2017 Briefing Report:
Mechanical Biological Treatment – 15 Years of UK Experience

September 2017
This report has been prepared by Tolvik Consulting Ltd on an independent basis using our knowledge of the current UK waste market and with reference inter alia to various published reports and studies and to our own in-house analysis. This knowledge has been built up over time and in the context of our prior work in the waste industry.

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EXECUTIVE SUMMARY

◆ 15 years on from the signing of the first major MBT projects in the UK, and following the recent announcement of the termination of the Greater Manchester waste project, this report independently reviews the UK’s experience in using Mechanical Biological Treatment (“MBT”) in the treatment of Residual Waste.

◆ In 2007, DEFRA identified five potential outcomes for a local authority in procuring an MBT based treatment solution. They were to increase recycling, reduce the tonnage of waste to landfill, prepare a “compost like output” (“CLO”) suitable for land remediation, generate biogas and/or to prepare a Refuse Derived Fuel (“RDF”) to a specification. MBT was seen by many as an alternative to energy from waste (“EfW”).

◆ A report prepared by Juniper as early as 2005 recognised that, for political reasons, MBT would have an important role to play in the UK waste management sector. Seen by many at the time as endorsing MBT as a solution, in fact the report clearly identified many of the challenges the MBT sector has since encountered.

◆ Based on available data, it is estimated that total Residual Waste inputs to MBT facilities in the UK in 2015/16 were circa 2.6Mt – or around 9% of the total market. Almost all of this Residual Waste was delivered by local authorities under term contracts. The total capacity currently operational or in construction is estimated to be around 4.0Mt.

◆ Recycling – reported recycling rates for MBT facilities currently range between 1% and 18% of all inputs, but in the majority of cases reviewed the recycling performance at MBT facilities has consistently fallen below contractual targets. This is for a number of reasons – including increasing pressure on recyclate quality (secondary materials extracted from Residual Waste are almost always more heavily contaminated than source segregated materials) and the changing composition of Residual Waste.

◆ Reduced tonnage to landfill – either by reducing mass or biodegradability. With the UK now expected to comfortably meet its 2020 Landfill Directive targets, using MBT to reduce the biodegradability of waste to landfill yields little or no commercial benefit. Using MBT to reduce the moisture content of Residual Waste prior to landfill yields some commercial benefit, but with the cost of landfill over £100/t, in this configuration MBT is costly compared with alternatives.

◆ CLO for land remediation – with tightening environmental legislation reducing potential land applications, opportunities for long term, sustainable markets for CLO have been found to be very limited and much of the CLO which is produced is now used solely for landfill restoration.

◆ Biogas generation - the average reported “load factor” (power generation divided by installed capacity) for larger MBT facilities producing biogas is just 21%. By way of reference a typical food waste Anaerobic Digestion (“AD”) facility would have an average load factor of at least 70%. The low biogas yields are largely due to less food waste in the Residual Waste stream and technical issues relating to anaerobic digestion of Residual Waste.

◆ RDF production – the market for RDF (both domestic and export) has expanded rapidly in the last 5+ years. However the market for a high calorific value, refined RDF (as is generally produced by MBT facilities) is relatively limited and, as a result, for those MBTs without a contractually secure outlet, the delivered cost of RDF has risen from an expected £35-£40/t (to cement kilns) to as much as £85/t (RDF for export).

◆ The 2017 WRAP Gate Fee report suggested that for local authorities median MBT gate fees were £88/t – a little lower than the median gate fees for EfW. However, the WRAP report acknowledged that the integrated nature of such contracts means that it is very difficult to assess a per tonne gate fee for an MBT facility in isolation.

◆ This report has therefore considered the total cost of waste management for 29 Waste Disposal Authorities in England for which data was available. Whilst not necessarily the most robust
analysis, it is unlikely to be a co-incidence that the five authorities with the most expensive total waste management cost per tonne of Residual Waste generated had primarily contracted an MBT based Residual Waste solution. In context, only 7 of the 29 Waste Disposal Authorities were regarded as having primarily contracted an MBT based solution.

- Furthermore, using confidential data from a number of projects, a cost model was developed for a generic 120ktpa MBT facility producing RDF based on 2017 costs. This suggests a gate fee of around £125/t; with more prudent assumptions this rises to £138/t. By comparison, average gate fees for smaller new EfWs are more typically around £95/t.

- On the basis of the available evidence it is difficult not to conclude that in general for local authorities (the main customers for MBT), MBT led Residual Waste solutions have proved to be more expensive than EfW based alternatives.
1. INTRODUCTION AND CONTEXT

1.1. Background

The decision, 15 years ago, by East London Waste Authority (“ELWA”) to award Shanks a long term waste contract based on the treatment of Residual Waste in a Mechanical Biological Treatment (“MBT”) facility along with the signing of the 25 year MBT based contract between Biffa and Leicester City Council represented key moments in the development of MBT in the UK.

And 2017 sees the commissioning of DONG Energy’s “first of a kind” 120ktpa REnescience facility in Cheshire which uses DONG’s proprietary enzyme based MBT process.

Drawing from a wide range of information sources, this report independently reviews the track record of MBT in the UK since 2002, identifies some of the successes and failures and, most significantly, the key lessons learnt.

It is aimed both at those with an interest in MBT in the UK and international clients keen to learn from the UK’s experience of the technology.

1.2. What is MBT?

In this report, MBT is defined as any waste treatment facility designed for the processing of untreated Residual Waste through mechanical and biological means.

It excludes Residual Waste treatment facilities which solely use mechanical processes (“Dirty MRFs”) but includes facilities which incorporate autoclaves and associated treatment. It excludes In Vessel Composting and Anaerobic Digestion (“AD”) facilities designed solely for the treatment of source segregated organic wastes – e.g. food waste, garden waste, industrial effluents etc.

![Figure 1: An Illustration of the potential MBT Options](Source: DEFRA, with amends)

It is generally accepted that MBT originated in Germany in response to restrictions on landfilling unprocessed Residual Waste. It was seen as an alternative to Energy from Waste (“EfW”), extracting recyclables from Residual Waste and reducing the greenhouse gas effects associated with the landfilling untreated waste.
1.3. DEFRA Waste Technology Briefs

To assist local authorities in making informed decisions to meet EU recycling and landfill diversion targets, DEFRA (UK Department for Environment, Food and Rural Affairs) produced a series of “Waste Management Technology Briefs”. The first edition on MBT, issued in 2007 and subsequently updated in 2013 identified that “a key advantage of MBT is that it can be configured to achieve several different aims” with the potential to:

- **Increase Recycling** – by diverting a proportion of Residual Waste going to landfill through mechanical separation into materials for recycling;
- **Reduce Biodegradability** – (specific to EU landfill diversion targets) reduce the biodegradability and volume of Residual Waste to landfill;
- **Permit the application of waste to land** – by stabilising Residual Waste such that it could be used as compost like output (“CLO”) for restoration purposes;
- **Generate Biogas** – converting the organic fraction of Residual Waste into a combustible biogas for energy recovery; and/or
- **Prepare RDF** - dry/mechanical separate Residual Waste, so producing a high calorific, fraction for use as refuse derived fuel (“RDF”).

Using this as a framework, this report will review the performance of the UK MBT sector against these five target outcomes.

1.4. The Juniper Report

In 2005, prior to the DEFRA Brief, and in recognition an increasing interest in the technology, Juniper Consultancy Services released an independent, comprehensive 350+ page report entitled “Mechanical Biological Treatment: A Guide for Decision Makers – Policies, Processes and Markets”. The report, funded by SITA Environmental Trust, provided a comprehensive view of what then was a rapidly developing UK MBT market.

The Juniper Report covered 28 facilities in 8 countries as a snapshot of 27 technologies operating 80 operational MBT reference facilities and took over a year to compile. The report identified 12 of the 27 as “fully commercial”.

<table>
<thead>
<tr>
<th>Target Outcome</th>
<th>Selected Juniper Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase Recycling</td>
<td>&quot;With regards to recycling, MBT only provides a modest increase in the amount of dry recyclables&quot;</td>
</tr>
<tr>
<td>Reduce Biodegradability and volume to landfill</td>
<td>&quot;All of the generic process designs....will reduce the biodegradable content of the input waste.... the extent to which is it reduced is inextricably linked to the type of output the process is designed to produce&quot;</td>
</tr>
<tr>
<td>Use as CLO and application to land</td>
<td>&quot;The policy framework affects the viability....of land remediation and landscaping applications....and has significant uncertainties today at both the EU and UK level&quot;</td>
</tr>
<tr>
<td>Biogas generation</td>
<td>&quot;MBT configurations that focus on biogas production are often more attractive....Plastics have posed technical challenges....which affect the performance of the digester and biogas yield...&quot;</td>
</tr>
<tr>
<td>Preparation of RDF</td>
<td>&quot;Cement companies will often prefer other types of waste derived fuel...&quot;</td>
</tr>
</tbody>
</table>

Figure 2: Extracted Comments from Juniper Report – Executive Summary

As the Juniper Report noted the rationale behind the development of MBT in the UK was very clear:

“One of the prime motives for the development of MBT.......to find an alternative to incineration as a route to reducing the amount of biodegradable waste to landfill. The enthusiasm for MBT is predominantly due to a political desire to avoid the use of incineration – regardless of its merits as a proven, safe and economic approach to maximising resource recovery from waste when combined with appropriate levels of recycling.”
The report also concluded “MBT is an important option for the waste management sector.”

Figure 2 sets out the key observations within the Juniper Report with regards to the potential ability of MBT to deliver the five potential outcomes identified by DEFRA in their Technology Brief.

In reviewing the Juniper Report it is notable the extent to which the opportunities and challenges associated with MBT had been identified as early as 2005.

1.5. About Tolvik and the Author

Tolvik Consulting was set up in 2009 to provide independent market analysis and commercial due diligence to the waste and bioenergy sectors in the UK. Its customers include many of the UK’s largest waste companies, project developers and a number of debt and equity investors.

Adrian Judge, the author of this report, started his career in the waste sector with Cory Environmental in 2000. One of his earliest projects in 2004 was to lead Cory’s MBT based bid for a long term Residual Waste contract with Gloucestershire County Council; the procurement was subsequently abandoned.

More recently Adrian was Managing Director at the UK Green Investment Bank. There he led the bank team providing senior debt finance to the Wakefield MBT contract and in supporting a bidder in the North London Waste Authority Part A MBT based PFI contract.

This report has been subject to peer review by an individual with recent experience at developing and operating several MBT facilities in the UK.
2. THE UK MBT MARKET

2.1. MBT Capacity in the UK

With MBT being a term used to describe a wide range of different technologies and processes, MBT facilities are not restricted to a specific type of environmental permit or waste management licence. In order to identify MBT facilities, it is therefore necessary to use a range of information sources. Whilst Tolvik has taken all reasonable steps to identify all MBT facilities in the UK with a capacity greater than 25ktpa, the analysis is therefore not guaranteed to be fully comprehensive.

DEFRA maintains a list of waste infrastructure in England – its “Residual Waste Treatment Infrastructure Project Listiii. The December 2016 edition identifies 3.89Mt of MBT capacity in operation or construction. However, further analysis reveals that this includes 0.64Mt of “Dirty MRF” capacity – i.e. facilities which do not have a biological processing stage and which are excluded from this report.

Based on the available information, it is estimated that the UK MBT market comprises 2.86Mt of MBT capacity of which is currently operational. There is a further 1.15Mt currently in construction/commissioning - the much delayed Courtauld Road MBT in Essex, DONG Energy’s Northwich facility and four MBT facilities being co-developed as pre-treatment processes alongside new EfWs. Summary details for all MBTs can be found in Appendix 1.

<table>
<thead>
<tr>
<th>Status</th>
<th>Capacity (Mt)</th>
<th># of Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational</td>
<td>2.86</td>
<td>23</td>
</tr>
<tr>
<td>In Construction</td>
<td>1.15</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>4.01</td>
<td>29</td>
</tr>
<tr>
<td>Ceased Operation</td>
<td>1.02</td>
<td>6</td>
</tr>
</tbody>
</table>

Based on available data, it is estimated that total Residual Waste inputs to these MBT facilities in 2015/16 were circa 2.6Mt – or around 9% of the total Residual Waste market. Almost all of this Residual Waste was delivered by local authorities under long term contracts.

2.2. MBT - Desired Outcomes

Using a range of sources, it is also possible to identify which of the five target “outcomes” are relevant to the 29 MBTs which are currently in operation or construction. Most have more than one such target outcome. These results are summarised in Figure 4 showing a focus on recycling and RDF production.
3. OPERATIONAL PERFORMANCE REVIEW

3.1. Recycling

From the start one of the key attractions for local authorities procuring MBT based Residual Waste solutions was the potential for MBT to make a significant contribution to recycling rates. Figure 5 shows an early document released during MBT construction by one local authority which suggested that 25% of the incoming Residual Waste will be able to be recycled – including aggregates, glass, paper and card (into composting), metals and plastics.

![Figure 5: How an MBT plant works](Source: Anon)

However, as DEFRA’s 2007 Technology Brief specifically noted:

“Recyclables derived from the various MBT processes are typically of a lower quality than those derived from a separate household recycle collection system and therefore have a lower potential for high value markets. The types of materials recovered from MBT processes almost always include metals (ferrous and non-ferrous) and for many systems this is the only recyclate extracted.”

The Technology Brief then went on to identify the issues associated with extracting recyclables from the input Residual Waste stream specifically:

- **Glass** – the opportunity to recycle glass into high value products was discounted and the Technology Brief instead identified that, subject to achieving a suitable quality material, recovered glass could find application for use as a low grade aggregate;

- **Plastics** – the Technology Brief identified that the use of optical sorting technology offered the potential to recover plastic by polymer type but noted that capital costs associated with installing such technologies were high, and cost/benefits of adopting them would be significantly influenced by the effectiveness of any recycling achieved upstream through kerbside collection systems;

- **Textiles, Paper/Card** – the Technology Brief noted, if extracted, these materials extracted via MBT were unlikely to receive an income as a recyclate.

In terms of assessing the recycling performance of MBTs in the UK, it is worth noting that the definition of the “contracted” recycling performance (i.e. as required under contract with the local authority) may differ from the recycling performance used in official returns. A typical example would be the classification of organic “fines” used in land remediation/improvement projects which are not eligible for inclusion in official recycling statistics but which have been contractually accepted as “recycling”.

This report has considered, where reported, the “contracted” recycling performance as arguably this better represents the expected outcome from the local authority client.
The highest (self-) reported recycling performance for an MBT in the UK which Tolvik has been able to identify is 18%.

<table>
<thead>
<tr>
<th>Recycled Material</th>
<th>Range reported</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals (Ferrous and Non Ferrous)</td>
<td>1 - 3%</td>
<td>All MBTs recover metals – may include metal recovery from IBA from resultant thermal treatment of outputs</td>
</tr>
<tr>
<td>Heavies (Glass and Stone)</td>
<td>0 – 8%</td>
<td>Generally need to pay (reduced) disposal cost</td>
</tr>
<tr>
<td>Plastics</td>
<td>0 – 6%</td>
<td>With low oil prices, poor quality and reduced demand from China, very limited available markets</td>
</tr>
<tr>
<td>Organic Fines</td>
<td>0 – 9%</td>
<td>Used to produce CLO for land remediation</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1 – 18%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6: Reported Recycling Rates at UK MBTs

Where publicly reported, for the majority of MBTs reviewed the recycling performance has consistently fallen below contractual targets, largely due to difficulties in finding suitable markets for the “recyclates”.

It is understood that some local authorities have written to DEFRA suggesting that leachate and evaporation from the MBT process should be treated as recycling. As yet there has been no definitive decision on this, however the challenge is to prove that these losses occur from recycling, rather than disposal, process.

**Case Study – Barnsley, Doncaster and Rotherham (“BDR”)**

In 2012 Shanks, in a joint venture with SSE, signed a 25 year contract with the BDR Partnership for the treatment of Residual LACW from the three local authorities. The contract involved the construction of an MBT facility at Bolton Road, Manvers in Rotherham (which includes a dry anaerobic digestion system). The first waste was accepted at the MBT in February 2015 and full service commencement was achieved in July of the same year.

In a paper prepared for the partnership authorities in January 2017, the MBT recycling performance for the period April 2016 to December 2016 was reported to be 11.2% against a target of 19.0%.

<table>
<thead>
<tr>
<th>% of input Residual Waste</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals (Ferrous and Non Ferrous)</td>
<td>1.11%</td>
</tr>
<tr>
<td>Glass and Stone</td>
<td>1.45%</td>
</tr>
<tr>
<td>Plastic</td>
<td>3.37%</td>
</tr>
<tr>
<td>Fines</td>
<td>3.42%</td>
</tr>
<tr>
<td><strong>Total on site</strong></td>
<td><strong>9.35%</strong></td>
</tr>
<tr>
<td>Metals recovery from EfW</td>
<td>1.17%</td>
</tr>
<tr>
<td>Third Party</td>
<td>0.66%</td>
</tr>
<tr>
<td><strong>Total Recycled</strong></td>
<td><strong>11.18%</strong></td>
</tr>
</tbody>
</table>

Figure 7: BDR MBT Recycling performance Apr-Dec 2016

The report noted that, aside from various technical issues which limited the generation of recyclate, the market for plastics was poor and the contractor was having to pay to get plastics reprocessed.

It was subsequently reported that for the year as a whole the recycling rate had risen, following various improvements by the contractor, to 12.8%, but that remained significantly below the contractual target. However, it is understood that there is an expectation for this particular project that as the leachate from the MBT process is an input into the dry AD system (the outputs being biogas and CLO) DEFRA will accept moisture loss as “counting” towards recycling.
3.2. Reduce Biodegradability and Volume to Landfill

In the mid 2000s there were real concerns that the UK would be unable to meet the 2020 EU Landfill Directive target which set limits on the tonnage of biodegradable waste which could be sent to landfill. As a result, and in addition to rising landfill tax, in 2005/6 the government introduced Landfill Allowances Trading Scheme. This set local authorities with annual limits on the tonnages of waste they could send to landfill. The devolved regions set in place similar measures. Local authorities who landfilled in excess of their limit were subject to a potential fine of £150/t.

Since the targets were set with respect to the biodegradable element of Residual Waste, MBT processes which reduced the biodegradability of input waste as well as reducing its volume were an attractive option to local authorities which did not support EfW.

However, by 2011 the UK was sufficiently on track to meet the EU targets and the government abolished Landfill Allowances Trading Scheme; and whilst a reduced tonnage of waste to landfill continued to have a benefit to local authorities, a key driver in commissioning MBT had been removed.

Using a wide range of data sources of varying accuracy, an analysis of the average annual moisture loss at operational MBT facilities in the UK suggests performance ranging from between 1 – 34% with an input weighted average loss of 20.2%. Across all UK current MBTs this is the equivalent of a total mass reduction of 0.42Mt. This figure is used by Tolvik in its mass balance calculations for the UK Residual Waste market.

Those MBTs designed to maximise moisture loss through forced aerobic degradation of the waste are achieving a reduction in mass in excess of 22.5%, whilst those MBTs which focus upon biogas production are all achieving a mass reduction of below 10%. This highlights that in general an MBT can be configured to maximise the generation of biogas or maximise mass loss, but not both.

It is also worth noting that for plant operators there is a commercial balance to be struck between the retention time in the biological stage and the operational capacity of an MBT facility. A long retention time will increase mass loss but reduce capacity.

![Reported Mass Loss](image)

Figure 8: Reported Mass Loss as % of input Tonnage for UK MBTs

**Case Study – Cambridgeshire**

In 2008 Cambridgeshire County Council signed a £730m contract with Donarbon (who were later acquired by Amey) which included the construction of a large MBT at Waterbeach.

The intention was that, as the local authority was not supportive of EfW, aside from making a significant contribution to recycling, the MBT plant would reduce both the tonnage and biodegradability of waste sent to landfill.
In 2012 it was announced that the MBT had already helped to save £3m of landfill costs. In 2015/16, uniquely for MBT in the UK none of the outputs from Waterbeach MBT were sent for thermal processing.

By September 2016 it was reported that the contract was being reviewed in order to identify cost savings as the overall cost of the solution was relatively expensive. Options to be considered included the removal of the MBT from the overall solution, refinancing the project and/or switching to RDF production.

In August 2017 Amey confirmed their plans to develop a large scale EfW on the same site.

3.3. Application to Land

By configuring an MBT to process the mechanically separated organic fraction it is possible for an MBT to produce a partially stabilised CLO/digestate material. The 2007 DEFRA Brief identified:

“The potential applications of these outputs are dependent upon their quality and legislative / market conditions. CLO and digestate has the potential to be used as a source of organic matter to improve certain low quality soils, e.g. in the restoration of brown field sites, or for landfill cap restoration.”

The 2007 Brief also went on to identify the potential scale of the market for CLO/digestate in excess of 11 million tonnes. However, with developing UK legislation, an updated version of the Technology Brief issued in 2012 was significantly less bullish and pointed out that:

“CLO or digestate from mixed waste processing will not qualify for British Standards Institute (BSI) Publicly Available Specification PAS100 and PAS110 respectively, and is unlikely to be applicable for inclusion in recycling rates/targets..... Trials on mixed waste derived materials have reported large amounts of physical contaminants (e.g. glass) and levels of potentially toxic elements above limits for the standard PAS 100.... The use of CLO produced from mixed MSW on agricultural land is currently not permitted by the EA. If an outlet cannot be found for the CLO then it may have to be disposed to landfill. This will incur a disposal cost and any remaining measured biodegradable content will affect local authority landfill diversion targets”

In practice, other than for very specialist land remediation schemes (e.g. china clay workings in Cornwall) and landfill restoration (which is increasingly at risk that the CLO will in fact be subject to landfill tax), there is no significant markets for CLO in the UK and so MBT facilities are increasingly configured solely for RDF production.
Case Study – Lancashire and Blackpool

In 2007 Global Renewables was awarded a 25 year PFI contract by Lancashire and Blackpool to develop and operate two large MBT facilities at Thornton and Leyland.

The Global Renewables solution was based on the UR-3R MBT processes which they had developed in Australia and operated at Eastern Creek. Like many MBT processes it initially involved a mechanical separation process. This was followed by a system of large percolators, the purpose of the percolators being to separate and wash the organic waste which was then sent to a compost hall where it was to be transformed into a CLO. The plan was that this CLO would be used to plant 2.5 million trees over the course of the 25 year contract. The liquor from the percolators, rich in organic materials, was then drained off and sent to AD.

The local authorities were strongly against EfW and selected the technology as “Global Renewables Limited had been the only company to offer a biological waste disposal solution that did not require an incineration process”. The 2005 Juniper Report had identified that the technology was “unproven.”

![Thornton MBT](image)

Figure 10: Thornton MBT

In 2014 the local authorities terminated the contract and took control of the facilities. In 2016 the decision was taken to largely close the facilities.

In practice, the two MBT facilities faced a number of challenges:

1. No market for CLO - the expectation that, with time, the CLO would not have to be sent to landfill was over-optimistic. In practice regulations remained in place which meant that the opportunities to use CLO for tree planting were limited. The expectation that 75% of input waste could be diverted from landfill was undeliverable – in 2012 the figure was reported to be just 25% and so the local authorities ended up carrying the additional landfilling cost which meant that the overall solution was very expensive.

2. Changing waste composition - with the roll out of the separate collection of food waste across much of Lancashire, the organic content of the remaining waste sent to the MBT facilities was lower than expected.

3. Technical – there were a series of major mechanical failures and major odour issues, and Global Renewables was fined £150k for breaches of their environmental permit.
3.4. Biogas Generation

One of the key marketed advantages of MBT was the potential for it to be configured to generate renewable energy using the mechanically separated organic element of the Residual Waste stream in an AD process to generate biogas. The DEFRA Technology Brief suggested that biogas “electricity production per tonne of waste input can range from 75 up to 225 kWh, varying according to the feedstock composition, biogas production rates and electrical generation equipment”.

As Figure 11 identifies, including the Lancashire MBT facilities, to date 8 MBTs in the UK have operated with an installed electrical generation capacity of greater than 1 MW. The average reported “load factor” (power generation divided by installed capacity) for these facilities since 2011 is just 21% - a figure distorted by one facility with an average load factor in excess of 60%. By way of reference, a typical food waste AD facility would have an average load factor of at least 70%.

![Biogas Load Factor](image)

Figure 11: Average Biogas Load Factors  Source: Variable Pitch

Whilst such a low load factor is not explicitly a metric of technical underperformance, it seems unlikely to be cost efficient for an MBT facility to be designed with a generation capacity significantly in excess of the expected output (i.e. with a low load factor).

There are a number of potential causes of this apparent underperformance, and most commonly it is reported that the changing composition of Residual Waste – and in particular the lower food waste content as a result of the increased separate collection of food waste – is adversely impacting biogas yields.

Case Study – Greater Manchester

In 2009 Greater Manchester Waste Disposal Authority entered a 25 year contract with Viridor Laing for the management of waste across the city. The solution included 4 MBT facilities with associated AD processing capability, with the AD element “maximising the value of waste processed through the generation of green electricity and reducing the volume of fuel subsequently sent for energy recovery”.

In August 2017 it was confirmed that the contract had been terminated. The operation of the MBT facilities will now revert to the Authority who plan “modifications (which are yet to be fully determined) to the current suite of facilities” in order to save money. The general expectation is that the MBT facilities will either, like Lancashire, be shut or their operations significantly scaled back.
Figure 12 is an extract from the report presented at the 2017 Annual General Meeting of the Authority where it was stated that “in the period when all 4 plants were operational peak outputs were 25% of forecast and generation levels in 2016/17 were 15% of anticipated levels”. The Authority went on to report that there was “limited confidence in the long term reliability or performance of the plants compared to forecast.”

The reasons for the termination of the contract are understood to have been primarily due to economics – the procuring authority has described it as “expensive compared with current market rates” and the underperformance of the MBT and AD facilities.

The key operation issues were:

1. Corrosion – there were significant delays in the final acceptance of a number of project facilities largely due to corrosion defects at the MBT and AD plants; Costain as construction contractor had been engaged in an extensive programme of rectification;

2. Lower than expected recycling – this was due to a number of factors, but the capture of grit and metals at the MBT in particular were poor which meant that the overall recycling performance was only half that expected – as illustrated by Figure 13.
3.5. RDF Preparation

In the mid 2000s the potential outlets for RDF produced by MBT facilities were identified as being:

- Industrial intensive users for power, heat or both (Combined Heat and Power, CHP);
- Cement kilns;
- Co-firing with coal at power stations;
- Co-firing with biomass fuels in conventional technologies;
- Purpose built incinerators with power or power and heat (CHP);
- Advanced Conversion Technologies, such as pyrolysis and gasification.

The expectation then was that the focus would be upon UK co-incineration facilities – particularly cement kilns – and there were concerns that this was a relatively limited market in which RDF would need to compete with other fuels.

Early experience of MBT operators identified that the fuel specification requirements for cement kilns and co-firing facilities were constantly evolving and that, in practice, for an MBT to consistently produce a suitable fuel from an ever-changing local authority feedstock was challenging.

On the face of it, the development of the RDF export market since 2011 and the increase in the number of UK EfW facilities (both using conventional and Advanced Conversion Technologies) would appear to have significantly expanded the potential market for RDF. However the conundrum MBTs face is that, whilst the RDF they produce is “cleaner” and of higher calorific value than untreated Residual Waste, there remain relatively few outlets that truly “value” these attributes. The vast majority of EfW plants are designed to process high quantities of low calorific value fuel and their income model is principally based on the gate fee for their fuel rather than the energy produced.

As a result, whilst capacity has increased to meet demand, for those MBTs without a contractually secure outlet, the cost of RDF has risen from an expected £35-£40/t (to cement kilns) to as much as £85/t (for RDF export).

The recent 2017 WRAP Gate Fee report provides the split for RDF outputs from UK MBT facilities as shown in Figure 14.
Case Study – East London Waste Authority

The ELWA contract is one of the longest running MBT contracts in the UK, and over the period of its operation the configuration of the two MBT facilities have been developed to reflect changing market dynamics.

The original contract was structured to maximise recycling and, with the absence of alternative energy recovery markets, the production of Solid Recovered Fuel ("SRF") for co-incineration. The higher specification of the SRF meant that residence time in bio-drying stage was significant.

As the thermal markets have developed, including the market for RDF exports (with Shanks the first to export from the UK in 2010), production of a lower grade RDF has increased which requires a shorter residence time, allowing the MBTs to “maximise the diversion of waste from landfill”.

To support the production of in excess of 200ktpa of RDF, Shanks made an investment of £2m in new balers in 2016; it was also announced in the same year that Shanks had entered a 10 year contract for the export of 100ktpa to an EfW in the Netherlands.
4. COMMERCIAL CONSIDERATIONS

4.1. Background

The Juniper Report commented:

“Critics of MBT have said that because it is only an interim treatment, the overall costs of an MBT led-solution will always be higher than alternatives. Whilst this will often be the case, we do not think it has to be in every case”

This section of the report considers the relative cost of MBT when set against EfW.

4.2. WRAP Gate Fee Report

The 2017 WRAP Gate Fee report considered the gate fees reportedly paid by local authorities. The report’s authors advised that they had 18 responses to their survey relating to MBT facilities, which suggested that the median gate fee for MBT was £88/t compared to £85/t last year, showing no significant market change. The most common (mode range) response was £80-£85/t and the range was £66/t - £170/t.

These reported gate fees are the “full” cost – i.e. include the disposal costs of all streams. However, the complex pricing structures of many long term local authority contracts means it is very difficult to assess a per tonne gate fee for an MBT facility in isolation; however if the analysis in the WRAP report is correct then the median MBT gate fee paid by local authorities is below the median gate fee for more recent EfW contracts.
The difficulties in estimating a per tonne gate fee are such the WRAP report findings require further analysis. Two alternative approaches have therefore been taken:

- A review of local authority budgets;
- The creation of a “costed” model for a generic MBT solution.

4.3. Local Authority Budgets

Using publicly available data, a review has been made of the 2017/18 net revenue budgets of 29 Waste Disposal Authorities in England and excluding local authorities which are also Waste Collection Authorities (i.e. unitary authorities). The budgets for these (largely shire councils and specialist waste disposal authorities) do not include the cost of waste collection. The data for 4 Waste Disposal Authorities was not available in a format which could be analysed.

In addition to the total cost of Residual Waste treatment, these budgets also include the operation of waste transfer stations, treatment of other waste streams, civic amenity sites, recycling credits, closed landfills etc. In this sense they do not provide a “clean” data set – but the largest single item is almost certainly the cost of Residual Waste treatment. They may also be influenced by third party revenue sources, government credits (e.g. via the Private Finance Initiative) and the extent to which the local authorities own assets rather than procuring a service from a private sector contractor.

This total cost has been compared with the tonnage of Residual Waste generated in 2015/16 (the last year for which comprehensive data is available) to give a net cost per tonne. The data was then plotted in Figure 18.

![Cost per tonne of Residual Waste](image)

Figure 18: WDA Net Revenue Budget/Residual Waste tonnage  
Source: Tolvik analysis

It should not be inferred that the cost per tonne shown in Figure 18 is the average Residual Waste gate fee – as described the cost includes a number of other elements. However, the red dots represent those Waste Disposal Authorities whose principal form of Residual Waste treatment is MBT – Cambridgeshire, Cumbria, ELWA, Essex, Greater Manchester, Lancashire and West Sussex. Of the 29 analysed Waste Disposal Authorities, the 5 authorities with the most expensive total waste management cost per tonne of Residual Waste had primarily contracted an MBT based Residual Waste solution.

4.4. Cost Model

Using a range of data sources, a simplified financial model has been developed for a purpose built, subsidy free MBT processing 120ktpa on the basis of the mass balance set out in Figure 19. A 20% mass reduction is in line with the UK average albeit in practice the percentage will either be higher (for those systems using an aerobic biological stage) or lower (for those generating biogas).
Figure 19: Modelled MBT mass balance  
Source: Tolvik analysis

<table>
<thead>
<tr>
<th>Waste</th>
<th>%</th>
<th>Tonnes</th>
<th>Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td></td>
<td>120,000</td>
<td>MBT Input</td>
</tr>
<tr>
<td>61%</td>
<td></td>
<td>73,200</td>
<td>RDF for Export</td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td>24,000</td>
<td>Moisture Loss</td>
</tr>
<tr>
<td>4%</td>
<td></td>
<td>4,800</td>
<td>Plastics</td>
</tr>
<tr>
<td>2.5%</td>
<td></td>
<td>3,000</td>
<td>Metals Recovery</td>
</tr>
<tr>
<td>2.5%</td>
<td></td>
<td>3,000</td>
<td>Heavies</td>
</tr>
<tr>
<td>10%</td>
<td></td>
<td>12,000</td>
<td>Rejects to Landfill</td>
</tr>
</tbody>
</table>

Figure 20: Modelled costs for waste outputs  
Source: Tolvik analysis

Figure 20 provides indicative costs for the disposal of each of the outputs from an MBT process. The assumed cost of £65/t for RDF export represents the least cost ex-works price reported by Letsrecycle over the last 5 years, whilst the landfill cost is based on landfill tax of £84.40/t + £22.00/t median gate fee in the WRAP Gate Fee report. The price for metals, plastics and heavies is affected by the cleanliness of the recyclate stream. Recyclates from MBTs will inevitably be less clean than from source segregated dry recyclates collections or metals extracted from IBA and so will attract lower values.

<table>
<thead>
<tr>
<th>Waste</th>
<th>Waste</th>
<th>Tonnes</th>
<th>£/tonne</th>
<th>Sub-Total £k</th>
<th>Total £k</th>
</tr>
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<tbody>
<tr>
<td>MBT Input</td>
<td></td>
<td>120,000</td>
<td>£125.08</td>
<td>15,724</td>
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<tr>
<td>RDF for Export</td>
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<td>73,200</td>
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<tr>
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<tr>
<td>Plastics</td>
<td></td>
<td>4,800</td>
<td>-£65.00</td>
<td>-312</td>
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<tr>
<td>Metals Recovery (Fe)</td>
<td></td>
<td>2,400</td>
<td>£50.00</td>
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<tr>
<td>Metals Recovery (Non Fe)</td>
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<td>600</td>
<td>£300.00</td>
<td>180</td>
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<tr>
<td>Heavies</td>
<td></td>
<td>3,000</td>
<td>-£50.00</td>
<td>-150</td>
<td></td>
</tr>
<tr>
<td>Rejects to Landfill</td>
<td></td>
<td>12,000</td>
<td>-£116.40</td>
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<tr>
<td>Operating cost</td>
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<td>120,000</td>
<td>-£17.50</td>
<td>-2,100</td>
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<tr>
<td>Overhead and Profit</td>
<td></td>
<td>120,000</td>
<td>-£10.00</td>
<td>-1,200</td>
<td></td>
</tr>
<tr>
<td>Capital Cost recovery – 20 years discounted basis, 2.5% inflation</td>
<td></td>
<td></td>
<td></td>
<td>-3,562</td>
<td></td>
</tr>
<tr>
<td><strong>Balance</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>0</strong></td>
<td></td>
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</tbody>
</table>
Based on confidential data from a number of waste management facilities, the operating cost for such an MBT has been modelled at £17.50/t and the overhead and profit element for the operator a further £10.00/t.

Using various benchmarks, the capital cost for such a facility is assumed to be £42 million.

Based on a minimum return on equity of 8% and excluding any tax, a gate fee of £125.00/t is generated. This represents a “floor” to the expected gate fee for such an MBT facility if built in 2017.

If more conservative assumptions of (£75.00/t for RDF and £20.00/t operating cost) are applied with regards to a need for an operator margin and expected market prices and the required % equity return modelled at 10%, then the gate fee increases to £138.00/t.

This compares with an average gate fee of c.£95.00/t for a recently closed local authority project based on EfW technology. Notably, this actual EfW gate fee is in line with the WRAP median gate fee for a post 2000 EfW.

4.5. MBT Operator Financial Performance

The nature of long term waste contracts is that the contractor accepts much if not all of the operating cost risk. If a local authority gate fee is low, it may well be because the operator under-bid the cost. This is evidenced by the poor financial performance by MBT operators. Publicly available examples include:

4.5.1. Shanks (now known as Renewi)

By any metric Shanks is the largest MBT operator in the UK, with its facilities accounting for around 27% of total UK MBT capacity. The UK operations of its municipal division accounted for some £175m of turnover – almost all of which was in the UK, but with an operating loss for the 12 months to March 2017 of £4.2m. As the most recent report noted:

“The cost of some RDF contracts has doubled from a lowest point of €40 per tonne to current rates of around €80 per tonne, at an exchange rate that has moved adversely by over 20% during the past 18 months”.

In 2017 Shanks provisioned for £28m (up from £5m) for onerous contracts.

4.5.2. PandaGreen (previously New Earth Solutions)

In October 2016, New Earth Solution was purchased by Ireland based PandaGreen. New Earth Solutions operated 3 MBT facilities in the UK and went into administration earlier in 2016 following the posting of a £29m loss.

This loss accrued in large part due to a failure to successfully develop an associated Advanced Conversion Technology EfW facility, necessary to make the MBT processes economically viable through delivering lower disposal costs than could be achieved by exporting the RDF.

4.6. Conclusion

The available evidence means it is difficult not to conclude that the identified criticisms of MBT referred to in the Juniper Report were correct and that MBT led Residual Waste solutions are generally more expensive than an EfW based alternative.
## APPENDIX 1 – MBT LIST

<table>
<thead>
<tr>
<th>Local Authority</th>
<th>Facility Name</th>
<th>Biogas</th>
<th>Year Ops</th>
<th>Operator</th>
<th>Capacity (ktpa)</th>
</tr>
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<tbody>
<tr>
<td>Poole</td>
<td>Canford</td>
<td></td>
<td>2003</td>
<td>Panda</td>
<td>125</td>
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<tr>
<td>Newcastle</td>
<td>Byker</td>
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<td>2006</td>
<td>Suez</td>
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<tr>
<td>Leicester City</td>
<td>Bursom</td>
<td>Yes</td>
<td>2006</td>
<td>Biffa</td>
<td>150</td>
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<td>Dumfries &amp; Galloway</td>
<td>Dumfries</td>
<td></td>
<td>2007</td>
<td>Shanks</td>
<td>65</td>
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<tr>
<td>Western Isles</td>
<td>Creed Park</td>
<td></td>
<td>2007</td>
<td>Council</td>
<td>15</td>
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<tr>
<td>ELWA</td>
<td>Frog Island</td>
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<td>2007</td>
<td>Shanks</td>
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<td>ELWA</td>
<td>Jenkins Lane</td>
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<td>2007</td>
<td>Shanks</td>
<td>180</td>
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<tr>
<td>Darlington</td>
<td>Aycliffe Quarry</td>
<td></td>
<td>2009</td>
<td>John Wade</td>
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<tr>
<td>Cambridgeshire</td>
<td>Waterbeach</td>
<td></td>
<td>2009</td>
<td>Amey</td>
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<tr>
<td>Leicestershire</td>
<td>Cotesbach</td>
<td></td>
<td>2010</td>
<td>Panda</td>
<td>50</td>
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<tr>
<td>West of England</td>
<td>Avonmouth</td>
<td></td>
<td>2011</td>
<td>Panda</td>
<td>200</td>
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<td></td>
<td>2011</td>
<td>Shanks</td>
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<td>Cumbria</td>
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<td>2013</td>
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<td>Bredbury Pk</td>
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<td>2013</td>
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<td>Greater Manchester</td>
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<td>Cobden St</td>
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<td>Viridor</td>
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<td>Reliance St</td>
<td>Yes</td>
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<td>Viridor</td>
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<td>Southwark</td>
<td>Old Kent Road</td>
<td></td>
<td>2012</td>
<td>Veolia</td>
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<td>Wiltshire</td>
<td>Northacre</td>
<td></td>
<td>2013</td>
<td>Hills</td>
<td>90</td>
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<td>BDR</td>
<td>Manvers</td>
<td>Yes</td>
<td>2015</td>
<td>Shanks</td>
<td>286</td>
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<td>Wrexham</td>
<td>Wrexham</td>
<td></td>
<td>2015</td>
<td>FCC</td>
<td>75</td>
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<tr>
<td>Wakefield</td>
<td>South Kirkby</td>
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<td>2016</td>
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<td>Biffa</td>
<td>327</td>
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<tr>
<td>Essex</td>
<td>Courtauld Road</td>
<td></td>
<td>2017</td>
<td>UBB</td>
<td>377</td>
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<tr>
<td>Milton Keynes</td>
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<td>2017</td>
<td>Amey</td>
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<tr>
<td>Cheshire</td>
<td>Renescience</td>
<td>Yes</td>
<td>2017</td>
<td>DONG</td>
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<tr>
<td>North Yorkshire</td>
<td>Allerton Park</td>
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<td>2018</td>
<td>Amey</td>
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<td>Derbyshire</td>
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<td>2018</td>
<td>Shanks</td>
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<td>GRREC</td>
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<td>2018</td>
<td>Viridor</td>
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<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
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<td></td>
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**Ceased Operations:**

<table>
<thead>
<tr>
<th>Local Authority</th>
<th>Facility Name</th>
<th>Year Ops</th>
<th>Operator</th>
<th>Capacity (ktpa)</th>
</tr>
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<tr>
<td>Neath Port Talbot</td>
<td>Crymlyn Barrows</td>
<td>2002/2008</td>
<td>Council</td>
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<td>Merseyside</td>
<td>Huyton</td>
<td>2008/2011</td>
<td>Orchid</td>
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<td>Rotherham</td>
<td>Rotherham</td>
<td>2007/2012</td>
<td>Sterecycle</td>
<td>100</td>
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<tr>
<td>Gateshead</td>
<td>Derwenthaugh</td>
<td>2010/2013</td>
<td>Graphite</td>
<td>320</td>
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<td>Lancashire</td>
<td>Leyland</td>
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<td>Council</td>
</tr>
<tr>
<td>Lancashire</td>
<td>Thornton</td>
<td>Yes</td>
<td>2010/2016</td>
<td>Council</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1,020</strong></td>
</tr>
</tbody>
</table>
APPENDIX 1 continued – LOCATION MAP OF MBTs
APPENDIX 2 - GLOSSARY

ACT  Advanced Conversion Technology
AD  Anaerobic Digestion
C&I Waste  Commercial & Industrial Waste
CHP  Combined Heat and Power
CLO  Compost Like Output
DEFRA  Department for Environment, Food and Rural Affairs
EU  European Union
EfW  Energy from Waste
Ktpa  ‘000s tonnes per annum
Mt  Million Tonnes
MBT  Mechanical Biological Treatment
MRF  Materials Recycling Facility
Residual Waste  Waste which remains after recycling
RDF  Refuse Derived Fuel
SRF  Solid Recovered Fuel

APPENDIX 3 - SOURCES

iii  data.defra.gov.uk/Waste/residual_waste_mar2016_05.xls
iv  http://www.variablepitch.co.uk/
v  http://www.wrap.org.uk/gatefees2017