

Development of a Greenhouse Gas Emissions Performance Standard for London's Municipal Waste

The Greater London Authority

Authors:

Adam Baddeley

Ann Ballinger

Siobhan O'Brien

August 2010

Report for:

Doug Simpson, Environmental Policy Officer

Prepared by:

Adam Baddeley, Project Manager

Approved by:

Mike Brown

.....

(Project Director)

Contact Details

Eunomia Research & Consulting Ltd
62 Queen Square
Bristol
BS1 4JZ
United Kingdom

Tel: +44 (0)117 9450100

Fax: +44 (0)8717 142942

Web: www.eunomia.co.uk

Disclaimer

Eunomia Research & Consulting has taken due care in the preparation of this report to ensure that all facts and analysis presented are as accurate as possible within the scope of the project. However no guarantee is provided in respect of the information presented, and Eunomia Research & Consulting is not responsible for decisions or actions taken on the basis of the content of this report.

Acknowledgements

Eunomia Research & Consulting thanks participants of the Steering Group (from North London Waste Authority, West London Waste Authority, Tower Hamlets Borough Council, Croydon Borough Council, London Borough of Barking and Dagenham, London Waste and Recycling Board, London Councils and Environment Agency) for their input to this study. It should be acknowledged that the views presented in this report, however, do not necessarily reflect those of all members of the Steering Group.

Contents

1.0	Background and Objectives.....	1
2.0	The ‘Whole Waste System’ EPS.....	3
2.1	Approach and Methodology.....	3
2.2	Setting the Level of the EPS.....	6
3.0	Carbon Intensity ‘Floor’ for Energy Generation from Waste	14
3.1	Approach and Methodology.....	14
3.2	Options for Meeting the Carbon Intensity ‘Floor’	15

1.0 Background and Objectives

The London Mayor's draft Municipal Waste Management Strategy (MWMS) was published for public consultation in September 2010. A core objective of the MWMS is to develop a greenhouse gas (GHG) emissions performance standard (EPS) for the management of London's municipal solid waste (MSW). The GHGs falling within the scope of the EPS include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) emitted during waste management activities including recycling, treatment and landfill. For simplicity, and in line global GHG accounting protocols, all non-CO₂ emissions are converted to CO₂ equivalents (CO₂e) for measurement against the EPS.¹

The EPS concept is an increasingly popular way of regional and national authorities managing carbon emissions in the industrial, manufacturing and power generation sectors. Following an announcement by the new coalition Government in May, the Department of Energy and Climate Change (DECC) is currently developing an EPS for all new thermal power stations, which might be achieved by either coal-fired or combined cycle gas turbine (CCGT) power stations through fitting of carbon capture and storage (CCS) infrastructure.² The development of an EPS for London is therefore consistent with such approaches being undertaken at a national level.

Two of the key principles within the new draft MWMS can be summarised as:

1. Encouraging a focus on recovering materials and reprocessing routes, which deliver greater CO₂e reductions; and
2. Providing support for decentralised energy generation from waste that is no more carbon intense than the alternative form of new base-load energy generation.

To deliver upon these two principles, a 'whole waste system' EPS has been developed, which includes a carbon intensity 'floor' for energy generation from waste. The methodology and rationale behind the development and setting of values for these mechanisms is described within this Summary Report. A range of associated technical and environmental information is included within a set of short Appendices to this document.

It is emphasised that both the core EPS and the carbon intensity 'floor' will function as quantitative reference points to aid London's waste authorities (both Boroughs and Joint Waste Disposal Authorities) act in general conformity with the MWMS. This is such that waste authorities, in undertaking their waste management functions, can

¹ WORLD RESOURCES INSTITUTE & WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT/WRI & WBCSD (2007) The GHG Protocol for Project Accounting, 2007

² This was announced by Secretary of State for Energy, Chris Huhne, in June 2010

be best aligned with wider strategic objectives of moving waste up the hierarchy and generating energy to achieve the greatest climate change mitigation benefits.

To facilitate wider understanding and practical use, the core EPS and carbon intensity 'floor' have been developed using the Environment Agency's WRATE life-cycle modelling tool, which is commercially available to all organisations. This approach is such that there are no barriers to waste authorities (WAs) determining their own performance against the EPS, whilst also ensuring that in future, the EPS can be credibly updated to take into consideration future modifications by the Environment Agency to WRATE.

In some cases, Eunomia has identified deficiencies or limitations of WRATE, particularly with regard to how the tool models emissions of CO₂ and methane (CH₄) from landfill.³ In the case of the 'carbon intensity floor' for energy generation, it has been necessary to develop a separate tool using data from WRATE to enable the required analysis.⁴ All such issues are discussed in more detail in Appendix 1. It is anticipated that further, more detailed guidelines, along with both EPS and carbon intensity 'floor' 'Ready Reckoner' tools for ease of use by WAs, will be published at a subsequent time.⁵

Whilst there is significant focus within this study on GHG emissions, it is important to highlight the potential tension between the development of waste infrastructure, particularly low-carbon energy generation from waste, and the minimisation of air quality impacts. Primarily, these impacts relate to oxides of nitrogen (NO_x) and particulates (PM₁₀ and PM_{2.5}), for which in London there are currently elevated concentration levels which are estimated to exceed related targets.⁶ These pollutants are of concern in London because of their potential impacts on human health. The potential air quality impacts from all new developments (not just waste-related) in London are considered on a case by case basis through the local and strategic planning process. The development of new residual waste facilities might result in exceedances of both NO_x and PM₁₀ in specific locations, particularly in those areas where concentrations are already elevated. Waste treatment facilities considered in this study - if managed and operating as designed, located in appropriate locations and using best available abatement and mitigation technology- are unlikely to have a significant effect on meeting air quality objectives.

³ Eunomia has recently been commissioned by Defra to undertake a study into emissions of methane from landfill, such that this might inform future revisions to the WRATE model. Eunomia has discussed this in detail with the Environment Agency as part of this study on behalf of the GLA

⁴ It should be noted that to facilitate the inclusion of a range of technology configurations and related assumptions, Eunomia has needed to develop a range of 'user-defined' processes within WRATE. It is intended that these will be made available by the GLA to all London waste authorities

⁵ The development of these 'Ready Reckoner' tools is currently being considered by the Environment Agency and WRAP. They will otherwise be commissioned directly by the Greater London Authority

⁶ GLA (2010) Clearing the Air: The Mayor's draft air quality strategy for public consultation, March 2010

2.0 The ‘Whole Waste System’ EPS

2.1 Approach and Methodology

2.1.1 Determination of Baseline CO₂e Performance

Prior to setting an appropriate EPS level, an assessment of London’s current performance with regard to CO₂e emissions from MSW management is required. Eunomia developed this baseline information by drawing upon data from the Environment Agency’s WasteDataFlow tool and feeding this into WRATE. The results of this modelling exercise showed that the net emissions from waste management activities in London are currently around 130,000 tonnes of CO₂e per annum (tpaCO₂e). These emissions can be broken down as set out in Table 2-1, which shows how emissions reductions provided by recycling activities offset emissions from residual treatment and landfill to give an overall net figure.

Table 2-1: Baseline Emissions from Waste Management in London (2008)

Waste Management Activity	Waste Managed (ktpa) ¹	Associated Emissions (ktCO ₂ e)
Residual Waste		
Landfill	1,830	466.77
MBT	278	1.31
Incineration	838	8.88
Organic waste		
Anaerobic Digestion	4	-0.37
In-vessel Composting	124	-5.81
Open Air Windrow Composting	143	1.40
Materials Recycling / Reprocessing		
Paper / Card	385	-115.18
Glass	62	-10.51
Metals (ferrous)	49	-135.00
Metals (non-ferrous)	13	-28.86
Plastics	24	-52.63
Textiles	12	0.03
Wood	33	0
TOTAL	3,797	130.05
Notes:		
1. Excluded from this analysis are 10ktpa of waste which were sent for reuse, and a further 176ktpa which represent rejects streams from Material Recovery Facilities (MRFs) and Mechanical Biological Treatment (MBT) facilities, along with incinerator bottom ash. These have not been included in the model as their composition, and thus impact in landfill, cannot be modeled accurately in WRATE. If these streams were included, total waste managed in London would be 3,955ktpa, which is consistent with related Defra figures		

Table 2-1 shows that materials recycling, composting and anaerobic digestion (AD) have a significant role in determining baseline performance, and thus in Table 2-2, we have provided a summary of the emissions factors used within WRATE to model the benefits of recycling, composting, and AD of specific materials. WRATE also includes a range of emissions factors should these materials be sent for energy generation, which are included within Appendix 3.

Table 2-2: Emissions Reduction Factors for Materials Recycling (WRATE)

Material	Impact of Activity (kgCO ₂ /tonne of waste managed)		
	Recycling ('closed loop')	Anaerobic digestion (electricity only)	Composting
Paper and card	-299	n/a	n/a
Food waste	n/a	-82.9	-47 ¹
Garden waste	n/a	n/a	-41.7 ²
Wood	0.968	n/a	n/a
Textiles	-4,372	n/a	n/a
Plastic (dense)	-1,182	n/a	n/a
Metals (ferrous)	-1,623	n/a	n/a
Metals (non-ferrous)	-10,721	n/a	n/a
Glass	-169	n/a	n/a
Aggregate materials	21	n/a	n/a
Notes:			
1. In-vessel composting (IVC)			
2. Open-windrow composting (OWC)			

2.1.2 Basis for Development of the EPS

On behalf of the GLA, Eunomia recently undertook a related study to assess the costs of meeting the proposed recycling or composting targets set out in the draft MWMS.⁷

⁷ Eunomia (2010) Economic Modelling for the Mayor's Municipal Waste Management Strategy, on behalf of The Greater London Authority, August 2010

This associated study focuses on modelling 11 'whole waste system' scenarios, six of which meet the Mayor's proposed recycling and composting targets in 2015, 2020 and 2031. These six scenarios have been used as the core basis for modelling and setting the EPS.

The six scenarios vary according to whether there is an initial 'focus' on the collection of dry recyclables or upon food waste collection in order to meet the proposed recycling and composting targets, with a further variant being a sole 'focus' on doorstep recycling collection services. Details of the waste flows for these six scenarios can be found in Appendix 2, along with information relating to the order in which new collection services are introduced from 2008 to 2015, which is the key differentiating factor between the 'focus on dry' and 'focus on food' scenarios.

All six scenarios include every element of the waste management system for which waste authorities are responsible, including:

- Materials and bulky waste reuse;
- Household and small business recycling and composting collection services, on-the-go recycling, 'bring' sites and Household Waste Recycling Centres (HWRCS) for subsequent materials reprocessing (including the intermediate use of MRFs);
- Treatment of source separated organic (food and green) wastes by composting and AD; and
- Treatment of residual waste, including materials recovery, energy generation and any reject streams sent to landfill;⁸ and
- Direct landfill of wastes.

Emissions from transport, including collection from the kerbside and onward movement of waste, however, have been excluded from the modelling of EPS on the basis that:

1. They are extremely challenging to model with any degree of accuracy. This is because information on transport movements is not reported by waste authorities into the Environment Agency's WasteDataFlow tool. Furthermore, waste authorities are often not fully aware of the final destination of materials collected for recycling and reprocessing; and
2. They usually contribute a relatively small proportion of total emissions from waste management activities (approx 5-10%).

It was therefore agreed by Eunomia with the Steering Group for this study that National Indicator (NI) 185 provides sufficient incentive for waste authorities to

⁸ It should be noted that to facilitate the inclusion of a range of technology configurations and related assumptions, Eunomia has needed to develop a range of 'user-defined' processes (UDPs) within WRATE. These will be made available by the GLA to all London waste authorities

reduce emissions from their transport operations. Furthermore, TFL has developed a Freight Operation Recognition Scheme (FORS) to help Boroughs reduce emissions from their vehicle fleets.⁹

It should also be noted that the EPS does not include any CO_{2e} savings which might be achieved from reusing waste. This is because there is currently significant uncertainty over appropriate emissions factors to ascribe to different reuse routes and thus such factors are not included within WRATE. The EPS has been developed, however, to be flexible over time to accommodate reuse activities should future versions of WRATE include such factors.

It should be acknowledged that the six scenarios upon which the EPS is based, do include an annual one per cent waste reduction 'factor'. This is equal to an assumed zero per cent growth in waste produced per household between 2008 and 2031 when the number of households in London is expected to grow by approximately 20 per cent.

Albeit, therefore, with the exclusion of transport and reuse impacts, and taking into consideration that WAs manage varying tonnages of waste, the most appropriate metric for setting the EPS is according to 'tonnes of CO₂ emitted per tonne of waste managed' (tCO₂/t waste managed).

As mentioned above, all assumptions relating to the scenarios can be found both in the waste flows detailed in Appendix 2 and in more detail, in the aforementioned study undertaken by Eunomia on behalf of the GLA, which was commissioned to assess the associated costs of future waste management in London.¹⁰

2.2 Setting the Level of the EPS

Based on the scenario modelling described above, the level of the EPS has been set at the level of the *lowest* performing of the six key scenarios which meet the recycling and composting targets set within the draft MWMS. This results in an EPS of -0.30 kgCO₂/t waste managed in 2015.

Figure 2-1 summarises the results of the modelling for all target years, which are broken down according to emissions from recycling, treatment of source-separated organics and residual wastes. In line with the increasing levels of recycling and composting performance required within the Mayor's MWMS, Figure 2-1 shows that the EPS becomes stricter over time from the 2008 baseline (current practice) to 2031. All assumptions relating to capture rates of materials from different recycling activities and the modelled roll out (and performance) of different waste treatment technologies have been developed using information published by WRAP.¹¹

⁹ More information on FORS can be found at <http://www.tfl.gov.uk/microsites/fors/>.

¹⁰ Eunomia (2010) Economic Modelling for the Mayor's Municipal Waste Management Strategy, on behalf of The Greater London Authority, August 2010

¹¹ WRAP (2009) *Analysis of kerbside dry recycling performance in England 2007/08*, available at: http://www.wrap.org.uk/local_authorities/research_guidance/collections_recycling/benchmarking.html

Figure 2-1: Setting the EPS for London (2008-2031)

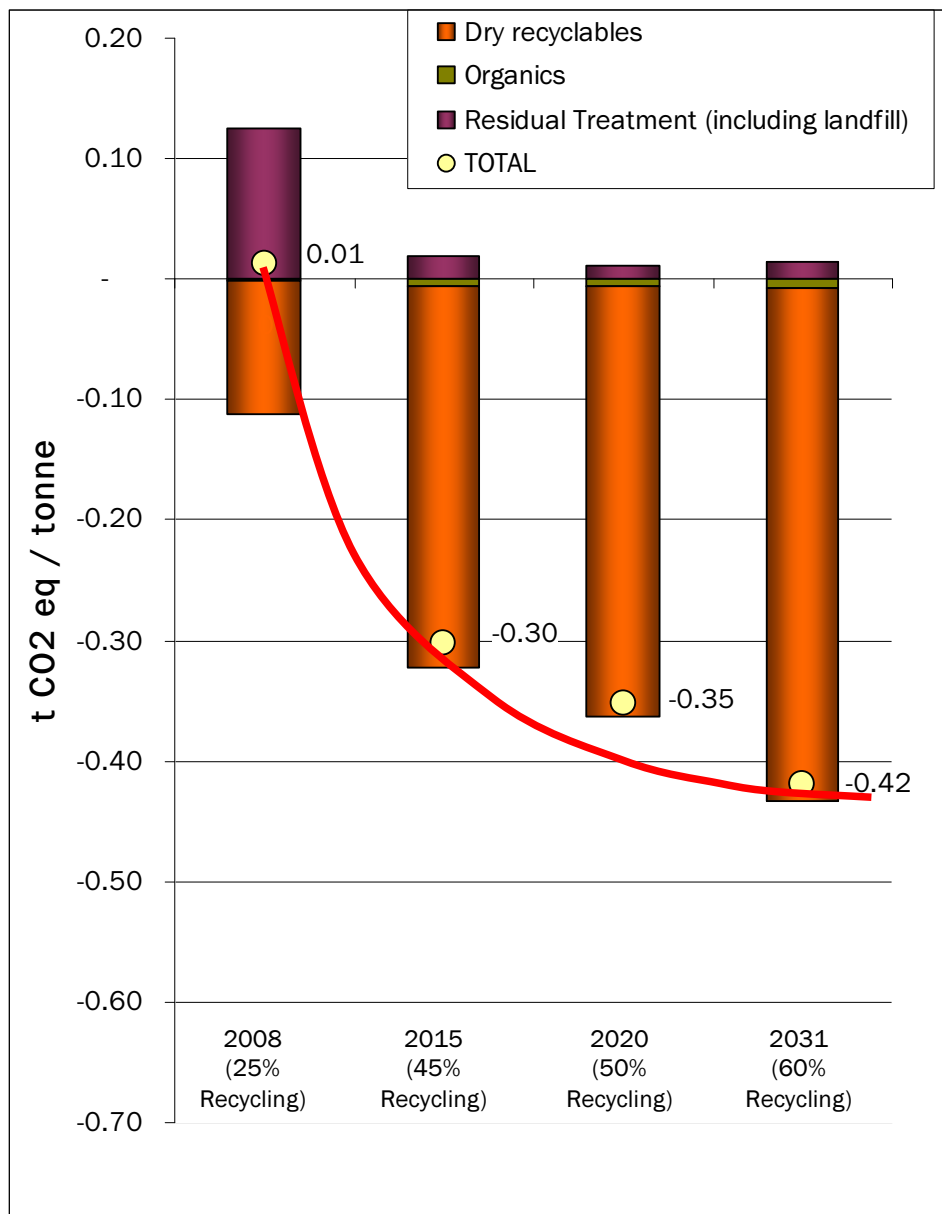


Table 2-3 presents the total emissions associated with meeting the EPS in each target year, alongside related tonnages of waste managed by each different activity. As mentioned above, it should be noted that the EPS is set at the level of the lowest

performing of the six key scenarios, and therefore not all residual technologies employed in the wider modelling are included.¹²

It should also be acknowledged that there is a reduction in incineration capacity over the period 2015 to 2031 due to the assumed closure of the Edmonton plant. Furthermore, for all residual technologies, the CO₂ impact of each tonne of waste treated changes over time and in general, becomes more 'carbon intense'. This is because year-on-year increases in the level of recycling vary across different materials results in a changing residual waste composition in each target year. In the case of incineration, for example, this results in a situation whereby in 2031, whilst less waste is being processed than in 2020, there are higher total CO₂ emissions. Finally, between 2015 and 2020, there is assumed to be a fall in the level of residual treatment as, due to the increasing tonnage of materials recycled to meet the 2020 target, some of the residual capacity developed before 2015 is temporarily no longer required for MSW.

¹² Notably, autoclaving is absent from Table 2-3, but is included in other scenarios

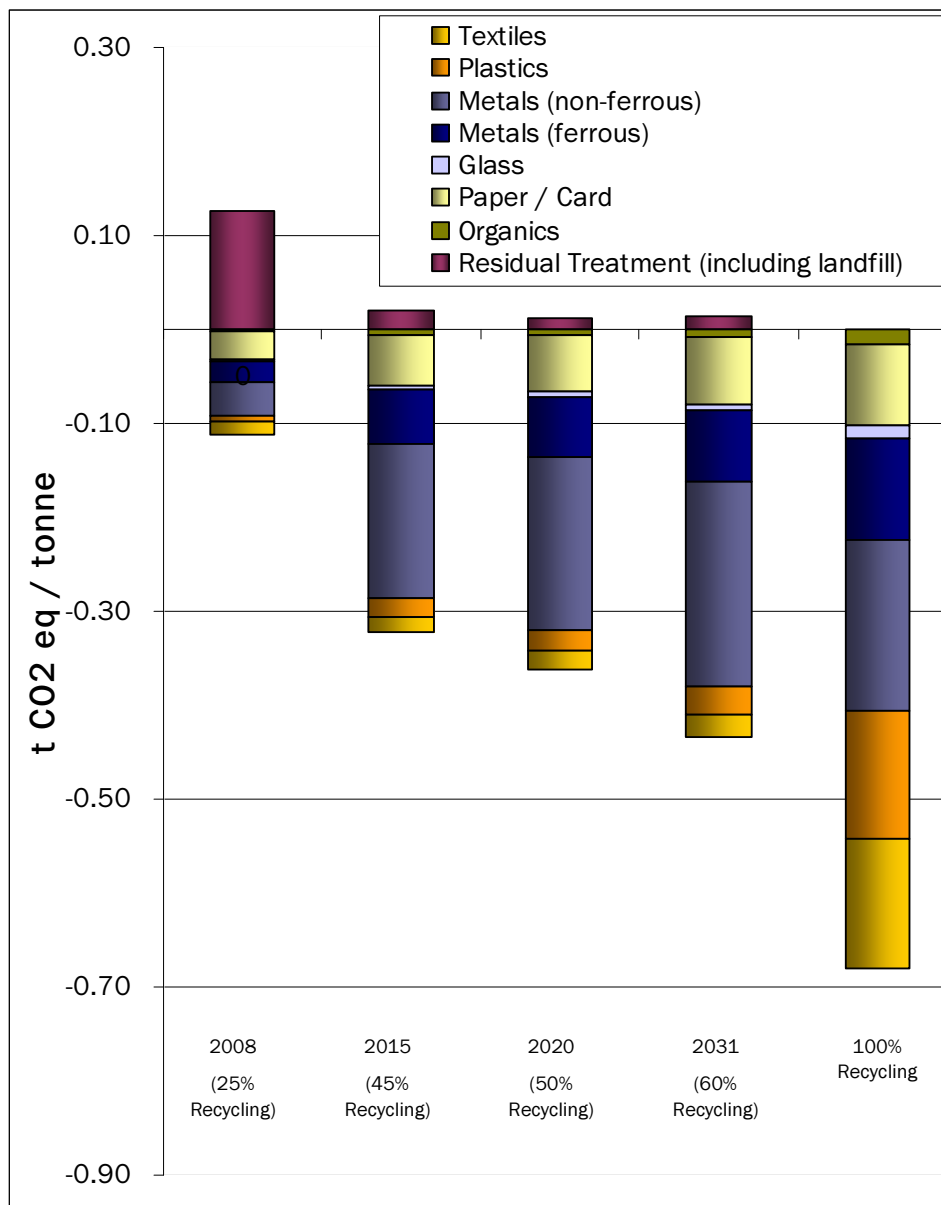
Table 2-3: Total Emissions associated with meeting the EPS for London

Waste Management Activity	Waste Managed (ktpa)			Associated Emissions (ktCO2e)		
	2015	2020	2031	2015	2020	2031
Residual Waste¹						
Landfill	300	150	0	75.3	36.2	0
Incineration	1,318	1,318	788 ²	-27.3	-8.7	28.6
Incineration (bio-drying)	167	82 ³	107	9.3	4.9	11.2
Gasification - Steam Turbine (bio-drying)	111	82 ³	107	16.7	13.9	23.8
Gasification - Gas Engine (bio-drying)	0	41	321	-	-2.8	-8.7
Organic waste						
AD	126	157	205	- 10.5	- 13.1	- 17.0
IVC	247	278	329	- 11.6	- 13.1	- 15.4
OAW	199	213	277	1.9	2.1	2.7
Materials Recycling / Reprocessing						
Paper / Card	713	780	905	- 213.1	- 233.1	- 270.6
Glass	107	110	128	- 18.2	- 18.6	- 21.7
Metals (ferrous)	138	153	184	- 223.8	- 247.9	- 298.7
Metals (non-ferrous)	59	65	79	- 633.4	- 701.8	- 845.7
Plastics	65	76	97	-76.8	-89.7	-115.1
Textiles	15	18	22	- 64.6	- 79.6	- 98.3
Wood	42	44	58	0	0	0.1
TOTAL	3,885	3,845	3,875	-1,176	-1,351	-1,624
EPS (tCO2/t)				-0.303	-0.351	-0.419
Notes:						
<ol style="list-style-type: none"> 1. The EPS is set at the level of the lowest performing of the six key scenarios, and therefore not all residual technologies, for example, autoclaving, which are employed in the wider modelling, are included here 2. It is assumed that Edmonton closes between 2015 and 2020 3. The fall in tonnage gasified is due to the increasing tonnage of materials recycled to meet the 2020 target, which could result in over-capacity of residual treatment infrastructure 						

Figure 2-1 above demonstrates that the bulk of emissions reductions required to meet the EPS must be delivered by materials recycling and reprocessing. Figure 2-2 provides a further breakdown of the *relative* contribution each material type makes towards meeting the EPS in each year. To give further context, an additional bar has been included in Figure 2-2 to show the maximum (100%) potential which might be delivered by recovery of each different material. As mentioned above, all assumptions relating to capture rates of materials for recycling or composting have been developed using information published by WRAP.¹³

¹³ WRAP (2009) *Analysis of kerbside dry recycling performance in England 2007/08*, available at: http://www.wrap.org.uk/local_authorities/research_guidance/collections_recycling/benchmarking.html

Figure 2-2: Materials assumed to be recovered for Recycling and Reprocessing



Note: In the 50% and 60% scenarios there is already a very high percentage of non-ferrous metals being recycled. Recycling of ferrous metals, therefore, appears lower under the '100% recycling' scenario, as there is very little additional non-ferrous metal being recycled, but a significantly increased total tonnage of all materials being recycled

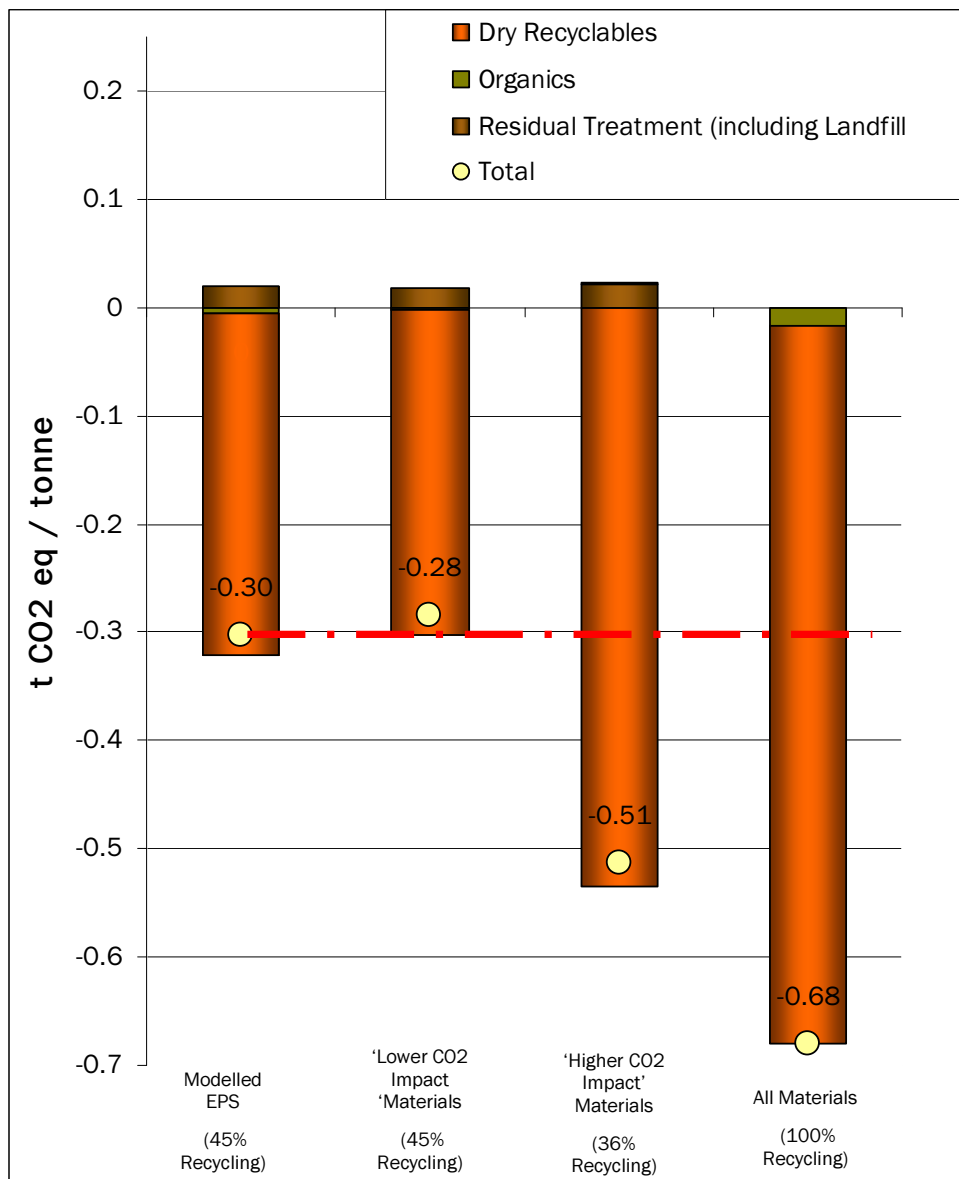
The key principle of the 'whole system' approach is that, as much as possible, it is flexible and 'output' based. The approach allows, for example, the potential for WAs which may find it difficult to collect high volumes of recyclables (due to significant amounts of high density housing) to focus attention on the recovery of materials which deliver greater CO₂ benefits. This is demonstrated in Figure 2-3 by the

modelling of the EPS for 2015 (of -0.30 tCO₂e/t waste managed) alongside three further scenarios whereby:

1. The EPS is met (with performance of -0.51 tCO₂e/t waste managed) by focusing on collection of 'higher impact' materials such as plastics and metals, but the tonnage recycling targets are not met; and
2. There is a focus on 'lower impact' materials such as glass and paper, and whilst the tonnage targets are met, the EPS is not (performance is 0.28 tCO₂e/t waste managed); and
3. 100% of all materials are collected to demonstrate the maximum potential CO₂ performance of -0.68 tCO₂e/t waste managed.

This approach supports the principle of delivering 'real' environmental benefits, rather than seeking to deliver upon 'weight-based' targets, which offer negligible gain, for example, collecting glass which subsequently crushed for use in aggregate markets. Associated materials capture rates modelled for both the 'higher' and 'lower' impact approaches are provided in Appendix 4.

Figure 2-3: Performance of Different Approaches to Materials Collection against EPS



3.0 Carbon Intensity ‘Floor’ for Energy Generation from Waste

3.1 Approach and Methodology

Energy generation forms an element of the residual waste treatment module within the ‘whole waste system’ EPS. However, in line with the Mayor’s principle within the MWMS of providing support for low carbon, decentralised energy, a distinct ‘floor’ level of performance is required.

Setting a carbon intensity floor aligns the Mayor’s waste management policy goals with those in his Climate Change Mitigation and Energy Strategy (CCMES) for delivering low carbon energy in London.¹⁴ In aligning the MWMS and the CCMES, the Mayor proposes that all London’s MSW used for energy generation should have a carbon intensity less than, or equal to, the source of energy generation it displaces (otherwise known as the ‘marginal source’ of generation), regardless of the location of the facility.

Based on Defra guidance for studies of this nature, and in line with the approach taken in the 2007 National Waste Strategy for England, the ‘marginal’ source of generation which is considered to be displaced for the purposes of this study is combined cycle gas turbine (CCGT) plant.¹⁵ Such facilities are assumed to generate electricity at a carbon intensity of 387gCO₂ per kilowatt hour (CO₂/kWh), and therefore facilities generating energy from London’s MSW must perform at a level equal to or below this ‘floor’. Performance against the ‘floor’ must therefore be expressed in terms of kgCO₂/kWh (of electricity generated).

Towards alignment with the Mayor’s wider approach in the CCMES to appraising all types of generation plant in London, i.e. not solely those generating energy from waste, performance against the carbon intensity ‘floor’ should focus on modeling of emissions from the thermal facility alone, such that the scope of the ‘life-cycle’ boundaries:

- Exclude any CO₂ benefits of materials capture and subsequent reprocessing;
- Exclude the emissions from any reject streams sent to landfill;
- Exclude the parasitic load of fuel preparation facilities, but includes the ‘parasitic load’ of facilities generating energy;
- Exclude direct emissions (including N₂O) from fuel preparation facilities; and

¹⁴ Mayor of London (2010) Delivering London’s energy future: The Mayor’s draft Climate Change Mitigation and Energy Strategy for consultation with the London Assembly and functional bodies, February 2010

¹⁵ Defra (2006) Greenhouse Gas Policy Evaluation and Appraisal in Government Departments, April 2006

- Include the benefits of heat production and subsequent use when operating in CHP mode.

As mentioned above, WRATE has been designed as a life-cycle assessment tool, and as a result, has not been developed to express the CO₂e performance of energy generation from waste in kgCO₂/kWh. Eunomia has therefore developed a separate tool using data from WRATE to take this into consideration when setting the carbon intensity ‘floor’.¹⁶ The methodology for developing this tool is summarised in Appendix 1. Again, it is anticipated that further, more detailed guidelines, along with an associated ‘Ready Reckoner’ tool to enable greater ease of use for waste authorities, will be published at a subsequent time.¹⁷

It should also be noted that WRATE does not currently include the capability to model the carbon intensity of producing liquid or gaseous transportation biofuels from waste. As all such biofuels are used to displace very carbon intense fossil fuels such as petrol and diesel, however, it is assumed that waste authorities following this approach will meet the EPS if there is a minimum of 50% biomass in the feedstock sent for processing.

Furthermore, it is acknowledged that some waste authorities in London plan to produce a solid recovered fuel (SRF) from pre-treatment processes to be sent for use as a fuel in cement kilns. These focus on the generation of heat and do not produce electricity and therefore performance cannot be easily modelled against the carbon intensity ‘floor’. As processing of solid recovered fuel SRF will usually displace coal (a very carbon intense fuel), it will be assumed, as for biofuels, that waste authorities following this approach will meet the EPS if there is a minimum of 50% biomass in the feedstock sent for processing.

3.2 Options for Meeting the Carbon Intensity ‘Floor’

3.2.1 Required Biomass Content of Feedstocks for Energy Generation

The ability of a particular WA to meet the carbon intensity ‘floor’ depends upon three key variables:

- The core generation technology employed, i.e. combustion or gasification, and also for the latter, whether a steam turbine or gas engine is employed;
- The amount of biomass in the feedstock supplied to the facility; and
- Whether the feedstock sent to the facility is untreated or has been processed into SRF.

¹⁶ Furthermore, as mentioned above, it should be noted that to facilitate the inclusion of a range of technology configurations and related assumptions, Eunomia has needed to develop a range of ‘user-defined’ processes within WRATE. It is intended that these will be made available by the GLA to all London waste authorities

¹⁷ The development of this ‘Ready Reckoner’ is currently being considered by the Environment Agency and WRAP. It will otherwise be commissioned directly by the Greater London Authority

Ultimately, pre-treatment technologies such as mechanical-biological treatment (MBT) or autoclaving might be configured to produce SRF which contains sufficient levels of levels of biomass to meet the EPS. It should be noted, however, that all MBT (bio-drying) facilities operating in the UK are currently configured to produce high calorific value fuels (with significant levels of plastic) for the cement industry. Furthermore, whilst autoclave suppliers claim their processes can produce very high biomass fuels, it has not yet been possible to verify this.

Table 3-1 provides indicative requirements, in terms of biomass content, for meeting the 'floor' under a range of different generation technology scenarios, for both untreated wastes. In Table 3-2 a range of further scenarios are detailed to demonstrate how varying levels of generation efficiency and biomass content will impact upon the ability of WAs to meet the 'floor' value. It is intended that both Table 3-1 and Table 3-2 function as reference points for WAs when considering options to generate energy from MSW. The efficiency of incineration plant currently operating in London (Edmonton and SELCHP) are around 21%, and therefore the information presented in Table 3-1 suggests that such plant would require untreated waste input with 80% biomass content to meet the 'floor' value. It should also be noted that WAs using the same energy recovery facility can 'combine' their residual waste within WRATE such that it is the net biomass content which is modelled against the carbon intensity floor.

Table 3-1: Indicative Requirements for achieving the Carbon Intensity 'Floor'

Technology	Mode of operation	Assumed Generation Efficiency (%) ¹		CV from Biomass (%) ³	
		Electricity	Heat ²	Untreated waste	SRF
Incineration	Electricity only	28%	n/a	71%	68%
	Electricity only	21%	n/a	80%	78%
	CHP	19%	30%	58%	55%
Gasification (steam turbine)	Electricity only	25%	n/a	79%	76%
	CHP	17%	27%	64%	61%
Gasification (gas engine)	Electricity only	33%	n/a	65%	63%
	CHP	33%	24%	43%	41%

Notes:

1. Generation efficiencies for gasification take into account the losses that occur during the conversion of the energy contained within the waste to syngas
2. Generation efficiencies for heat assume a load factor (i.e. the proportion of heat generated that is used) of 60%
3. Values for SRF are calculated in WRATE on a dry matter basis, whereas those for untreated wastes are calculated on a fresh matter basis (i.e., including the impact of the moisture content)

Table 3-2: Further Example Scenarios modelled against the Carbon Intensity 'Floor'

Technology	Fuel type	Mode of operation	Assumed Generation Efficiency (%) ¹		CV from Biomass (%) ³	Meets Energy EPS?
			Elec.	Heat ²		
Incineration	SRF	Elec only	29%	n/a	66%	yes
	SRF	Elec only	24%	n/a	68%	no
	Untreated wastes	CHP	20%	26%	60%	yes
	Untreated wastes	CHP	18%	33%	55%	no
Gasification Steam turbine	SRF	Elec only	23%	n/a	76%	yes
	SRF	Elec only	25%	n/a	72%	no
	SRF	CHP	18%	23%	64%	yes
	SRF	CHP	16%	30%	60%	no
Gasification Gas engine	SRF	Elec only	32%	n/a	65%	yes
	SRF	Elec only	37%	n/a	55%	no

Notes:

1. Generation efficiencies for gasification take into account the losses that occur during the conversion of the energy contained within the waste to syngas
2. Generation efficiencies for heat assume a load factor (i.e. the proportion of heat generated that is used) of 60%
3. Values for RDF are calculated in WRATE on a dry matter basis, whereas those for untreated wastes are calculated on a fresh matter basis (i.e., including the impact of the moisture content)

A further consideration is how AD of source separated organic (i.e. food or green wastes) wastes might interface with the carbon intensity 'floor'. As AD does not generate any energy from fossil fuels (i.e. plastics), operated in isolation, such facilities will always meet the 'floor' of 387gCO₂/kWh set by CCGT as the marginal source of generation. This is demonstrated by modelling of AD of 100% food wastes using the default AD model within WRATE, which results in a carbon intensity of 0.3gCO₂/kWh; therefore some way below the proposed 'floor'.

The separate collection of food and green wastes for AD, however, reduces the amount of biomass within residual wastes, and therefore potentially makes it more challenging for WAs to meet the indicative biomass requirements set out in Table 3-1. It is therefore relevant to consider the evidence as to whether WAs should be able to use the CO₂e benefits of generating energy via AD to offset the performance of residual waste facilities treating more carbon intense feedstocks. Under this approach, therefore, the net performance of all facilities (both AD and residual), would be modelled to assess performance against the carbon intensity 'floor'.

Table 3-3 shows the potential percentage biomass of residual waste following upfront recycling of varying levels of 25%, 45%, 50% and 60%.¹⁸ These results can be compared with the data in Table 3-1 to assess the degree to which pre-treatment (MBT or autoclaving) technologies must refine the input waste to increase the level of biomass of the output SRF to meet the carbon intensity 'floor'. This comparison shows that, with a 45% recycling rate, for example, if energy is subsequently generated via gasification (with a steam turbine) or by incineration, the biomass content must be increased by 16% and 8% respectively. If a gas engine was employed (with a gasification plant), however, no further pre-treatment would be required to meet the energy floor.

¹⁸ It should be noted that these levels of biomass are indicative only. Waste authorities might focus on different materials to achieve the same levels of recycling, which would result in different levels of biomass in the residual composition

Table 3-3: Biomass potentially within Residual Waste Streams

Assumed Recycling / Composting Rate ¹	CV from Biomass of Residual Waste (%) ^{2 3}
25%	62%
45%	60%
50%	53%
60%	49%

Notes:

1. All assumptions for capture rates of different materials are based on information published by WRAP (2009). A maximum of 15% of the total recycling / composting rate is derived from food waste collection
2. It should be noted that these levels of biomass are indicative only. Waste authorities might focus on different materials to achieve the same levels of recycling, which would result in different levels of biomass in the residual composition
3. The composition of the residual waste modelled under each recycling / composting rate is provided in Appendix 5

The evidence presented within the scope of this study suggests, therefore, that even WAs which are collecting food wastes from the kerbside, appear to have a reasonable chance of meeting the carbon intensity 'floor' for residual treatment plant if the procured solution includes the following:

- Pre-treatment via MBT or autoclaving;
- Higher efficiency generation technologies; and
- Use of heat to supply domestic or commercial buildings.

As a result, within the scope of analysis undertaken for this study, there does not appear to be a sound evidence base for allowing AD to offset performance, against the 'floor', of plant processing residual waste.¹⁹

¹⁹ It should be noted, however, that the scope of this study does not include any consideration of the costs of meeting the 'carbon intensity' floor