GREENHOUSE GAS BALANCES OF WASTE MANAGEMENT SCENARIOS – A SUMMARY REPORT

BACKGROUND

The most critical new driver for London's waste management is climate change. Waste management contributes about three per cent to total greenhouse gas emissions in the UK, largely made up of methane emissions from organic waste degrading in landfill. This presents a significant challenge for London to shift its reliance away from landfill and on to waste management techniques that reduce London's impact on climate change.

The Greater London Authority (GLA) commissioned Enviro Centre and Eunomia to carry out a study into the greenhouse gas impacts of waste management scenarios using lifecycle assessment methods. Such methods examine the environmental and economic effects of a product or activity (in this case residual municipal waste) at every stage of its existence, from production to final disposal. Residual municipal waste is that which is left in the waste stream over after recycling and composting has taken place.

The goal of the study is to measure and rank a range of residual waste management scenarios with regard to their performance on greenhouse gas emissions[1]. Each scenario includes a number of waste management techniques and technologies including anaerobic digestion, gasification, incineration and landfill. The results for this study will supplement the evidence base that will inform the Mayor's revised Municipal Waste Management Strategy, the London Plan and the Climate Change Action Plan in determining the right 'mix' of waste management technologies for London. The study does not consider the impacts of waste collection due to their relative insignificance[2], focusing instead on residual waste treatment and energy recovery.

The Mayor's Climate Change Action Plan highlights the importance of waste management facilities generating energy in the form of heat and power in helping London move away from reliance on the national grid and on to local, lower-carbon de-centralised energy systems. The London Plan estimates that around 300 additional waste management facilities (of which around 50 are needed for residual waste treatment) are necessary in London for the capital to meet the Mayor's self-sufficiency targets

SCOPE OF THE STUDY

Twenty-four waste management scenarios were modelled using a range of technologies to treat residual municipal solid waste. The scenarios were selected based on a mix of proven technology performance and their potential for being built and operated in London. Whilst it is accepted some of the technologies assessed are still largely in the development phase, one of the goals of the study is to report exemplar technology configurations that have the potential to deliver both greenhouse gas benefits and that fit with wider policy goals nationally and regionally.

Some scenarios include de-centralised energy generation in the form of electricity and/or heat. In such cases, the energy generated from these scenarios is assumed to displace more carbon intense centralised energy generation (e.g. from coal or gas), thus reducing overall greenhouse gas emissions. The net effect of these savings is factored into the overall greenhouse gas balance of the scenario. This study also considers carbon emissions from treating the biodegradable fraction of residual waste, otherwise known as "non-fossil emissions". Explanation on the consideration of non-fossil emissions for this study is set out in the executive summary and section three of the report. Explanation on each technology modelled is set out in section six.

The methodology used and conclusions drawn by Enviro Centre and Eunomia for the study have been peer reviewed by EMRC Consulting, who concluded that the report is free from

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[1] Only carbon dioxide and methane emissions are assessed as they make up over 98 per cent of greenhouse gas emissions from waste management.
[2] Greenhouse gas emissions from transport contribute less than one per cent of greenhouse gas emissions from waste management.

major flaws in terms of the methods and data used. The findings and recommendations of the peer review have been incorporated into the final report.

RESULTS AND COMMENTARY

The results of the twenty-four waste management scenarios modelled are set out in Chart A. Each scenario is ranked in terms of its greenhouse gas performance using a traditional lifecycle analysis (LCA) approach. The performance of each scenario is expressed in kilograms of carbon dioxide-equivalent[3] per tonne of waste treated.

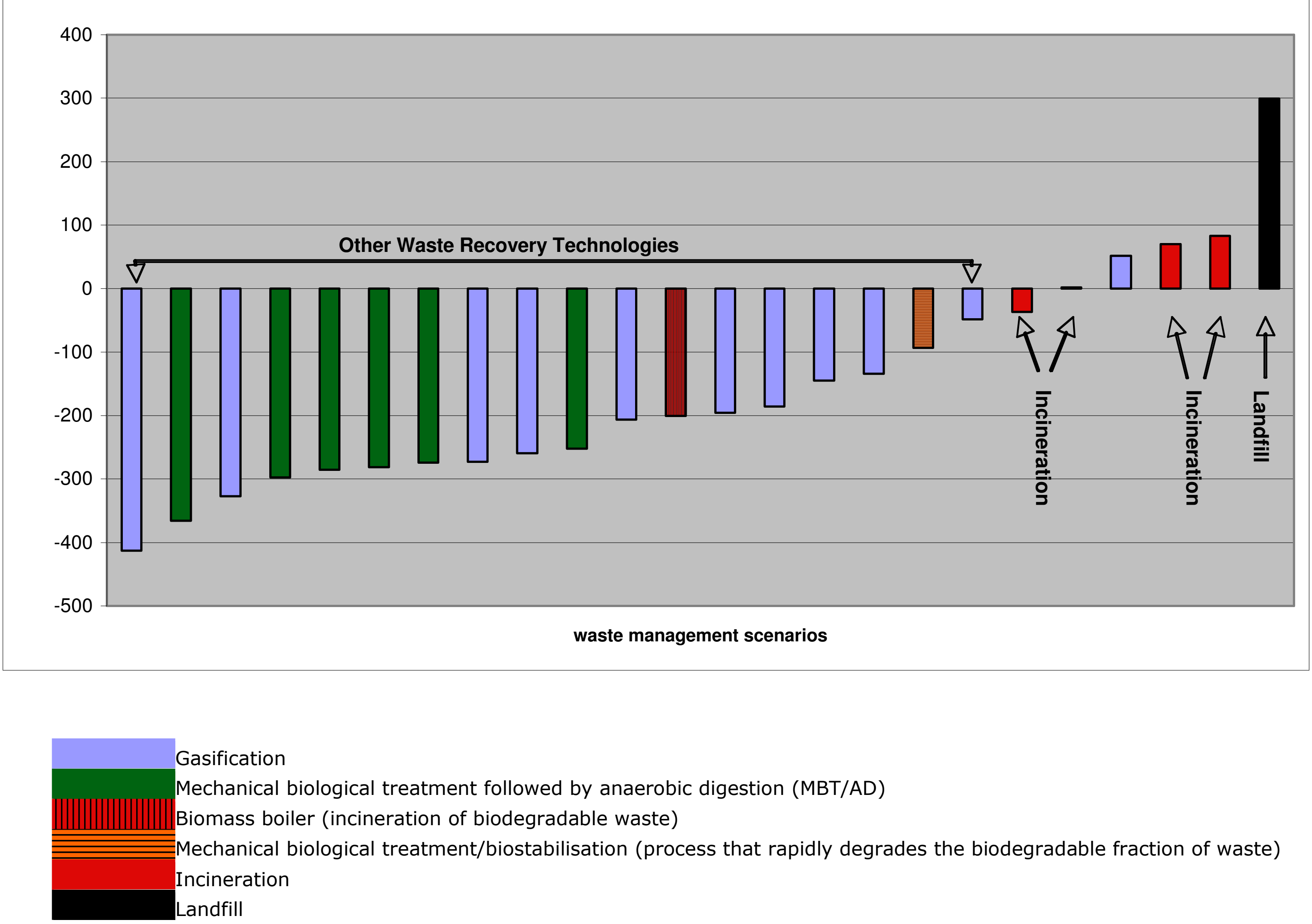

Chart A: greenhouse gas performance of waste management scenarios

The best performing scenarios, in terms of their greenhouse gas impact, were those based on either mechanical biological treatment (MBT) followed by anaerobic digestion (AD) or on gasification followed by autoclave, coupled with hydrogen fuel cell technologies. These scenarios performed particularly well due to MBT or autoclave processes capturing materials suitable for recycling from the waste stream. The results show that recycling, particularly of plastics, makes a considerable difference to greenhouse gas impacts by avoiding emissions from virgin manufacturing processes. All of the scenarios that incorporated hydrogen fuel cell technologies performed particularly well due to the far

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[3] Methane and carbon dioxide have different global warming impacts (e.g. methane is 23 times stronger than carbon dioxide). A carbon dioxide-equivalent figure is used to represent the warming impact of both gases.

greater conversion efficiencies of fuel cells when compared to other energy generation technologies.

Biogas [4] produced from anaerobic digestion and syngas[5] produced from gasification can be used in either a gas engine or hydrogen fuel cell to generate energy. The use of biogas in fuel cells is proven at commercial scale for stationary power generation.[6] MBT/AD scenarios coupled with gas engines to generate energy might currently be affordable to local authorities and, in the right configurations, be practical technologies for use today. However there has been limited research into the use of syngas derived from municipal solid waste in hydrogen applications. The results show that there is significant potential for such technologies to play a key role as they mature to efficiently treat residual waste and generate de-centralised energy.

Finally, scenarios using incineration were amongst the poorest performing and were considerably worse than the best performers. This is largely due to low levels of recycling along with significant emissions from wholesale combustion of plastics, which negates the benefits of emission savings from energy generation.

CONCLUSIONS AND RECOMMENDATIONS

The key conclusions drawn from the study were:

1. In terms of greenhouse gas emissions, waste management scenarios using mechanical biological treatment (followed by anaerobic digestion) and gasification (followed by autoclave), coupled with hydrogen fuel cell technologies were the best performing. Pending the commercialisation of hydrogen fuel cells technologies, scenarios using MBT, AD and gasification linked to CHP gas engines are the best performing on reducing greenhouse gas emissions.
2. More research is needed in order to realise the potential of fuel cells to generate energy from hydrogen converted from syngas from gasification.
3. The incineration scenarios modelled were amongst the worst performing on greenhouse gas emissions, with all but one of the scenarios being a net contributor to climate change. This could be improved if the burning of plastics no longer takes place and there is provision for good quality combined heat and power (CHP).
4. A key advantage of anaerobic digestion and gasification over incineration is that they can be coupled with more efficient generation technologies, whilst incineration remains locked to the use of a steam turbine.

The results of the study fits well with both the national and London policy preference for using anaerobic digestion for treating biodegradable municipal waste and recognising the greenhouse gas benefits of de-centralised energy generation. The results also support the Mayor’s preference for anaerobic digestion and gasification technologies over incineration for treating residual municipal waste. The GLA is working with the Government, the London Climate Change Agency and technology providers on developing potential commercial opportunities for extracting hydrogen efficiently from syngas derived from residual waste for use in fuel cells.

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[4] Biogas is a methane-rich gas derived from treating biodegradable waste (e.g. food and green garden waste) in the absence of oxygen.

[5] Syngas or synthetic gas is produced by gasification and pyrolosis processes and is a mixture of nitrogen, hydrogen, carbon dioxide, carbon monoxide, and various other hydrocarbon gases.

[6] A stationary 250kW Molten Carbon Fuel Cell (MCFC) designed by MTU CFC Solutions is operating at 47% electrical efficiency at an anaerobic digestion facility in Leonberg, Germany