Objectives
Energy from Waste (EfW) is a core component of Government's Renewable Energy (RE) and Municipal Solid Waste (MSW) Management strategy. Deployments of EfW technologies, especially MSW incineration and Advanced Thermal Treatment (ATT), are impacted by available Government incentives, their cost of compliance, and barriers to eligibility. This research assesses these issues, and discusses the implications for MSW Operators. In order to do this, this research set out to meet the following objectives:
1. To assess how the incentives for EfW impact their development, deployment and contribution towards meeting Government targets on energy and waste.
2. To assess whether the Renewable Obligation (RO) incentives for MSW incinerators are adequate to meet the costs of eligibility compliance.
3. To identify barriers facing MSW incinerators to avail of RO incentives, and examine whether these are justified in the context of an environment-friendly economy.
4. To discuss the implications and best outcomes for MSW incinerator operators in the UK.

Introduction
There is an environmental, social and economic imperative to wrest the maximum value from waste. Historically, Waste Management in the UK was synonymous with large scale landfill disposal. The EU’s Landfill Directive of 1999, changed this approach and established binding targets for a reduction of waste to landfill by 2020. Furthermore the EU’s Waste Frame Work Directive of 2008 introduced a hierarchy of waste treatment, mandating waste prevention, and resource and energy recovery measures over landfill disposal. In parallel, and to meet global CO₂ abatement commitments, the EU Renewable Energy Directive of 2009 established a binding renewable energy target for the UK to comply with by 2020. In response to these EU Directives, the Government published the Waste Strategy for England in 2007, and the Renewable Energy (RE) Strategy in 2009. Under both strategies, Energy from Waste (EfW) is seen as a core component in meeting targets set by the EU Directives.

To meet their Waste Management targets, Local Authorities and MSW Operators have embarked on a new generation of Waste Management infrastructure. A large part of this infrastructure will be based on EfW technology. These are long-term, complex and capital intensive undertakings. Funding is expected to come from a risk-averse private sector, who are reluctant to make the investments without Government support. Currently this financial support is provided by the Renewable Obligation (RO), the Government’s main financial incentive for achieving renewable energy targets, and the supplementary Feed in Tariffs (FITs) and the Renewable Heat Incentive (RHI). These incentives will influence and shape the EfW technology landscape for the next 20-30 years. Therefore having the right incentives for the right technology is important to achieve renewable energy and waste targets. The RO currently provides uneven support for EfW technologies. In addition it stipulates that the older, more established MSW incinerators have to include a Combined Heat and Power (CHP), with demonstrable useful heat utilisation for incentive eligibility.

MSW Operators manage a variety of Waste Management technologies. Their future decisions will be based on technology viability under available incentives. This research assessed the Government strategies, incentives and targets, and their relationship to the deployment of EfW technologies. It assessed the financial viability for MSW incinerators Operators, who alone have to incur substantial CHP capital costs for
RO eligibility. Finally, it discussed these and other barriers in terms of meeting targets, and implications for MSW Incinerator Operators. The incentives are under constant, consultative review with stakeholders to react to technology and market developments. This research adds to this process to ensure that the best outcomes, in terms of meeting energy and waste targets, are achieved.

Methodology
This research comprises four discrete components, each achieving the objectives stated above, and each one feeding into the next. To meet the first objective, this research first assessed the various Government strategies, targets and incentives for EfW technologies from literature review and electricity generation statistics. These include the Non-Fossil Fuel Obligation (NFFO), Levy Exception Certificates (LECs), FITs, and the RHI. The NFFO is included because EfW contracts under the NFFO are still current. The research focussed on the RO because it is the main support vehicle, and as MSW incinerators come out of NFFO support it is the only incentive currently available for large EfW plants. The research then investigated the contribution of various EfW technologies towards energy and waste targets. These included MSW incineration, landfill gas, anaerobic Digestion (AD) and Advanced Thermal Treatment (ATT) technologies like gasification and pyrolysis. It identified MSW Incineration as being best suited to deliver on these in terms of robustness and low technology risk.

The second objective was met with input from an MSW Incinerator Operator. The research modelled the financial viability of MSW incinerators with CHP to meet RO eligibility. It emulated the operational cash-flow of an MSW incinerator with CHP for a range of heat off-take scenarios, to see whether the RO support was adequate.

Interviews and further literature review informed the third objective. Various barriers facing MSW incinerator Operators seeking RO eligibility were identified. These were discussed in terms of financial, legislative, competitive, and social barriers. Finally, findings from these three objectives were consolidated to meet the fourth, where the research findings were discussed in terms of implications for MSW incinerator Operators.

Results
As the first Government incentive for renewable energy, the NFFO accelerated the development of EfW technologies, notably landfill gas and MSW incineration. It made these competitive with conventional fuels, and established that electricity generation from MSW Incineration did not need more Government support. In 2009, renewable electricity contributed 6.7% to total electricity generated. Against the RE Strategy target of 7.3% for 2020, the research indicated that the RO was on course to deliver. MSW incineration contributed 0.63% to this energy mix. The Waste Strategy aimed to use 25% of MSW for energy recovery by 2020, up from the current 12.2% of MSW. As energy demand and MSW arising projections were expected to remain flat, this represented 0.9% of total electricity generation in 2020.

AD was considered a key technology in meeting both energy and biodegradable waste targets, and was justifiably awarded additional incentives under the RO. Landfill gas, though contributing a larger share of renewable energy than all other EfW technologies, was not seen as viable in the long term. This was reflected in the low level of support under the RO. NFFO support for ATT technologies has been available since 1990, but no contracts have been awarded for these. They also enjoyed additional support under the RO, which has resulted in a substantial number of current planning applications for ATT plants, despite their unproven technical record. In addition, the lack of identifiable markets for their resultant fuels did not justify the additional support under the RO.

MSW incineration recovered energy from 12.2% of of MSW in 2009. However, as the majority of new EfW plants were planned to be based on unproven ATT, of which very few were expected to be operational by 2020, it was uncertain whether the energy recovery target of 25% of MSW would be met by 2020. In this respect, MSW incineration was the most established technology, with demonstrable long-term commercial viability in energy recovery. The RE Strategy indicated that CHP could make a major contribution to renewable heat targets. It also recognized that the district heating infrastructure required to utilise CHP
needed Government support, and that the RHI was intended to address this. Though MSW incineration contributed less than 1% to the total electricity mix, at the scale of renewable heat required they had the potential to make a substantial contribution to renewable heat production through CHP.

However, the financial model showed that under the current RO support, MSW incineration with CHP was not fully financially viable. To be eligible for incentives, all UK CHP plants needed to adhere to the CHP Quality Assurance standard (CHPQA). This defined threshold power efficiencies (Quality Index - QI) for RO and other Government incentives (i.e LECs support) respectively. Qualifying MSW incinerator plants are eligible for 1 RO Certificate (ROC)/MWh. Table 1 below shows the Net Present Value results from the model for a hypothetical base case, where an MSW incinerator with CHP processed 100,000 tonnes of MSW. The two scenarios modelled for reflected plant efficiencies required for maximum RO and LECs support.

### Table 1 : NPV (in £ millions) for a 100K tonne MSW CHP under the RO incentive.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>% of electricity used for heat off-take</th>
<th>Internal Rates of Return (IRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At 8.00%, in £ millions</td>
</tr>
<tr>
<td>Case 1 : QI(ROCs)=100</td>
<td>38.00%</td>
<td>-£7.54</td>
</tr>
<tr>
<td>Case 2 : QI(CHP)=105</td>
<td>67.00%</td>
<td>£22.15</td>
</tr>
</tbody>
</table>

Using indicative cost figures the model showed that for Internal Rates of Return (IRRs) of 8%, 10% and 12%, current RO support was inadequate at the QI(ROCs) threshold, with heat off-takes of about 38%. Viability was reached nearer 67% of heat off-take, reflecting higher revenue from increased heat sales. However, this was not acceptable due to the temporal variations in heat demand. At periods of low heat demand, the plant would dip into non-viability. A sensitivity analysis of the model found that if the RO incentive for MSW CHP plants was doubled to 2 ROCs/MWh, only the lower public body IRR enjoyed full viability. Raising gate fees posed a similar situation, i.e. partial viability, dependent on constant high heat demand. Without additional RO support, the model showed that a possible route to full viability is by raising revenue through increased gate fees, higher ROC prices, or winning consistent high heat demand customers.

The model exposed the complexities of attempting to assess the financial viability of a MSW incinerator with CHP. A major and uncertain component of the capital expenditure (capex) was the district heating network (DHN), which could only be fully ascertained once the heat demand was determined. The research found that heat provision costs were high for MSW incinerators, only second to that of AD. The model proved that additional support was required to enable MSW incinerators to build out CHP DHN infrastructure, and compete with conventional and renewable heat generation. Without this, the uneven RO support between thermal treatments for MSW, and the CHP requirement for MSW incineration posed an insurmountable competitive barrier for MSW incinerator Operators seeking RO eligibility.

The research identified additional barriers facing MSW incinerators. The RO incentive is payable on the biodegradable fraction of MSW. This fraction was expected to decrease to meet EU Landfill Directive targets, reducing potential RO revenue. In addition, ATT plants needed Solid Recovered Fuel (SRF) as a feedstock. Demand for SRF was expected to rise with the deployment of a large number of ATT plants, reducing the quantity of MSW available for incineration.

Finally, the research found that adverse social perceptions about MSW incinerators raised the risk of thwarted planning applications.

**Discussion, Conclusions and Implications for MSW Incinerator Operators**

The findings established that EfW incentives have helped develop and secure a long-term, competitive and renewable energy generation capacity for landfill gas and MSW incineration. The research showed that MSW incineration played a minor role in total electricity demand. However, whilst renewable electricity generation has had a head start with support from the NFFO, RO, and FITs, the renewable heat sector is still
in infancy. The RHI rightly recognises the importance of CHP and district heating towards making a substantial contribution towards meeting renewable heat targets. The need for renewable heat is irrefutable and urgent, and should be viewed as a growth sector by MSW incinerators Operators. However, it remains for effective long-term Government incentives to expedite this. The need for renewable heat through CHP should ensure that all MSW heat sources are utilised. Thus it would be justified to base a double ROC (or added-value heat incentive) eligibility on CHP delivery from all thermal treatments of MSW, incineration and ATT. This would level competitive forces between ATT and MSW incineration, and in turn reduce demand for SRF. It would also shift focus to the imperative need for renewable heat instead of on the need to develop waste markets for niche fuels like syngas. Finally, the research found no evidence to validate public concern about any adverse emission effects from MSW incinerators.

The research concludes that currently, EfW, in particular MSW incineration, plays a much bigger role in Waste Management than renewable electricity production. In the context of the EU’s waste hierarchy, it is the penultimate step before landfill disposal. Where up-stream waste recovery endeavours prove less cost beneficial, energy recovery through incineration is the most established, simplest and proven technology. It has, however, the potential to make a bigger contribution to renewable heat generation through CHP. It is the lack of RO support in this respect that is the biggest barrier for MSW incinerator Operators.

A Summary of Key Findings is given below:

- Whilst MSW incinerators play a nominal role in renewable electricity production, they have the potential to make a significant contribution to the renewable heat initiatives via the provision of CHP.
- As they come out of NFFO contracts, MSW energy recovery operators not converting to CHP to avail of RO incentives, remain viable through electricity generation. They will need to ensure that their electricity sustains cost competitiveness against conventional electricity. Value added services can be utilised to extract further value from residual waste.
- The Government’s current RO incentive is not adequate for MSW incinerator Operators to invest in CHP plants, except at low IRRs. Added incentive is required to underwrite the high capex incurred in building out DHNs, and for operating in heat and electricity markets.
- Site selection for an MSF incinerator with CHP is critical in establishing predictable, high value heat demand, whilst minimising DHN infrastructure costs. This would also increase the chances of positive planning permission outcomes.
- MSW incineration plays a major role in national Waste Management, extracting energy from 12.6% of MSW in 2008. There are challenges in meeting the 25% target for 2020, especially since the ATT technologies being opted for have not been proven at MSW scale.
- In meeting national renewable targets, the ATT’s double ROC benefit under the RO is unjustified.
- Landfill gas and MSW incineration are still benefiting from contracts from the NFFO. Only landfill gas continues to benefit from the RO.
- CHP should be an RO eligibility requirement for all MSW thermal treatment plants, ATTs and incinerators. Double ROCs should be available for all MSW thermal treatment plants with CHP.
- SRF will compete with MSW incinerator Operators for MSW feed stock as MSW quantities are reduced through various initiatives, public awareness, and growth of ATT plants. MSW incinerators need to widen their customer base to secure an adequate supply of feed stock.
- The RHI should be extended from 2020 to 2037 to match the RO, so that MSW incinerator investments in CHP can be made good over the longer period.
- MSW incinerators would benefit from transparency and proactive engagement with public perception, emphasising their role in energy and resource recovery instead of on solely on waste management.