Executive Summary of DOUGLAS BURGESS’S MSc THESIS

CENTRE FOR ENVIRONMENTAL POLICY
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Objectives:
Five main Objectives were identified:
1. To provide an overview of the current uptake of Mechanical Biological Treatment (MBT) and Mechanical Heat Treatment technologies (MHT) in the UK by collecting market data on existing and proposed MBT and MHT facilities
2. To categorize and group MBT and MHT configurations into representative options in order to identify trends and possible drivers in the uptake of each technology
3. To assess the performance of the representative options in terms of their mass balance, energy balance and cost
4. To compare the representative options using all sustainability and business criteria simultaneously assuming different potential scenarios that reflect present and future market conditions by conducting a Multi Criteria Analysis (MCA)
5. To discuss the implications of the findings with regard to waste management in the UK and Veolia decision making.

Introduction
The introduction of new legislation and policy has dramatically changed waste management in the UK, in particular the European Union Landfill Directive (99/31/EC) which has forced countries to develop residual waste treatment capacity. This has made a range of alternative treatment technologies commercially viable, including MBT, MHT and Gasification and Pyrolysis Technologies (from here on referred to as Advanced Thermal Treatment, ATT), and increased the scope for more traditional technologies such as energy recovery and recycling. Some of these technologies present opportunities for environmental and commercial benefit. However, there is a need for them to work in an integrated way.

In the UK further drivers affect selection including national targets set in the Waste Strategy 2007, changing conditions of output markets as well as planning issues associated with the negative public perception of certain technologies. Some of these drivers are conflicting and have resulted in applications of technology that appear misguided or are unlikely to maximise commercial and environmental benefit. By evaluating the present application of MBT and MHT technology in the UK it is possible to separate the most cost effective and environmentally beneficial applications from the misguided and inefficient. Such information is valuable both to the UK waste management industry, with regard to how best to meet present and future targets, and to Veolia with regard to which technologies are likely to be successful in the future and therefore where to invest.

This project describes the present market for MBT and MHT technology, examines possible drivers for uptake and uses a mass balance and energy balance approach to evaluate representative configurations. These configurations are then compared using an MCA designed to reflect present and future market conditions. The implications of the findings are discussed with regard to waste management in the UK and Veolia decision making.
Methodology
In completion of Objective One a database was compiled of existing and proposed MBT and MHT facilities in the UK. Data categories were selected in order to provide an overview of the present technological landscape, including location, operational status and core treatment technology. In Objective Two MBT and MHT facilities were grouped into representative ‘options’ (Table 1) based on type of core treatment technology, type or destination of output and type or position of materials separation. The options were then compared in terms of multiple criteria, including frequency of occurrence, operational status and cost. This permitted the identification of trends and possible drivers in the uptake of different MBT and MHT configurations.

Table 1: Representative options identified from the database, options in grey are those selected for further analysis in Objective Three

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
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<tbody>
<tr>
<td>Anaerobic MBTBF (Wet &amp; Dry MS)</td>
<td>Anaerobic MBT with a pre-treatment of dry materials separation followed by further wet materials separation and secondary outputs of Low Calorific Value Biomass Fuel (LBF) and Refuse Derived Fuel (RDF).</td>
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<tr>
<td>Anaerobic MBTBF (Dry MS Only)</td>
<td>Anaerobic MBT with a pre-treatment of dry materials separation only and secondary outputs of LBF and RDF.</td>
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<tr>
<td>Anaerobic MBTCLO</td>
<td>Anaerobic MBT with a pre-treatment of dry materials separation followed by further wet materials separation and secondary outputs of Compost Like Output (CLO) and RDF.</td>
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<tr>
<td>Aerobic MBT (Front End MS)</td>
<td>Aerobic MBT with front end materials separation and a primary output of CLO and secondary output of RDF</td>
</tr>
<tr>
<td>Aerobic MBT (Back End MS)</td>
<td>Aerobic MBT with back end materials separation and a primary output of CLO</td>
</tr>
<tr>
<td>Aerobic MBTATT</td>
<td>Aerobic MBT with front end materials separation, a primary output of CLO and a secondary output of dry biodegradable fraction for use in purpose built ATT facility</td>
</tr>
<tr>
<td>Aerobic MBTATTWD</td>
<td>Aerobic MBT with back end materials separation and a primary output of biomass fuel for use in purpose built ATT facility</td>
</tr>
<tr>
<td>Bio-drying MBT</td>
<td>Bio-drying MBT with primary output of Solid Recovered Fuel (SRF)</td>
</tr>
<tr>
<td>Autoclave ADBF</td>
<td>Autoclave with anaerobic treatment of autoclave fibre and a secondary output of LBF</td>
</tr>
<tr>
<td>Autoclave ADCLO</td>
<td>Autoclave with anaerobic treatment of autoclave fibre and a secondary output of CLO</td>
</tr>
<tr>
<td>Autoclave</td>
<td>Autoclave with a primary output of autoclave fibre</td>
</tr>
<tr>
<td>Continuous Heat Treatment (CHT)</td>
<td>CHT with a primary output of SRF</td>
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</table>

In Objective Three, eight of the twelve options from Objective Two were selected for more detailed analysis in terms of mass balance, energy balance and cost (Table 1). Component processes were substituted for specific technologies and mass and energy balances estimated. This permitted the estimation of the net energy status of options and the extent to which they contribute towards meeting targets, including landfill diversion and recycling as well as incentive schemes such as the Renewables Obligation (RO). Options were then scored and ranked to evaluate performance overall. In Objective Four the criteria from Objective Three were weighted according to their relative importance under present and future market conditions based on background research. Finally Objective Five was completed through the integration of the results from the above Objectives into an overall discussion and conclusions section.

Results
- A total of 31 MBT and 10 MHT existing, proposed and rejected facilities were identified, with 18 contractors offering MBT technology and 5 offering MHT technology
- Existing and proposed capacity is equivalent to around 1 third of residual waste generation for England, two thirds of which targets MSW only, whereas one third targets either MSW and Commercial & industrial waste (C&I) or just C&I
- The most common MBT and MHT configurations were the bio-drying MBT (11), autoclave (6), anaerobic MBTBFs (both types, 5), aerobic MBTs (both types, 5) and aerobic MBTATT (4)
• The most capital intensive configurations were the autoclave ADBF/CLO (440 £/t), aerobic MBTATT (300 £/t), anaerobic MBTCLO (285 £/t) and anaerobic MBTBFs (279 £/t)
• Only two of 23 contractors offer more than one core treatment technology
• RDF-producing options appear to use much of the material that is rejected by SRF-producing options in the production of RDF
• When CLO and RDF were included as outputs anaerobic MBT options scored highest overall followed by the bio-drying MBT, whereas when RDF and CLO were excluded the bio-drying MBT and autoclave ADBF scored highest followed by the anaerobic MBTBF
• When energy content from RDF was excluded the highest energy producers were the bio-drying MBT and autoclave ADBF
• The autoclave ADBF is potentially the largest generator of Renewable Obligation Certificates (ROCs)
• In the MCA under weights for present market conditions and under weights for three of four future scenarios the bio-drying MBT scored highest followed by the anaerobic MBTBF
• The bio-drying MBT appears to produce a similar mass of SRF to the CHT at similar cost with the additional benefits of low energy consumption and flexibility of outputs
• The anaerobic MBT options produce less biogas and energy than the autoclave ADs but at reduced cost
• The autoclave options produce a large mass of biomass fuel at high energy consumption or high cost, whereas the bio-drying MBT produces less biomass fuel but at low energy and low cost.

Discussion, Conclusions and Policy Implications

Background research and results suggest that markets for CLO, and particularly RDF, are severely limited. On this basis the energy balance and overall comparison were calculated including and excluding RDF and CLO. This significantly affected results. However, results that exclude RDF and CLO were considered to more accurately reflect the relative merits of the options. Under these conditions the bio-drying MBT ranks first due to the high energy production in the form of SRF, the low residual waste generation, low parasitic energy consumption and low cost. This is followed by the autoclave ADBF and incineration and then the anaerobic MBTBF. All options scored higher than direct landfill although only the bio-drying MBT and autoclave ADBF scored higher or equally to incineration. All other options scored lower than incineration. When cost was eliminated as a factor the autoclave ADBF scored highest due to high recyclables production, high energy production, high biomass fuel production and low residual waste generation. In terms of landfill diversion targets, when no outputs were landfilled RDF-producing options diverted the most waste, when just RDF and CLO were landfilled the SRF and biomass fuel-producing options diverted the most waste, whereas when all outputs were landfilled the CLO-producing options diverted the most waste. Under present market conditions the heavy weighting of cost lowered the position of the autoclave ADBF considerably, with the bio-drying MBT and anaerobic MBTBF options scoring highest. Two of the best performing options, the bio-drying MBT and the anaerobic MBTBF, are also two of the most common. However, two of the other most common options, the autoclave and aerobic MBT, are two of the poorest performing options.

It is important to recall that this study does not consider all configurations in the same level of detail, and that the configurations considered have been selected from the UK market. As a result options identified in Objective Two, such as the aerobic MBTATT, in addition to international or hypothetical configurations may actually perform better and would need to be accounted for in decision making.

A major limitation of the project was the selection of criteria. The inclusion of additional criteria is likely to significantly affect results. For example, the inclusion of a green house gas balance may improve the performance of CLO producing options through the potential for carbon sequestration of CLO. Further a wide range of assumptions were used in the energy and mass balances which should be considered when making decisions based on the results of the project. For example the assumptions for biogas and energy production from anaerobic MBT and particularly autoclave AD options are expected to overestimate biogas and energy generation.
A summary of the key findings of the market and technical assessment is presented below.

- The large number of contractors offering MBT and MHT technology and the wide range of core treatment technology on offer suggests that the market is diverse in terms of technologies and contractors. However, the commitment of contractors to single core treatment technologies suggests that this diversity may not be available to local authorities which may be forced to choose between technologies offered by bidders as opposed to the full selection in the market.

- Contractors do not appear to offer alternative core treatment technologies instead preferring to restrict bids to existing portfolios. As a result the ability of contractors to promote their preferred technology is considered to be a key driver in the uptake of all configurations.

- C&I waste, in addition to MSW, is considered to be important in the uptake of MBT and MHT technology.

- The high value of biogas in generation of ROCs is considered the main driver for the uptake of anaerobic MBT and autoclave AD technologies whereas opportunities to sell LBF as ROC/EUA compliant fuel, the problematic regulatory status of CLO and reduced cost by avoiding the need for ABPR compliance are considered the main drivers for the observed preference for anaerobic MBTBF over anaerobic MBTCLO options.

- High confidence in operational performance and low cost are considered the main drivers in the observed preference for the bio-drying MBT option.

- High guaranteed diversion rates and low cost are considered the main drivers in the historical growth of the aerobic MBT. In contrast the continued growth of the technology is considered to be linked to the production of dry-biomass fuel for use with ATT and therefore indirectly driven by the RO.

- Risk averse local authorities may still select aerobic MBT options due to the high guaranteed diversion rates offered. However, with the growth in the solid fuel market this option in the long-term is expected to be outperformed by solid fuel-producing options in terms of regulatory targets and potentially environmental impact.

- In many cases incineration may be a more commercially and environmentally beneficial residual waste treatment technology than MBT or MHT technology.

- The high cost of autoclave AD, aerobic MBTATT and anaerobic MBT options is expected to be due to the increased infrastructure of energy generation and/or multiple core treatment technologies.

- In general under present and future market conditions options that produce large amounts of CLO and RDF are expected to be outperformed by options that produce large amounts of SRF, biomass fuel or energy from biogas.

- The bio-drying MBT appears to produce a similar mass of SRF to the CHT option at a similar cost with the added benefits of very low energy demand and potentially the ability to either bio-dry or bio-stabilize as required. As a result the bio-drying MBT for the production of SRF is considered to outperform the CHT under most circumstances.

- The autoclave ADBF appears to produce the most biogas and ROC compliant energy. However, it is expected that the anaerobic MBTBF, with some improvements to biodegradable material and recyclables capture rates, could produce similar amounts of these outputs at significantly reduced cost and may therefore be preferred.

- The autoclave produces a large mass of biomass fuel but at high energy demand, whereas the autoclave ADBF produces a large mass of biomass fuel but at high cost. In contrast the bio-drying MBT produces significantly less biomass fuel but at low cost and low energy demand. As a result the preferred option for the production of biomass fuel will depend on the priorities of the decision maker. However, with increasing value of ROCs the autoclave options may be preferred.

- The results of the study do not support the uptake of autoclave technology for the production of fuel in the absence of biogas or biomass Combined Heat and Power (CHP). Drivers for the observed uptake are unclear but may include high recyclables production and low cost. However, where fossil energy is required for autoclave and drying processes this option is expected to be the least sustainable. The existence of a large number of facilities without a form of onsite biogas or biomass CHP is considered a concern.