technology type) for managing or treating waste including its purpose, conversion processes, stages of treatment and key inputs and outputs (including energy and waste residues)
2	Feedstocks	Types of suitable feedstocks, pre-treatment requirements, broad physical and chemical characteristics, key exclusions
3	Capacity	Processing or disposal capacity (in tonnes per annum) including typical values and ranges
4	Waste Hierarchy	How and where does the technology fit into the established waste hierarchy?
5	Landfill Diversion Potential	Potential to divert waste from landfill (for example, waste recycled/recovered and waste to landfill expressed as a percentage of total waste sent to facility)
6	Products and Residuals	Identify all products, outputs and residuals from the facility / process (including any potentially beneficial outputs and energy)
7	Capital Cost	Expressed as a total cost and $ per tonne of annual capacity
8	Operational Cost	Expressed as $ per tonne of waste processed / disposed
9	Gate fees	Typical gate fees charged to customers. Note gate fees do not necessarily correlate directly with running costs and may include a profit margin and be driven by market forces (ie, prices of alternatives)
10	Set-up Timeframe	Typical timeframe to establish the technology including planning, approvals, procurement, design, construction and commissioning
11	Lifespan	Typical lifespan of the technology taking into account standard maintenance and replacement practices
12	Footprint	Typical land footprint for a facility including for the core technology and any surrounding ancillary requirements (access roads, waste and product storage, buffers, etc.)

Ref	Information Parameter	Description
13	Buffer zones	Extent of buffers required around the plant, including typical existing facilities and any requirements in regulation
14	Emissions Performance	Typical pollutants arising from the process (solid, liquid and gaseous) – key substances and approximate quantities / concentrations. Also high level estimates of carbon impact including direct carbon emissions and indirect emissions from electricity use.
15	Environmental Performance	Compliance with regulations / permits, key environmental impacts including air, water, groundwater, noise, odour, dust, waste arisings
16	Social impacts / costs	Impacts on local community and neighbours, employment, local and economy impacts,
17	Compatibility with existing systems / technologies and supporting systems	To what extent is the technology compatible with the existing waste management system and facilities (sorting, collection, processing, disposal), what broad changes would be required and which other technologies are required to complement the technology
18	Risks	Identification of potential risks including technical, commercial, environmental, operational and market risks
19	Local Application	Most appropriate application of the technology to the local context (metro or non-metro, medium to high density)
20	Maturity of the technology	How long has the technology been in operation, it is considered proven and how many reference facilities exist in Australia and overseas
21	Availability	Typical annual maintenance shutdown requirements, and plant availability as a proportion of the name-plate capacity
22	Penetration	Extent of existing penetration of the technology in the Perth Metro and Peel regions and within Australia (such as number / total capacities of existing facilities)
23	Benefits	Benefits of the technology (financial, environmental, social) compared with alternatives including landfill diversion performance, flexibility, future-proofing, etc.
24	Barriers / constraints	Barriers to implementation including markets for outputs, policy and regulatory constraints, availability of technology and support in Australia, etc.
25	Other relevant information	Any other relevant information which becomes apparent during investigations

4 BACKGROUND

MBT is a well-established and generally proven family of waste technologies that can potentially make a significant contribution to resource recovery and landfill diversion objectives as well as abatement of carbon emissions from the disposal of biodegradable waste. It is not a total waste solution in itself and will not result in zero waste to landfill. MBT should be considered as part of a broader integrated waste management system and it should complement rather than replace existing waste management systems such as source separation of dry recyclables and garden organics.

An MBT facility combines established mechanical waste separation systems with a biological treatment process, selected and integrated in a manner that suits the particular goals of the project. It is a very flexible approach that can be designed for a variety of outcomes and situations, but its viability will often depend heavily on the availability of sustainable markets for each of the outputs.

4.1 TERMINOLOGY

Mechanical-Biological Treatment (MBT) is a broad term that covers a range of waste processing technologies which by definition, integrate mechanical separation of mixed waste streams with biological treatment of the organic fraction.

Although there are similarities in the equipment and technologies used to process source separated materials (such as in a materials recovery facility for dry recyclables, or in composting of food and garden organics), the term MBT is generally reserved for systems which process mixed residual waste streams (i.e. garbage) rather than source separated materials. Separate technology reports have been commissioned by DER to examine technologies for processing source separated organics and dry recyclables (Material Recovery Facilities, “MRF”).

The term MBT is commonly used in Europe and the UK where most of the technologies were originally developed and refined. In Australia, the term Advanced (or Alternative) Waste Treatment (AWT) is more common but tends to cover a broader range of processes, also incorporating technologies that process source separated organics (e.g. in-vessel composting, anaerobic digestion). In that respect, MBT can be considered a subset of AWT.

4.2 PURPOSE OF MBT

A local government or waste operator may choose to implement MBT technology for a number of reasons, including:

- To divert general waste from landfill to meet diversion targets, conserve landfill airspace, reduce environmental and social impacts and/or avoid landfill levies;
- To divert putrescible organic materials (food, garden waste, paper, cardboard and timber) from landfill, reducing methane production in the landfill and carbon liabilities;
- To recover recyclable materials (such as metals, plastics, glass and inerts) to generate revenue and off-set the use of virgin materials;
- To separate and stabilise the putrescible fraction prior to landfill and minimise methane generating potential;
- To reduce the volume and mass of waste requiring landfill disposal to maximise compaction rates in the landfill and conserve airspace; or
- To produce a refuse derived fuel (RDF).

The flexibility of MBT to recover different products and achieve different aims is one its main advantages. In Europe, some countries have implemented landfill bans on biodegradable or unprocessed waste and MBT was originally conceived as a pre-treatment option to reduce the biodegradability of waste prior to landfilling. In much of Europe, the compost outputs of MBT plants are generally not considered suitable for land application and increasingly, MBT is being used to produce RDF to fuel the abundant energy-from-waste (EfW) facilities.

In Australia, such regulatory constraints on landfilling generally do not currently exist and the main focus of MBT facilities is usually on diverting waste from landfill and recovering useful products (compost and recyclables). In the future, as EfW capacity is developed, RDF production may also become a key driver for MBT development. The viability of an MBT approach is heavily dependent on the existence of sustainable outlets for all of the recovered products.

4.3 BRIEF PROCESS OVERVIEW

The ‘mechanical’ part of an MBT process generally comes first and usually consists of a combination of various mechanical technologies to separate the mixed waste stream into the target material streams. This may include combinations of manual sorting (e.g. by hand on a picking line), shredding and grinding, screening (by particle size), density separation, magnetic separation of ferrous metals, eddy-current separation of non-ferrous metals and optical sorting. The output streams from the mechanical stage may include a fine organic fraction, various dry recyclable streams, heavy inert materials and the remaining residual fraction. In some cases, a refuse derived fuel (RDF) may also be produced comprising the highly calorific, dry components of the waste (paper, cardboard, plastic, timber), for use as a coal substitute in industrial furnaces or in dedicated waste-to-energy systems.

Following mechanical sorting, the fine organic fraction, which is typically the largest single stream, is processed biologically. The purpose of the biological stage is usually to decompose and stabilise the biodegradable organic fraction to produce a compost-like soil conditioner or soil amendment product. In most facilities, an aerobic composting process is used, similar to the in-vessel composting (IVC) systems used to process source separated food and garden organics. Where the compost is to be applied to land, a further mechanical screening and refining process may be applied after composting to remove physical contaminants.

Increasingly in Europe and the UK, an aerobic ‘bio-drying’ process is used to dry the organic fraction to produce an RDF, rather than fully composting and stabilising the organics. In some cases, anaerobic digestion (AD) is used to produce a high-methane content biogas from the organic stream which can be used to generate electricity and heat.

The mechanical process is generally well understood and will vary between facilities depending on the organic feedstock quality required for the biological process, final compost quality requirements and other recyclable materials to be targeted for recovery. More complex systems are able to recover more recyclables and produce a cleaner organics stream, but that will generally come at a higher price.

The biological stage generally differentiates technologies. In this study, Hyder has selected two case study facilities that use different variations of aerobic processes (tunnel and hall composting) and one facility which uses anaerobic digestion.

5 CASE STUDY DETAILS

On the basis of the selection criteria set out in 3.1 above, Hyder selected the following MBT facilities to use as case studies.

Type	Site Name / Operator	Location
Aerobic (Tunnel Composting)	Kemps Creek SAWT Facility, SITA	Sydney, NSW
Aerobic (Hall Composting)	Eastern Creek, GRL	Sydney, NSW
Anaerobic Digestion	Leicester MBT, Biffa	Leicester, UK

This section provides a brief description each facility including the key features that make them representative case studies of best practice MBT technologies and how they satisfy the criteria set out in section 3.1.

Case Study 1 – MBT with Tunnel Composting (NSW)

The SITA Advanced Waste Treatment (SAWT) facility is located at Kemps Creek in Western Sydney. It has a nominal processing capacity of 134,000 tonnes per annum and was constructed primarily to service waste treatment contracts with Penrith City Council and Liverpool City Council.

The plant processes the waste from the two Council areas separately in separate processing lines. One processing line treats approximately 30,000 tpa source separated organics (food and garden) received from Penrith. The other line processes approximately 100,000 tpa residual MSW (waste that is destined for disposal) received from Liverpool and other sources. The purpose of the separate processing lines is keep source separated organics separate to produce a higher quality compost product, compared to the MSW derived compost. The plant also receives small volumes of third party industrial organic waste for composting which may include grit from sewage treatment, poultry litter and manure and other high organic streams. The site is also licenced to receive biosolids but currently does not.

The process design for the facility was developed by SITA based on their experience in MBT processing in Europe but is different to most of their European facilities in the objective of the process. The main objective for the Kemps Creek facility is to produce compost and divert waste from landfill, whereas SITA's European facilities tend to primarily produce RDF and produce compost or stabilise the organic fraction waste prior to landfill., for which many use rotary drum based systems. As such, there are no other SITA reference facilities that use the exact same combination of processes but there are numerous other similar facilities in operation by other technology suppliers and operators.

Construction of the plant commenced in 2007 and commissioning was in 2009. SITA is currently investigating and consulting with the community about the potential to expand the facility capacity to 220,000 tpa[i].

The process combines upfront mechanical sorting and separation, followed by aerobic composting in a tunnel system. The separated fine organic fraction is loaded into sealed concrete tunnels where it is composted under controlled aeration, moisture and temperature conditions. Following active composting in the enclosed tunnels, the compost is matured on an external, uncovered maturation area.

The overall diversion performance of the facility is in the range 45% to 60% depending on the quality of the waste feedstock. The main product from the facility is a compost output which complies with the NSW EPA resource exemption for organics derived from mixed waste. The compost is currently distributed for use in mine site rehabilitation. Additional diversion is achieved through mass loss in the composting process (carbon dioxide and moisture). Recyclables recovered from the process primarily comprise ferrous and non-ferrous metals. The company previously undertook trials to recover paper and cardboard but it was not financially beneficial.

Figure 1: SITA SAWT Facility Kemps Creek

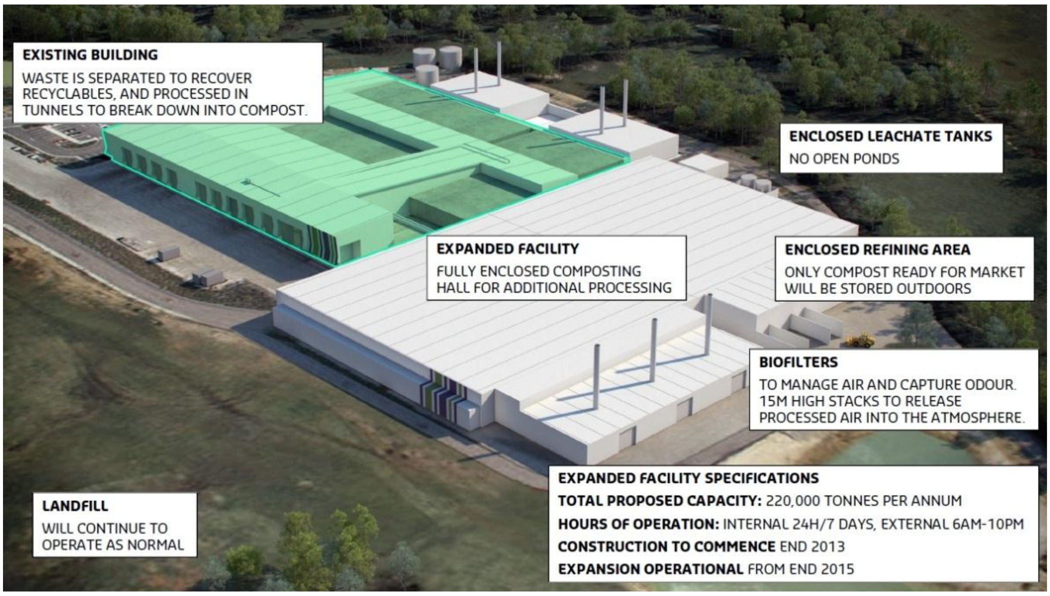


Figure 2: SITA SAWT Facility Kemps Creek – 2013 expansion plans[1]

The facility employs around 40 people and operates on two shifts, 5 days a week. Maintenance is undertaken between production shifts and on weekends. Weekend production shifts can be added to make up for unplanned downtime. As such, the plant comfortably achieves its contractual throughput requirements.

The plant is located adjacent to an active landfill site also operated by SITA, in an industrial and rural area to the west of Sydney. There are rural residential properties from approximately one kilometre of the site and with the nearest populated areas around 5 to 6 km away. Other commercial and industrial facilities are nearby. The plant has had some odour complaints after extended wet weather periods from residential neighbours which are thought to primarily arise from the external storage and maturation of compost. The external maturation pad can also be a source of leachate in wet periods. Water and leachate is generally recycled in the process and used to adjust the moisture levels in the compost tunnels. However in periods of heavy rainfall,

[1] http://www.sita.com.au/sawt

excess leachate can collect in the maturation area and may occasionally require off-site tankering for disposal. Hyder understands that part of the current expansion plans involve enclosing the maturation process.

Case Study 2 – MBT with Hall Composting (NSW)

The Global Renewables Australia (GRA) facility at Eastern Creek is Australia's largest MBT facility, processing 220,000 tonne per annum and thought to be the largest in the southern hemisphere. It was developed under a 25-year Public-Private Partnership (PPP) arrangement with Waste Service NSW (WSN) signed in 2003.

The plant was constructed over 2003-04 and the first waste was received in September 2004 followed by an eight month commissioning and ramp-up phase. At the end of 2008, the original owners of the facility sold it to management and an investment fund as a result of unfavourable commercial and performance terms in the original contract.

By mid-2010, the new owners had renegotiated a revised contract with WSN that included more a broader input specification and realistic and achievable diversion targets. SITA took over the role of contractual partner when it purchased WSN in 2011 and now provides feedstock from a number of councils in the Greater Sydney region.

Figure 3: GRL Eastern Creek MBT Plant, Sydney (source: GRL)

The MBT technology was developed when GRD Group, the original owner of GRL, decided to apply their expertise in materials handling gained in the mining sector, to the treatment of municipal waste. GRL terms the technology "Urban Resource-Reduction, Recovery, Recycling" or "UR-3R Process".

The process integrates core proprietary treatment processes from Europe which GRL is licenced to use. The composting process is based around the Biomax process by the Sorain Cecchini Techno (SCT) group in Italy and the AD process was supplied by ISKA of Germany. The mechanical sorting processes and integration of those technologies was designed by GRL.

The residual[2] MSW is delivered to the enclosed reception hall where it goes through a manual picking station to remove hazardous materials (e.g. car batteries, chemicals) and items that might damage the mechanical equipment. The mechanical process comprises manual sorting,

[2] waste that is destined for disposal.

shredding, screening, air sifting of film plastic and paper and metals recovery (magnets and ECS). The organic fraction is aerobically composted in a hall composting system, where material is placed in a single large windrow and automatically mixed and moved by an automated turning system with underfloor aeration. The finished compost is further refined to ensure compliance with quality standards set out in the NSW exemption for land application of AWT organics.

The plant was originally installed with a percolation system whereby water was percolated through the organic fraction prior to composting and the organic rich water was then anaerobically digested to produce biogas and electricity. However the AD process proved costly to operate and maintain and the cost was not justified by the revenue it generated as a result of low electricity prices. The AD process was decommissioned in 2010.

The plant is currently achieving an overall diversion rate of 66%[i] although this is calculated from a baseline that excludes hazardous and other material removed in the pre-sort process and is hence closer to 60% on an as delivered basis. Most of the diversion is through the Organic Growth Medium (OGM) compost product which is refined to comply with quality standards and used in mine and landfill restoration projects as well as agricultural applications. Ferrous and non-ferrous metals are recovered along with small quantities of plastic containers, film plastic and paper and cardboard.

The plant also produces an Alternative Daily Cover (ADC) material which is the stabilised oversize fraction from the screening of the finished compost which is used as daily cover at the adjacent landfill. This material therefore does not count as diversion but could potentially be used as RDF in the future should markets be available.

An overall process flow and mass balance is presented below.

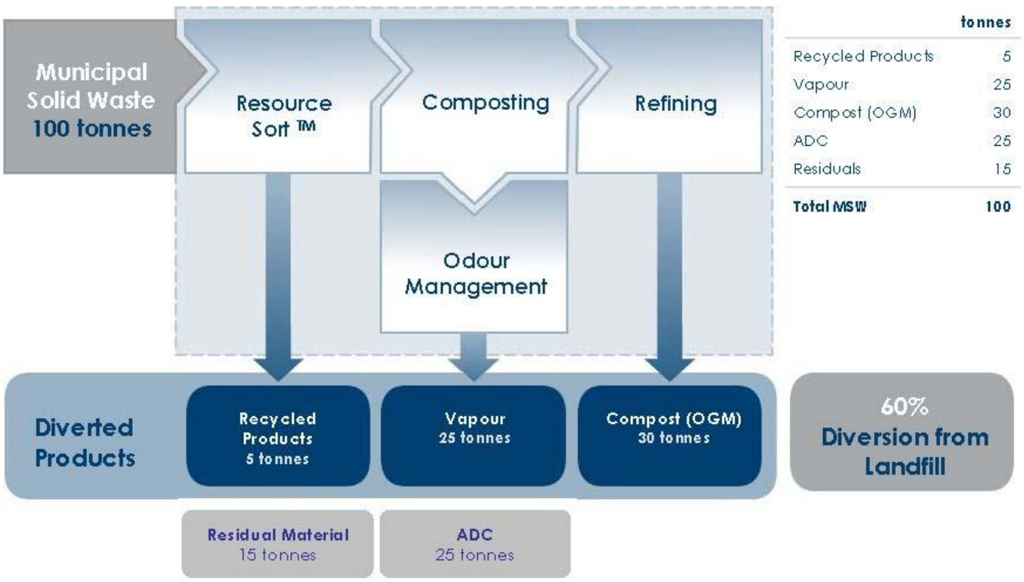


Figure 4: GRL Eastern Creek overall process flow and mass balance (source: GRL)

The plant is located in an industrial area to the west of Sydney. There are very few residential properties within a 1 km radius but there are other industrial facilities nearby and a landfill operation adjacent to the site. The plant has previously had odour complaints from residential and industrial neighbours although many of these are likely to have originated from nearby waste operations (including landfills, windrow composting). Monthly stormwater sampling and annual odour sampling results are published on GRL's website. The biofilter testing for 2012-13 indicates an 97% destruction of odours and 85% destruction of volatile organic compounds (VOCs) by the biofilter.

Other Reference Plants

The GRL technology has since been deployed in two facilities in the UK under another 25-year PPP arrangement with a partnership of Lancashire County Council and Blackpool Council. Although GRL developed and provided the technology for the UK facilities, they are no longer involved in the projects.

According to information published by Global Renewables Lancashire[ii], the Farington Facility was built at a cost of £125 million (GBP) but also incorporates a materials recovery facility and source separated green waste composting. The MBT facility can treat 170,000 tpa of residual MSW but the total facility capacity including MRF and IVC is 305,000 tpa. Total construction period was around three years after a three month planning application period. The AD process generates an average of 1.5MW electricity.

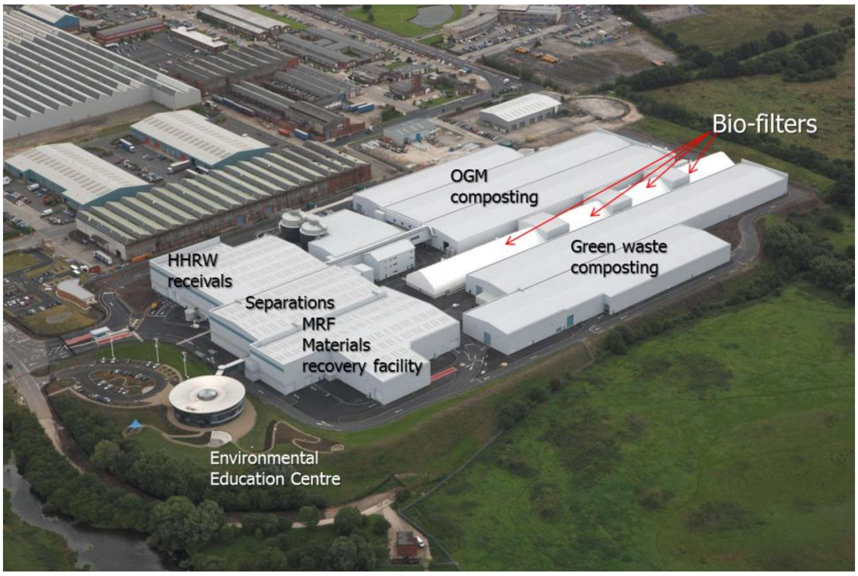


Figure 5: GRL Farington MBT Plant, Lancashire UK (source: Global Renewables Lancashire[ii]

The Farington facility suffered odour problems in its early operational stages attracting over 140 complaints in one month (July 2012). This led to improvements being made in the biofilter system and a raising of the discharge stack[ii].

The second Lancashire facility at Thornton is very similar to the Farington plant and also processes 170,000 tpa through the MBT facility. It also includes a MRF and IVC and cost £125 million (GBP) in total to construct over almost 3 years.

The two Lancashire facilities were reportedly still in commissioning and optimisation stages during the 2011-12 financial year when poor diversion performance was reported (average 25%). However, Council has claimed that they expect diversion performance to be "*well in excess of 60%*"[iii]. The plan was to spread to the OGM from the facilities to land and use it to help create more than 1,000 hectares of new woodland in the area but it is unclear whether the operators have been successful in securing the land and approvals required.

Figure 6: GRL Thornton MBT Plant, Lancashire UK (source: Global Renewables Lancashire[ii])

Case Study 3 – Biffa Leicester MBT Facility (UK)

The Biffa Leicester MBT plant was one of the first such large-scale plants in the UK and the first to utilise AD technology. It was constructed in 2003 to service a 25 year private finance initiative (PFI) contract with Leicester City Council and has a processing capacity of up to 120,000 tonnes per year of mixed residual waste. Uniquely, the MBT process is actually spread over two sites with the mechanical pre-processing taking place on one site (Bursom) and the AD facility located on a second site (Wanlip) approximately 5km away and within the site of an existing sewage treatment plant.

Also uniquely, the mechanical processing is based around a large ball mill plant which is used to crush and pulverise the waste before it is screened and classified into various fractions and materials. The MSW is first passed through a primary shredder and trommel screen which produces two fraction (less than 100mm and greater than 100mm). The undersize fraction which contains most of the organics is processed through the ball mill to reduce the particle size.

The mill is followed by a series of sorting processes including screens, magnets and air classification to produce a fine organic fraction for the AD as well as a 'floc' fraction which is used as RDF. The oversize fraction is also sorted with magnets and an ECS to recover metals and a ballistic separator recovers a light fraction which also contributes to the RDF. The RDF fraction is baled and currently exported to the Netherlands to fuel an existing EfW facility.

Figure 7: Ball mill at Biffa's Leicester MBT plant (source: Biffa website)

The fine organic-rich fraction (<13 mm) from the milled waste is transported to the AD facility which has a capacity of around 40,000 tpa. The AD plant uses a two-stage wet digestion process. The organic fraction is first mixed with water to form a wet slurry from which any heavy sand and grit particles are settled out. In the first stage, the slurry is pumped into one of two batch hydrolysis tanks where it is heated and aerated over a 24 hour period and maintained at around 70 degrees Celsius. The hydrolysis serves to breakdown and solubilise the organic material to prepare it for digestion and also sanitises the material of any pathogens in the waste.

The pre-treated slurry is then sent to the digesters where it is subjected to an 18-day thermophilic AD process. The biogas is used in cogeneration (CHP) engines where the heat is used to heat the hydrolysis and digester tanks and the excess power (around 0.7MW average) is exported to the grid. The digestate from the AD stage is then dewatered and the solid residue cake is matured on a pad and distributed as a soil conditioner product for use in remediation of brownfield sites. Process air from the hydrolysis tank and other odourous air is captured and treated in a biofilter.

The AD technology was supplied by the German company *Hese* which is no longer trading. Also Biffa has reported operational difficulties with the ball mill process and would not recommend its future use. Indeed, ball mills have not been used on any subsequent plants to Hyder's knowledge. The main issue is believed to be that by processing mixed waste through the ball mill, all waste is indiscriminately pulverised including plastic, glass and textiles which can cause blockages and problems for the wet AD process. Most MBT facilities would rely on either a shredder or rotary drum to size-reduce the waste and both approaches are now mature technologies.

6 LITERATURE REVIEW

In 2005, UK based consultants Juniper[iv] prepared a comprehensive review of MBT technologies which at the time, was recognised as the industry standard reference on the topic. It remains very relevant today even though there has been a degree of consolidation of technologies within the industry and a large number of new facilities have been commissioned since its publication. As well as providing detailed information on the status of MBT technology globally, it provides independent reviews of technologies in a standardised and comparable format.

The Juniper report identified that "*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*" and industry experience has only increased since its publication. The report shortlisted 27 established technologies for detailed review and identified a total 80 operational reference facilities between them at the time (2005). Most of the technologies reviewed originated in continental Europe (particularly Germany) although they also assessed one Australian-based technology (GRL).

MBT technology is now considered mature with many technologies now considered to be second or third generation. By far, the majority of installed MBT capacity at the time of the Juniper report was spread between Germany, Spain and Italy with Australia having the fourth highest total MBT capacity. The largest single facility identified in the Juniper report was in Madrid at 480,000 tpa.

However it should be noted that since that report, the installed capacity of MBT facilities in the UK and elsewhere has increased dramatically. A recent report on the European MBT market[v] estimated that there were 330 plants in Europe in 2011 with a total treatment capacity of 33 million tpa. The report forecast an increase to 450 plants and 46 million tpa over the next five years.

The Juniper report notes that MBT technologies have been employed with equal success in jurisdictions that already have high rates of source separated recycling (e.g. Germany and the Netherlands) and those which are relatively unsorted, such as in Italy and Spain.

MBT is a broad family of technologies that can be tailored to achieve a number of objectives. Wheeler[vi] categorises MBT process into five main types according to the primary output(s) and goals of the process as follows:

1. Those producing a compost product;
2. Those generating biogas (by AD) for electricity production and a digestate (compost) product;
3. Those producing an RDF product;
4. Those stabilizing waste prior to landfill; and
5. Those producing both a compost product (or a stabilized material for landfilling) as well as an RDF product

Note that most MBT processes recover dry recyclables in some form (mostly metals and plastic containers), but this is usually a minor fraction of the outputs (typically 5-10%).

In the context of the current *Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region* project, where the aim is to identify technologies which can divert waste from landfill (not just biodegradable waste), MBT is unlikely to be used to stabilise waste prior to landfilling. More likely, a compost product will be produced for land application or an RDF product may be considered where a waste-to-energy strategy is to be pursued. Producing both

RDF and compost products will deliver the highest diversion rates, where outlets exist for both products.

Incorporating biogas production (AD) into an MBT is unlikely to improve the overall landfill diversion performance (compared to aerobic composting) but provides other advantages and may be considered where it is justified by the financial and/or carbon abatement benefits.

6.1 PROCESS DESCRIPTION

Most MBT facilities comprise a mechanical separation phase followed by a biological treatment stage for the organics, as detailed below. A number of different equipment configurations and technology options are available to suit a particular purpose.

In certain technologies, there is a biological stage first or the biological and mechanical stages are combined. For example, in rotary digester processes, raw waste is usually fed directly into the digester drum where the slow rotation and gentle tumbling of the waste in the drum helps to pulverise and break down the waste (in lieu of shredding), while the organics fraction is simultaneously composted over a period of 2 to 5 days. Mechanical processing is then used to separate the compost from inorganic materials. This technology has been popular in Australia with four existing plants (SMRC Canning Vale facility, SITA's Mindarie facility, SITA's Cairns facility and the Port Stephens facility).

In facilities that produce a soil conditioner product, there may be additional mechanical processing applied after the biological treatment to remove contaminants from the compost.

Mechanical Separation

The purpose of the mechanical separation process is to separate the mixed waste stream into relatively homogenous materials streams which may include a fine organics stream, dry recyclables (e.g. metals, plastic containers, glass and inerts), RDF and/or a rejects waste stream.

Various types of automated shredding, screening, classification and sorting equipment can be combined and configured depending on the quality standards required for the downstream biological treatment and recycling markets. Most facilities shred the waste first, to open bags and liberate their contents and start to break down the components. A one or two stage screening process then produces different streams for further refinement. In large-scale facilities, more advanced equipment can be employed to recover additional recyclable materials and improve the quality of the organics stream.

Biological Treatment

The fine organics stream recovered from the mixed waste is usually sent for biological treatment which can be either aerobic or anaerobic in nature. It is noted that most anaerobic systems will generally incorporate a final aerobic stage to stabilise and 'cure' the digestate product.

Aerobic treatment involves various forms of in-vessel composting (IVC) in an enclosed environment such as in composting tunnels on in a composting hall. Enclosing the process allows for odours to be contained and captured and process variables (moisture, air flow, temperature) to be carefully controlled.

Composting is generally a slow process typically taking between 4 to 8 weeks. This long residence time means that the volume and footprint required for the composting process is comparatively large.

In tunnel composting, batches of compost are processed inside large rectangular concrete tunnels which, once loaded, are completely sealed and aeration is provided via in-floor channels in each tunnel.

In a compost hall process, composting takes places in turned windrows inside a large shed or hall. Different technologies may be defined by the method of turning the compost windrows which may include augers, large bucket-wheels and mobile compost-turning machines.

Bio-drying is a variation on the compost hall method where the aim is not to fully decompose the biodegradable waste but to initiate the composting process and use the natural heat of composting together with airflow to dry the material. Bio-drying is used in many UK and European MBT facilities to produce RDF for waste-to-energy applications, where markets for MBT compost are very limited.

Anaerobic digestion (AD) involves decomposition of organic material in the absence of oxygen (similar to a landfill environment), usually undertaken in large vessels where the process can be controlled in order to speed up reactions and harvest the resulting high-methane content biogas, which can be used for energy generation. AD still produces an organic residue called digestate which is similar in nature to compost. The digestate often requires a brief stage of aerobic treatment to fully stabilise any remaining biodegradable content and can be used in similar applications as compost.

There are a number of variations of AD processes available. Wet AD processes usually digest the organics as a wet slurry (less than 15% solids) while in dry AD systems, some water may be added to the waste but the solids content is kept above 15% and up to 40%. The biological digestion process can either be mesophilic (35-40 degrees Celsius) or thermophilic (50-55 degrees Celsius) where each type involves different primary organisms and leads to different biogas yields.

Furthermore, the digestion process may be single stage (in a single vessel) or multistage. Increasingly, a hydrolysis stage is being used prior to digestion to prepare the organic material and start to break it down through heating and/or acidification. In most cases, a hydrolysis stage can increase the overall biogas yield and reduce the required residence time in digestion.

In Europe, dry AD accounts for the bulk of MBT systems processing MSW (62%) while the majority of existing systems are single stage systems (93%) and mesophilic (67%)[vii].

Anaerobic digestion, as a biological process is somewhat more sensitive to conditions and toxins than the more robust aerobic processes. This presents challenges for processing of organics from mixed waste and the mechanical sorting stage becomes more critical. Sedimentation of heavy materials or floating layers of light fraction can cause significant issues in wet digesters.

Aerobic composting is an energy intensive process requiring significant energy for aeration and/or turning of the compost. Therefore, although the incorporation of an AD stage will add significantly to the capital cost of a facility, this can be offset by the reduced need for aerobic stabilisation, reduced energy consumption in operations and revenue gained from the sale of excess energy. SERC found, based on averaged data from a number of reference facilities, that an aerobic in-vessel composting process would consume around 62 KWh per tonne of organic waste processed while and AD facility may generate around 122 kWh per tonne.

6.2 EXISTING FACILITIES

Australia

Australia and in particular Western Australia has embraced MBT technologies. In WA, there are currently three operational MBT facilities with a fourth facility under construction and commissioning (at the time of writing), as summarised in the table below[viii].

Table 1 Existing AWT facilities (accepting waste from Perth or Peel regions)

AWT Facilities	Operator / Customer
Atlas Resource Recovery Facility	Atlas Pty Ltd / City of Stirling
MRC Neerabup Resource Recovery Facility	SITA / Mindarie Regional Council
SMRC Regional Resource Recovery Centre	Southern Metropolitan Regional Council
JFR (Jim) McGeough RRF*	AnaeCo / Western Metropolitan Regional Council

** under construction and commissioning as at April 2013*

The Atlas Resource Recovery Facility is operated by Atlas and the City of Stirling and was commissioned in 1998. It claims to be Australia's first such facility and can process up to 65,000 tpa of MSW. The facility consists of a separation combining mechanical and manual sorting to recover recyclables, while the fine organic stream is transported to a separate farm site to be composted in open windrows[ix].

The Mindarie Regional Council (MRC) facility at Neerabup (to the north of Perth) is operated by SITA. It reportedly cost around $80 million to construct and opened in 2011 with a nominal processing capacity of 100,000 tpa of residual MSW[x]. The process is based around the Conporec rotary digester technology where the mixed waste is loaded into large rotating drums for around 3 days which slowly pulverises the waste whilst rapidly composting the organic fraction. The material is then processed through a mechanical separation plant to separate the fine organic fraction and recover recyclables. The partially composted organics are then further stabilised in a tunnel composting process. In 2011/12, the facility reportedly processed 102,944 tonnes of waste and achieved an overall diversion rate of around 51%, of which around 28% was compost product[xi]. The apparent average processing charge is around $210 per tonne based on published total expenditure by MRC on the service and total waste delivered.

The Southern Metropolitan Regional Council (SMRC) run facility at Canning Vale in South Perth was commissioned in 2005. The MBT processed is based around the Bedminster rotary digester technology producing compost from mixed waste and the $100 million integrated facility also includes a MRF and green waste composting process[xii] with a processing capacity of 80,000 tpa. The facility suffered from serious and well publicised odour issues which eventually resulted in the regulator shutting the site down in 2012. SMRC subsequently negotiated with the regulator to allow limited operations to continue under an amended licence, while it implemented significant upgrades to its odour management systems and operational procedures.

The MBT facility at the JFR McGeough RRF at Shenton Park in Western Perth is currently being commissioned and incorporates an anaerobic digestion stage[xiii]. The facility is based on the Australian-based DiCOM technology by AnaeCo in which the organic fraction will be anaerobically digested in vertical vessels for 5 days, and then aerobically stabilised in the same vessel. The DiCOM technology has been demonstrated in a pilot facility but the Shenton Park facility will be the company's first commercial installation.

Across Australia, there are a further five large-scale MBT facilities known to Hyder to be processing mixed waste of which four are in NSW and one is in Cairns, Queensland. The largest MBT facility currently in Australia is the GRL facility in Sydney processing 220,000 tpa (see case study 2).

International

MBT has been applied extensively over the last two decades to process residual MSW in Europe and the UK. Below are some brief case studies on representative facilities based on information in literature.

Viridor Laing Manchester MBT facilities

As part of its integrated waste management contract with the Greater Manchester Waste Disposal Authority (GMWDA), Viridor Laing has constructed five new MBT facilities, four of which incorporate Anaerobic Digestion. Each facility uses a combination of mechanical sorting (shredding, screens, separators and crushing) followed by a wet AD process for the organic fraction. During the AD process, organics waste will be digested for 20-25 days at around 57 degrees Celsius with biogas from the process being utilised by CHP engines[xiv].

One of the first facilities to be commissioned, the Bredbury Park MBT, will have a capacity of 150,000 tpa and features two digester tanks which are 17m high. The facility also incorporates an in-vessel composting system for garden organics, transfer station and household waste drop-off centre.

Figure 8: Viridor Laing Bredbury Park MBT-AD facility (DEFRA[xiv])

The remaining digestate will then be de-watered and dried, with the five MBT facilities producing around 275,000 tonnes per annum of RDF in total which will be used in a purpose built EfW facility being constructed at a chemical works.

Avonmouth MBT, New Earth Solutions, UK

In the UK, the application to land of compost derived from mixed waste (or compost-like output in the UK) is limited by regulation and the market for this product is minimal: most MBT plants in the UK tend to focus on producing an RDF product. However one exception is the MBT process developed by New Earth Solutions (NES), which involves fully composting and sanitising the organic fraction in a composting hall type process. The technology was developed and tested at their Canford facility in Dorset and is now being implemented at various locations across the UK.

Figure 9 - Avonmouth MBT Facility (New Earth Solutions)

The Avonmouth MBT facility near Bristol started receiving waste in April 2011 after a reported construction period of 8 months[xv]. It has a total processing capacity of 200,000 tpa underpinned by a 120,000 tpa joint local authority contract. The mass balance for the upfront mechanical processing stage is reported by NES to be as follows:

Material	Percentage of input waste stream
Recovered metals	4%
Rigid plastics	3%
Compost product	18%
Mass loss from composting	20%
Refuse derived fuel	50%
Residuals to landfill	5%
TOTAL	100%

The upfront mechanical processing stage recovers metals and rigid plastics for recycling. The organic fraction is composted in aerated windrows inside a large hall and turned by a mechanical compost turner over a period of 5 to 6 weeks to produce a compost product and generate mass losses of around. The residuals from the mechanical processing and composting stages are mostly processed into RDF leaving only residuals to landfill and delivering an overall diversion rate in the order of 95% (subject to feedstock quality).

NES are also currently constructing a waste gasification facility, using their own technology, to process the RDF stream and recover up to 13MW electricity. It is noted that the residual waste feedstock to this facility generally arises from local authorities with extensive source segregation collection systems including separate weekly food waste collections, optional garden waste collections, an extensive list of dry recyclables and a residual collection (i.e. a 4-bin system). This may explain the lower rate of recovery of compost from the Avonmouth facility (relative to GRL) and higher proportional recovery of dry recyclables. It further shows that MBT can be complementary to a source segregation strategy.

Ennigerloh MBT Plant, Germany

The Ennigerloh MBT plant has a total capacity of 160,000 tpa and its primary objective is to produce RDF from residual[3] MSW. This summary information is taken from a case study by AEA Technology[xvi]. There are a large number of cement kilns and EfW plants near the town that can accept the RDF.

The mechanical sorting process was commissioned in 2002 and the composting stage followed separately in 2004. The technology for both was provided by Horstmann. The mechanical process comprises shredding, screening, magnets, air classification, ballistic separation and drying to produce RDF.

The biological stage involves composting in 16 tunnels, which are 32m long and 6m wide. After 3 weeks in the tunnels, the compost is further matured in open bays. The air treatment system includes acid-gas scrubbers and a regenerative thermal oxidiser, because of the stringent emission limits applied to the plant.

The total capital expenditure in the plant was 51 million euros.

6.3 COSTS

Typical capital costs are in the range $50 to $100 million depending on the capacity and technology adopted. Recently constructed Australian MBT plants suggest a capital cost per tonnage capacity in the range $650 to $1,000 per tonne per annum processing capacity (adjusted to 2013 dollars). In all systems, economies of scale are gained at higher capacities and improved mechanical sorting is viable in larger facilities.

Information from the case studies indicates a wide range of operating costs, depending on the complexity of the process, from $50 to $120 per tonne. These costs generally exclude the landfill disposal of residuals which may be 35% to 50% of the input but will vary depending on the location of the plant (Sydney landfill prices are in the range $200-300 per tonne including the government levy, Perth Metropolitan landfill prices are $100-$150 per tonne including a levy of $28 per tonne).

Information on gate fees is difficult to obtain and most facilities only accept waste directly from councils under long-term contracts, the financial details of which are not made public, as is the case for each of the three facilities studied for this report. Some facilities are able to accept small proportions of third party waste but again the gate fees charged are commercially confidential. It is also important to note the fundamental differences between gate fees and operating costs. Gate fees are not always good indicators of operating costs and can be heavily affected by factors such as the cost of competing alternatives (e.g. landfill or incineration gate fees), allocation of risk in supply contracts, the types and quality of outputs and the availability of markets (e.g. for compost or RDF products).

For comparison, in the UK, the Waste and Resource Action Programme (WRAP) undertakes an annual survey of gate fees for various treatment and disposal technologies. Their 2012 Gate Fees Report [xvii] indicates that the median gate fee for MBT facilities in the UK was 79 GBP per tonne (approximately $119 per tonne[4]) with a range of 65 to 84 GBP per tonne (approximately $98 to $126 per tonne). However, the report recommends caution in using these figures, given

[3] waste that is destined for disposal.

[4] Based on approximate currency exchange rates as of May 2013 at 1.50 AUD per GBP.

the wide variety of treatment processes that fall within the MBT category. Furthermore, a direct comparison using currency exchange rates is not reliable as it does not account for the higher cost of labour, energy and materials in Australia.

6.4 OUTPUTS

Material products from MBT (including compost and dry recyclables) are generally of a lower quality with higher rates of contamination, than materials obtained through source separated recycling systems. This results in more limited and lower value market outlets.

Recyclables

Most MBT facilities recover metals in the mechanical processing given that they tend to be relatively easy to extract and high in value, despite the contamination. Other materials such as plastic containers, film plastic and cardboard, can also be recovered although the contamination may make it more difficult to identify sustainable markets for those outputs. Glass will generally be crushed in the process but it may be possible to recover it and other stones and inert particles for use as a low grade recycled aggregate material.

The availability of viable markets for recyclable materials will usually determine the configuration of the mechanical separation and ideally, the process should be flexible to adapt to changing market conditions.

Organic Outputs

In Europe and the UK, regulations generally limit the use of organic outputs from MBT plants on land to particular applications and under strict conditions. Spain is the exception where the compost product is seen as a valuable resource for improving and preserving soil quality in arid areas. In the UK, the compost-like output (CLO as it is known), cannot be used on agricultural land and may only be used in limited applications such as landfill restoration and brownfield land remediation in cases where the operator can demonstrate an overall ecological benefit.

In Australia, the application of MBT outputs is subject to varying State regulations but a number of the existing facilities market organic products to agricultural and horticultural markets, as well as lower value uses such as landfill restoration and mine site remediation. In WA, MBT organics are applied to agriculture.

Biogas and Energy

Anaerobic digestion systems can potentially recover a substantial proportion of the energy in the biodegradable fraction of the waste, depending on the feedstock composition and efficiency of the process. The biogas is usually used to fuel a reciprocating gas engine generator, similar to those used in landfill gas applications. Some pre-treatment of the gas may be required to prevent corrosion and damage of the engine. The net export energy may vary anywhere between 75 and 225 kWh of electricity per tonne of waste input, depending on the waste feedstock, type of process and scale of the process[xiv]. Additional heat energy may be available for use in the AD process or can be exported to other users.

It is also possible to use the biogas in other applications if the quality is upgraded, such as compressing it to substitute for compressed natural gas as a vehicle fuel or using it to fuel gas turbines which have a higher electrical conversion efficiency

Other notable outputs from the MBT process may include leachate and wastewater (including liquid digestate from AD), carbon dioxide emissions and water vapour released in composting and drying stages.

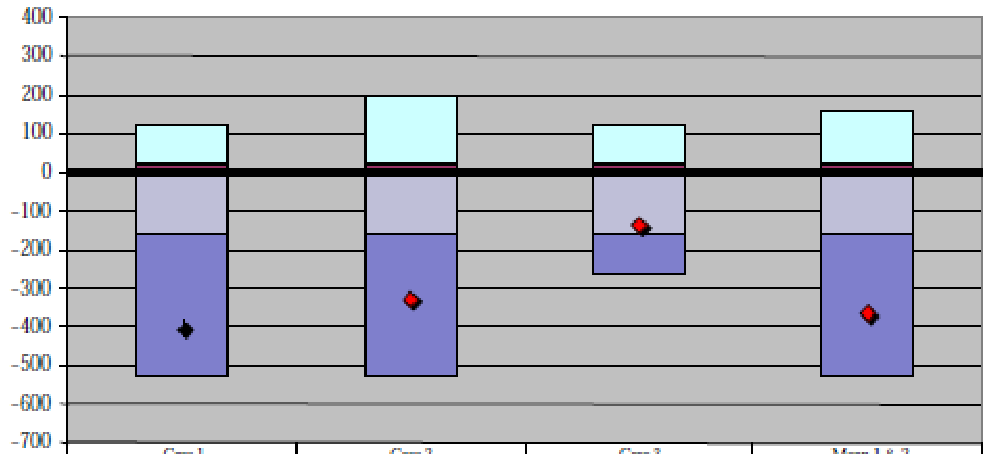
6.5 ENVIRONMENTAL PERFORMANCE

In pursuing diversion of waste from landfill, MBT is seen by some as the preferred alternative over energy-from-waste options which have often attracted significant public opposition overseas and raised concerns by some groups, with respect to precluding higher order recycling options. Environmental groups such as Greenpeace[xviii] have previously publically advocated MBT (producing compost) as their preferred waste management solution for residual waste, particularly over incineration options. In reality, MBT is not a complete solution and in many cases is complementary to EfW solutions or requires landfill disposal of residuals.

Climate Change

A number of studies have been undertaken to assess the relative environmental impact of MBT and other waste management solutions using tools such as life-cycle analysis (LCA). Unfortunately, with the wide variation in MBT configurations and outlets for the products, the studies often make varying assumptions in the modelling and arrive at different conclusions, which will not be relevant to all MBT options. Juniper [xix] notes that "*the environmental performance of an individual MBT facility is very dependent on the specific process configuration… the fate of the outputs from the plant and the way it is managed.*"

A report for the European Commission in 2001[xx] provided one of the most comprehensive assessments of the climate change impact of different waste management options including a number of MBT variants. The figure below, extracted from the report, shows the overall greenhouse impact of MBT with landfilling of the residuals in three cases: (1) highly stabilised waste with minimal gas capture; (2) less stabilised waste with 25% gas capture and (3) highly stabilised waste used as daily cover material. The chart shows the breakdown of greenhouse impact (kg CO2-e per tonne of MSW processed) including positive carbon fluxes (e.g. landfill gas, transport, energy use) and negative carbon fluxes (e.g. carbon sequestration, avoided energy use). The fourth column shows an average of cases 1 and 2. In each case tested, the overall net flux is negative. The study did not assess the recovery of compost through MBT and application to land.



	Case 1	Case 2	Case 3	Mean 1 & 2
N2O	0	0	0	0
CH4	97	171	97	134
carbon sequestered	-364	-364	-99	-364
transport CO2	5	5	5	5
avoided energy and materials	-162	-162	-162	-162
energy use CO2	22	22	22	22
process CO2	0	0	0	0
Net flux	-403	-329	-137	-366

Figure 10: Breakdown of greenhouse impact of MBT with landfilling of residuals and recycling of metals in kgCO2-e per tonne of MSW processed (AEA[xx])

In general, the direct carbon emissions from an MBT facility originate from biomass carbon (biogenic) and are therefore considered to have a negligible global warming impact. These arise from the aerobic decomposition of organic matter and, in the case of AD, the combustion of biogas. Other direct emission sources will include vehicles and mobile plant. Electricity consumption and therefore indirect carbon emissions can be significant, particularly in aerobic composting systems. Major power consumption will come from shredders, compost aeration fans and odour control and ventilation fans.

Air Emissions

Juniper[xix] provides a concise discussion of the environmental impacts of MBT, which are summarised below. Aside from carbon emissions, the primary air emissions from an MBT plant may include volatile organic compounds (VOCs), other odourous compounds, bio-aerosols and dust particulates. Modern facilities are fully enclosed and incorporate negative pressure systems which are generally effective at capturing odour and dust emissions from the process so that they can be treated to an acceptable level using established abatement technology. Nevertheless, some facilities, including the SMRC plant in Perth, have experienced serious odour problems, which have resulted in temporary closure of the plant at significant financial expense to the operator.

Bio-aerosols are complex mixtures of micro-organisms including bacteria and fungal spores which can be transported in the air and may cause health problems. While bio-aerosols have been found in elevated concentrations near open composting facilities they are unlikely to be a concern when the composting process is fully enclosed and process air is captured and treated.

Other Issues

Other emissions may include wastewater or leachate from the biological process, odour treatment systems and washdown activities. Appropriate design will ensure that wastewater is captured and contained to avoid environmental impact. Such water can usually be reused on-site (e.g. added to compost) but alternatively it may need to be treated on-site or discharged to sewer via a trade waste licence.

Noise may be a concern for some facilities where sensitive receptors are in close proximity, particularly noise associated with the mechanical separation plant and other large mechanical equipment such as aeration fans. Additional noise attenuation measures may be required in some cases.

Management of pest such as flies, rodents and birds should not be an issue given that the waste reception and processing is fully enclosed. Fly problems may arise in cases where waste is stored for excessive periods which is generally only likely in the event of an unexpected extended process shutdown.

Visual Impact

In terms of visual impact of the buildings, MBT facilities are mostly housed in low profile warehouse type structures. The exception is where AD is included in which case large digester tanks will be present and in some technologies, these can be over 30m high. In terms of building footprint, MBT facilities can take up a large area which is mostly determined by the composting stage. Full aerobic composting processes that require a residence time of several weeks will take up the largest area, while bio-drying or AD processes with significantly shorter aerobic stages will need less land. The environment inside composting buildings can be very corrosive to steel cladding (moist and acidic) so some facilities may use alternative cladding systems for these areas.

Footprint

The table below summarises the building footprint and total landtake for the case study facilities in this report and a number of existing MBT facilities in the UK. Although a limited sample, the data shows that AD systems require considerably less building space than aerobic composting systems due to the reduced need for aerobic stabilisation of the organics.

Table 2: MBT Area requirements (UK data adapted from DEFRA[xv])

Facility / Location	Type	Capacity (tpa)	Building Area		Total Landtake	
			Total (m^2)	Area per Capacity (m^2/ 1000tpa)	Total (m^2)	Area per Capacity (m^2/1000tpa)
SITA SAWT	Tunnel Composting	134,000	15,000	112	45,000	336
Southwark, London, UK (MBT only)	Tunnel Composting	87,500	16,200	185	56,000	640
GRL Sydney	Hall Composting	220,000	18,000	82	48,000	218
Farington, Lancashire, UK	Hall Composting	305,000	-		146,000	479
Thornton, Lancashire, UK	Hall Composting	225,000	-		170,000	756
Waterbeach, Cambridgeshire, UK	Hall Composting	110,000	17,750	161	30,000	273
Biffa Leicester	AD	120,000	8,000	67	-	-

Facility / Location	Type	Capacity	Building Area		Total Landtake	
Bredbury, Stockport, UK	AD	135,000	5,900	44	89,000	659
Reliance St, Manchester, UK	AD	100,000	5,900	59	38,000	380

Social Impacts

As noted above, MBT facilities can be a source of odours, dust, noise and additional heavy vehicle traffic which may impact on neighbouring residents and the local community. In siting the facilities, consideration should be given to their impact on visual amenity and the local landscape, given their large volume of the buildings.

MBT facilities tend to need a reasonably large workforce for operations and maintenance, depending on the process and the extent of automation. As such, they tend to provide a good boost to local employment opportunities, both for skilled and unskilled labour.

Traffic

The traffic impacts of an MBT facility can be higher than other disposal or thermal technologies by virtue of fact it is a conversion process and most of the waste that is received at the site is sent out again as products to market. Traffic impacts can be reduced by co-locating the MBT facility with a landfill and/or energy-from-waste plant, reducing the need to transport products and residuals on public roads. Alternatively, traffic impacts can be reduced by transporting waste and products by rail or barge where this is possible, and by making efficient use of back-loading on road vehicles.

6.6 PROBLEMS

One of the most common problems for MBT facilities is odour control. In Perth, the SMRC facility was temporarily shutdown in 2012 as a result of persistent odour complaints. Hyder understands this may have been related to operation of the plant’s biofilter.

Anaerobic digestion of organics derived from mixed waste in MBT facilities has suffered a number of problems in the past. These have related to the accumulation of contaminants (grit, plastics etc.) in the digester as well as the deposition of a calcium based scale. A number of high profile failures have occurred in Europe particularly in the application of wet AD systems to MSW organics. Dry AD systems tend to be more robust in handling the heterogeneous nature of and contamination in MSW organics however wet AD systems have developed in recent years.

The GRL facility in Sydney decommissioned the AD component of their process in 2010, although reportedly for commercial rather than technical reasons, after the high operational and maintenance costs were not justified by the low revenue from power sales.

7 SUMMARY OF WASTE TECHNOLOGY FEATURES

In the project brief, DER identified a number of key features and parameters to be identified for each technology type and case study. This information has been collated in the following summary table. By collating information in this standardised and summary format, a comparison of different waste technologies should be simplified.

Table 7-3 Summary Features – MBT Technology

Technology	1 Process Description	2 Feedstock (type and tonnes)	3 Annual processing capacity (tpa)	4 Place in waste hierarchy	5 Landfill diversion potential (%)	6 Products and residuals
MBT 1 (Tunnel Composting) SITA SAWT	Mechanical pre-sorting comprises manual sorting, shredding, screening and metals recovery (magnets and ECS). Organic fraction is aerobically composted in an enclosed concrete tunnel system, where material is loaded into the tunnels and composted under controlled conditions (aeration, moisture and temperature).Compost is further refined to remove contaminants after maturation on an external pad in large windrows.	One line processes source separated food and garden organics Second line processes residual MSW Small volumes of third party, high organic industrial waste is also composted (poultry litter, biosolids, sewage residues, and industrial organics).	134,000 tpa (~25% SS organics, 75% MSW)	Recycling - Preferred over energy recovery or landfill disposal	45% to 60% Dependent on waste feedstock quality	Compost 20 to 25% Metals (Ferrous and Non-ferrous) 1% Residuals 40 to 50%
MBT 2 (Hall Composting) GRL	Mechanical pre-sorting comprises manual sorting, shredding, screening, air sifting of film plastic and paper and metals recovery (magnets and ECS). Organic fraction is aerobically composted in a hall composting system, where material is placed in a continuous large windrow and automatically mixed and moved by an automated turning system with underfloor aeration.	Residual MSW Facility is capable of processing other feedstocks (C&I, green waste).	220,000 tpa	Recycling - Preferred over energy recovery or landfill disposal, but generally after source separated recycling	55% to 65% Highly dependent on markets for outputs and being able to meet strict product specifications	Compost (Organic Growth Medium - OGM) Metals (Ferrous and Non-ferrous), Paper & Cardboard Rigid Plastics Film Plastics

Technology	1 Process Description	2 Feedstock (type and tonnes)	3 Annual processing capacity (tpa)	4 Place in waste hierarchy	5 Landfill diversion potential (%)	6 Products and residuals
MBT 3 (AD) Leicester MBT, Biffa	Mechanical processing of MSW using shredder, ball mill, screening, magnets, ECS, air sifting and ballistic separator. Products include recyclable metals and RDF. Fine organic fraction transported to separate wet AD facility – 2 stage process of hydrolysis and thermophilic AD. RDF to European EfW, digestate to remediation uses.	Residual MSW Plus some liquid organic waste direct to AD (~100 tpd)	120,000 tpa for the mechanical stage 40,000 tpa for the AD plant	Recycling plus energy recovery – preferred over landfill disposal, but generally after source separated recycling	Around 77% overall diversion (18% rejects to landfill from mechanical stage, 14% rejects to landfill from AD)	Metals (Ferrous and Non-ferrous) ~ 7% AD Digestate ~ 10% of AD input, or 3.3% of overall inputs RDF ~ 42% of inputs (currently to Europe) Biogas / losses ~ 25% Biogas to power ~ Generates ~1.5MW, exports 0.7MW average Note – liquid digestate and heat recycled in process

Technology	7	8	9	10	11	12	13
	Capital cost[(a)]	Operational cost	Gate fees	Set-up timeframe	Lifespan	Technology/ facility footprint	Buffer
MBT 1 (Tunnel Composting) SITA SAWT	$50 million	$50-90 per tonne (excluding disposal of residuals and capital depreciation)		Approximately 18 month construction Approximately 3 month commissioning and ramp up	25 year	Total Process Building footprint approximately 15,000 m^2 Total site area approximately 45,000 m^2	Facility is located in a rural / industrial area – nearest residential neighbours (rural) are >1km away. The plant is adjacent to a landfill site.
MBT 2 (Hall Composting) GRL	Total $100 million	$120-150 per tonne (excluding disposal of residuals)	No gate fees - the facility is exclusively supplied by SITA under a 25 year contract and is unable to accept third party waste	Approximately 6-month design and procurement Approximately 12-month construction Approximately 8-month commissioning and ramp up	25 year PPP contract (finance, build, own, operate, transfer)	Total Process Building footprint approximately 16,000m^2 Other buildings (admin, lab, workshop, etc.) approximately 1000m^2 Total site area approximately 55,000 m^2	Facility is located in an industrial area – nearest residential neighbours (rural) are 850 m away. Other commercial/ industrial facilities within 100-150 m. The plant is adjacent to a landfill site and green waste composting operation.

Technology	7	8	9	10	11	12	13
	Capital cost(a)	Operational cost	Gate fees	Set-up timeframe	Lifespan	Technology/ facility footprint	Buffer
MBT 3 (AD) Leicester MBT, Biffa	Not provided – reported cost 20 million GBP (2003) ~ $320 per tpa capacity	Not provided	Not provided – the facility exclusively serves one council with only minor amounts of 3rd party liquid waste.	18 months construction and commissioning	25 year PFI contract	Total buildings: 8,000m^2	Bursom (Mechanical) facility within an industrial estates but within 100-150m of residential properties. AD (Wanlip) is within a sewage treatment plant and 500m from residential.

Notes: (a) Capital cost per tonne capacity is based on original reported capital cost, escalated by 2.5% per annum to 2013 dollars and divided by total original plant capacity (tpa). In the case of the UK facility, today's approximate exchange rate of 1.5 AUD/GBP has been applied.

Technology	14	15	16	17	18
	Emissions	Environmental impacts	Social impacts	Supporting technology required	Risks
MBT 1 (Tunnel Composting) SITA SAWT	Process air and odours – all process buildings sealed and operated under negative pressure – air is captured and treated through biofilters. Generally no wastewater / leachate – reused to moisten compost. Excess leachate may be generated in periods of high rainfall and require offsite disposal. As the process is considered to offset the generation of methane in a landfill, it is eligible for carbon credits until 1 July 2012 under the Carbon Farming Initiative.	Odour from internal processes is adequately managed by the existing air capture and treatment systems (negative pressure ventilation and biofilter) Some odour issues arise from external, uncovered maturation of compost under extended or extreme wet weather conditions. High energy consumption. No noise or dust issues reported. Water use is minimised by capturing stormwater. Wastewater and leachate is generally recycled to the compost process where possible.	Employs around 40 people total in operations and maintenance of the plant. With no close residential neighbours, community impacts are limited. Odours are the main impact.	Source separation of organics stream, however can process mixed residual MSW with no pre-sorting required, i.e. works with existing 2- or 3-bin collection systems	Markets for products and compliance with quality standards (particularly compost). Diversion performance is highly dependent on feedstock composition. Odour emissions are a risk to the operation if ventilation and biofiltration systems fail or underperform.

Technology	14 Emissions	15 Environmental impacts	16 Social impacts	17 Supporting technology required	18 Risks
MBT 2 (Hall Composting) GRL	Process air and odours – all building sealed and operated under negative pressure – air is captured and treated through biofilters. No wastewater / leachate – reused to moisten compost. Stormwater is captured, including first-flush system, and used in the composting process. As the process is considered to offset the generation of methane in a landfill, it is eligible for carbon credits under the Greenhouse Friendly program and Carbon Farming Initiative. A credit of approximately 0.6t CO_2-e is earned for each tonne of waste processed, compared against landfill disposal with gas capture.	Odour is adequately managed by the existing air capture and treatment systems (negative pressure ventilation and biofilter) High energy consumption (around 55-65 kWh per tonne waste processed). Water use is minimised by capturing stormwater and rainwater from roofs. Wastewater is generally recycled to the compost process where possible.	Employs around 80 people total in operations and maintenance of the plant. With no close residential neighbours, community impacts are limited. The site is adjacent to M4 motorway so has access to a road network that can accommodate the large truck movements.	None – no pre-sorting or processing required, works with existing 2- or 3-bin collection systems	Markets for products and compliance with quality standards (particularly compost). Diversion performance is highly dependent on feedstock composition and future performance may be affected by increase in 3-bin collection systems. Maintenance of imported equipment must be carefully managed. Feedstock supply and quality risks are mitigated in contract – appropriate risk sharing Odour emissions are a risk to the operation if ventilation and biofiltration systems fail or underperform.
MBT 3 (AD) Leicester MBT, Biffa	Odour is an issue due to poor building design. Excess wastewater from AD is discharged to sewer. Exhaust emissions from biogas CHP engines.	Odour is contained and treated but some issues with building fabric at Bursom – ongoing odour complaints. Wastewater discharge requiring treatment.	Odour emissions with close residential neighbours Traffic impacts increased by two remote sites.	None – no pre-sorting required, works with existing 2- or 3-bin collection systems	Markets for products Mechanical technology has matured since ball mill was selected - high contamination rate in organics with glass and fibre.

Technology	19	20	21	22	23	24	25
	Applicability to local WA context	Technology maturity	Availability rate	Regional penetration	Benefits	Barriers	Other
MBT 1 (Tunnel Composting) SITA SAWT	High – contributes to diversion and can complement other technologies (EfW).	Proven – No identical plants and no other MBT plants with tunnel composting in Australia, but numerous similar facilities overseas.	Around 90% based on planned operational hours. Most mechanical issues are fixed within 24 hours.	Eight large scale MBT facilities across Australia processing mixed MSW, three in WA, plus NSW and QLD – no others use tunnel composting.	Resource recovery from mixed residuals, diversion of organics from landfill, recovery of recyclables (metals), complements source segregation, can complement EfW, flexible process to waste feedstock, compost can improve soil quality and rehabilitate degraded land (e.g. mines).	• Management of odours and community concerns • Markets for outputs Disposal of residuals.	

Technology	19 Applicability to local WA context	20 Technology maturity	21 Availability rate	22 Regional penetration	23 Benefits	24 Barriers	25 Other
MBT 2 (Hall Composting) GRL	High – contributes to diversion and can complement other technologies (EfW).	Proven – 3 commercial facilities (1 in Sydney, 2 in the UK).	85-90% based on planned operational hours. Planned weekly maintenance is not included in this rate (i.e. 10-15% unplanned downtime).	Eight large scale MBT facilities across Australia (NSW, WA and QLD), of which most use hall composting.	Resource recovery from mixed residuals, diversion of organics from landfill, recovery of recyclables, complements source segregation, can complement EfW, flexible process, compost can improve soil quality.	Odour management and community concerns, markets for outputs, disposal of residuals – not a complete solution.	
MBT 3 (AD) Leicester MBT, Biffa	Yes, but ball mill technology may not be preferred.	Proven – numerous wet and dry AD facilities operating in UK and Europe.	Around 90% uptime.	No MBT-AD facilities currently in Australia processing MSW. GRL plant in Sydney ceased AD process due to commercial environment (low power prices), AnaeCo MBT-AD plant currently under construction in Perth.	Same as above plus recovery of renewable energy (biogas) and net export of electricity (rather than consumption).	Markets for MSW derived digestate very limited in UK – remediation only. Process issues with use of ball mill combined with wet AD.	

8 STUDY SYNOPSIS

Technology	1	2	3
	Process	Feedstock (type and tonnes)	Annual processing capacity (t/yr.)
MBT Study Synopsis	Mechanical sorting comprising various combinations of shredding, crushing, screening, air sifting, ballistic separation, metals recovery and hand-sorting. Biological treatment of the fine organic fraction in aerobic in-vessel composting (hall or tunnels) or anaerobic digestion.	Mainly residual MSW May be supplemented with C&I waste or other organic rich streams.	100,000 to 300,000 tpa.
Technology	4	5	6
	Place in waste hierarchy	Landfill diversion potential (%)	Products and residuals
MBT Study Synopsis	Recycling - Preferred over energy recovery or landfill disposal. Also energy recovery in case of AD.	50 to 65% Dependent on waste composition.	Compost or organic growth medium Metals (Ferrous and Non-ferrous) Plastics Paper & Cardboard RDF Methane or energy (in the case of AD)
Technology	7	8	9
	Capital cost	Operational cost	Gate fees
MBT Study Synopsis	$50 to 100 million $650-$1000 per tpa capacity	$50 to $120 per tonne.	Not available –generally competitive with alternatives (landfill).

Technology	10 Set-up timeframe	11 Lifespan	12 Technology Footprint
MBT Study Synopsis	6-12 months to design and procure equipment 12-18 months construction 3-6 months commissioning	20-30 years (25 years typical).	Buildings: 50-185 m^2 per 1000tpa capacity (lower range for AD). Total Land: 220-750 m^2 per 1000tpa capacity (site dependent).
Technology	**13 Buffer**	**14 Emissions**	**15 Environmental impacts**
MBT Study Synopsis	Generally > 500m to residential, but depends on local guidelines	Odours and process air Excess leachate discharge Exhaust emissions from engines (AD only)	Odour emissions High energy consumption (aerobic composting) Minimal noise and dust
Technology	**16 Social impacts**	**17 Supporting technology required**	**18 Risks**
MBT Study Synopsis	Odour Emissions Traffic Impacts – in and outbound materials Employment – labour intensive operations and maintenance, skilled and unskilled	Depends on technology See Section 7.	Markets for products and compliance with quality standards (particularly compost). Diversion performance is highly dependent on feedstock composition. Odour emissions are a risk to the operation if ventilation and biofiltration systems fail or underperform. Maintenance of imported equipment must be carefully managed. Feedstock supply and quality risks are mitigated in contract – appropriate risk sharing

Technology	19	20	21
	Applicability to local context	Technology maturity	Availability rate
MBT Study Synopsis	Highly applicable - contributes to diversion targets and can complement other technologies (EfW)	Proven – ~ 330 plants worldwide, mostly in UK and Europe. 8 large scale plants in Australia	85-90% of planned uptime. Potential to make up lost time by running extra shifts.
Technology	**22**	**23**	**24**
	Regional penetration	**Benefits**	**Barriers**
MBT Study Synopsis	Eight large scale MBT facilities across Australia processing mixed MSW, three in WA, plus NSW and QLD	Resource recovery from mixed residuals, no change in customer behaviour, diversion of organics from landfill, recovery of recyclables (metals), complements source segregation, can complement EfW, flexible process to waste feedstock, expandable process, compost can improve soil quality and rehabilitate degraded land	Odour management and community concerns, markets for outputs, disposal of residuals – not a complete solution

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