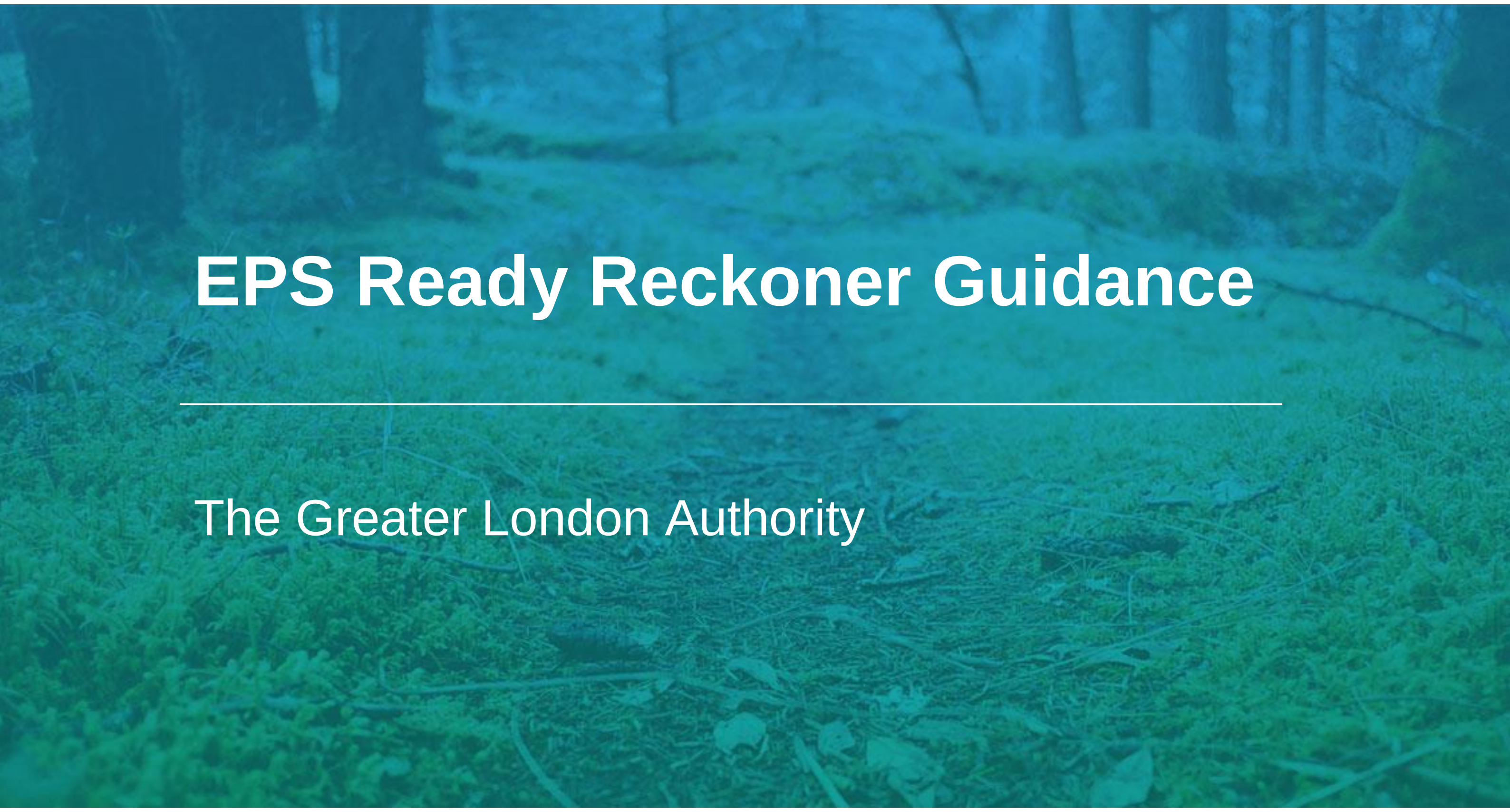

EPS Ready Reckoner Guidance

The Greater London Authority

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Report for Greater London Authority

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1.0 Introduction

This is a guidance document accompanying the Ready Reckoner, a simple way to model London boroughs' performance against greenhouse gas performance targets.

The greenhouse gas (GHG) emissions performance standard (EPS) forms a core element under the waste chapter of the Mayor's London Environment Strategy (LES).

Two of the key principles in the waste chapter of the Strategy are:

1) Encouraging a focus on recovering materials and reprocessing routes that deliver greater CO_2e reductions; and
2) Providing support for decentralised energy generation from waste that is no more carbon intensive than alternative new base-load energy generation.

To deliver upon these two principles, Eunomia has developed a 'whole waste system' EPS, as well as a carbon intensity 'floor' (CIF) which applies solely to generating energy from waste. EPS performance is measured in terms of **kg CO_2e/t**, or kilograms of carbon dioxide equivalent emitted per tonne of waste managed – it effectively measures the carbon intensity of different waste management methods. The CIF measures the carbon intensity of electricity generated from waste, in **g CO_2e/kWh** of electricity.

The GLA has also developed a tool for London boroughs to model their performance against the EPS and CIF, called the Ready Reckoner, which acts as a GHG calculator.[1] This allows you to:

- compare the current carbon impact of waste management against targets set in the EPS;
- compare current residual treatment against the CIF target; and
- test and model the impact of different interventions which will help you to meet the EPS and CIF and develop recycling plans and waste strategies.

The guidance document sets out:

- in Section 2.0 – the relative impact of different kinds of service changes and waste flow impacts when considering carbon rather than weight-based targets;
- in Section 3.0, how the EPS performance is calculated;
- in Section 3.1, how to use the Ready Reckoner tool to set up baseline performance (4.1) and model scenarios (4.3); and
- in Section 5.0, notes on setting KPIs related to lifecycle carbon emissions within contracts.

[1] The tool can be downloaded at www.london.gov.uk/priorities/environment/putting-waste-good-use/making-the-most-of-waste

2.0 Carbon vs Weight-Based Metrics

A different set of service change priorities emerge when considering carbon impact compared with traditional weight-based recycling targets. Table 2-1 below outlines a number of waste service changes or waste flow impacts and shows how they impact relatively on weight-based (recycling rate) and carbon-based (EPS) metrics.

The recycling rate impact result gives a typical indication of the scale of impact these initiatives have, whilst the carbon impact result gives a combined result of the scale of the tonnage impact and the carbon impact per tonne (which varies depending on the materials involved and the resulting fate of residual waste). A 'high' impact indicates a positive contribution towards achieving higher recycling performance, or achieving 'high' CO2 savings making a better performance towards the EPS.

The scores are allocated to provide an indication of the relative impact of different measures, but depend on the ambition, scale and effectiveness of these measures.

Section 3.0 goes into greater detail into how the EPS metric is calculated and the treatment of natural (biogenic) carbon and fossil (non-biogenic) carbon, and Box 2 below the table describes the 'scaling' effect indicated in the table.

Table 2-1: Impact of Initiative and Service Changes on Weight- and Carbon-based Metrics

	Recycling Rate Impact		Carbon Metric Impact (likely tonnage impact multiplied by the carbon impact/tonne)		
Service Change	**Indicative Impact**	**Rationale for Score**	**Indicative Impact (cf. Landfill)** *If would otherwise be destined for landfill*	**Indicative Impact (cf. Incineration)** *If would otherwise be destined for incineration*	**Rationale for Score**
Food waste prevention	Medium	Food waste is heavy and a large component of residual waste. Tonnage impact depending on the scale and success of initiatives	Medium	Medium Scaling up (see Box 2)	Preventing food waste to landfill has a positive carbon impact. Food waste to energy recovery has a small carbon impact, so reducing tonnages means EPS performance is scaled up as in Box 2 below.
Plastic waste prevention	Low	Plastics are lighter portion of the waste stream so the recycling rate impact is lower – again, the tonnage impact depends on the scale and success of initiatives	Low	High	Though light, plastics are high in fossil carbon. The carbon benefit from reducing plastic waste to incineration is significant.
Residual waste prevention	Medium	Again, dependent on the scale and success of residual waste prevention initiatives	Medium	Medium	Reducing quantities of general residual waste without reducing quantities of waste captured for recycling is good across all metrics, although the EPS metric (per tonne managed) will obscure the full carbon savings.

	Recycling Rate Impact		Carbon Metric Impact (likely tonnage impact multiplied by the carbon impact/tonne)		
Service Change	**Indicative Impact**	**Rationale for Score**	**Indicative Impact (cf. Landfill)** *If would otherwise be destined for landfill*	**Indicative Impact (cf. Incineration)** *If would otherwise be destined for incineration*	**Rationale for Score**
Separate food waste collections	High	As a dense material and a significant fraction of residual waste, separate collections of food waste tend to deliver a significant boost to recycling rates	High	Medium to Low	There are benefits from capturing food waste to AD compared to energy recovery in incineration, and significantly more so if it would otherwise be landfilled. The carbon impact depends on the relative energy efficiencies of AD and energy from waste facilities.
Residual waste collection: reduction in volume or frequency	High	Reduction in residual waste collections tend to divert significant tonnage into recycling and organics collections	High to Medium	High to Medium	This has an impact through increases in kerbside recycling yields. The extent of the carbon impact for landfill depends on its success in increasing kerbside food yields and the extent of the carbon impact for incineration depends on success in diverting plastics and textiles from residual waste.
Increase kerbside dry recycling yields	Medium	Dependent on the scale and success of initiatives.	Low	Medium	Increasing kerbside dry yields reduces waste to landfill and, if plastics are targeted, reduces fossil carbon sent to incineration.

	Recycling Rate Impact		Carbon Metric Impact (likely tonnage impact multiplied by the carbon impact/tonne)		
Service Change	**Indicative Impact**	**Rationale for Score**	**Indicative Impact (cf. Landfill)** *If would otherwise be destined for landfill*	**Indicative Impact (cf. Incineration)** *If would otherwise be destined for incineration*	**Rationale for Score**
Increase kerbside food waste yields	Medium	Dependent on the scale and success of initiatives.	Medium	Low	Food waste yields add to recycling rates, and avoid landfill emissions.
Increase capture of plastics (i.e. expand to full range of targeted plastics)	Medium to low	Depending on the coverage of existing plastics collections, increasing the range can deliver up to in the region of 10 kg/hh of additional pots, tubs and trays	Low	High	Plastics are a light material but high in fossil carbon. The carbon benefit from recycling plastics is particularly high when it would otherwise be incinerated.
Increase reuse or recycling of textiles	Medium to low	Textiles make up in the region of 5% of typical residual kerbside waste, but recycling yields tend to be relatively small in tonnage terms.	Medium	High	Textiles are relatively high in fossil carbon and intensive to manufacture – reuse and/or recycling delivers carbon benefits, the most when the material would otherwise be incinerated.
Charged garden waste service (from free)	Neutral to Negative	Likely to see some reductions in garden waste tonnage recycled, though the extent of this depends on participation levels in the charged service	Neutral to Negative (and scaling up – see Box 2)	Neutral to Negative (and scaling up – see Box 2)	A reduction in garden waste means a slightly higher net carbon impact (since garden waste treatment creates carbon savings) divided over a smaller amount of tonnage

	Recycling Rate Impact		Carbon Metric Impact (likely tonnage impact multiplied by the carbon impact/tonne)		
Service Change	**Indicative Impact**	**Rationale for Score**	**Indicative Impact (cf. Landfill)** *If would otherwise be destined for landfill*	**Indicative Impact (cf. Incineration)** *If would otherwise be destined for incineration*	**Rationale for Score**
Free garden waste service (from charged)	Medium to Low	May see an increase in garden waste tonnage recycled, dependent on current participation levels and number of households with gardens	Low (and scaling down)	Low (and scaling down)	A slightly reduced net carbon impact is divided over a larger amount of tonnage
Sorting residual waste prior to treatment/disposal (including extraction of wider range of plastics and film)	High	After exhausting household recycling collection services, residual sorting could divert significant fractions of residual waste to recycling (particularly metals and plastics)	Medium	High	In addition to a boost to recycling rates and getting a carbon benefit from material recycling, the highest carbon benefit arises where the sorting process extracts a wider range of plastics and prevents the incineration of these materials.

Other factors influencing carbon performance do not have any impact on recycling rates: how efficiently the energy content in waste is converted into electricity and heat to displace other fuel use, and how much fuel is used to collect and transport residual waste and recycling.

An additional complexity is that the EPS metric measures carbon emissions *per tonne of waste managed* – therefore, a reduction in the tonnage of low carbon waste materials means a similar net carbon impact is spread across a reduced tonnage. The net effect is to make the positive EPS score more positive (i.e., a slight increase), and the negative score more negative (a slight decrease). Where this effect occurs in the table below it is referred to as 'scaling up'. This effect is illustrated with numerical examples in in box 2.

Box 2: 'Scaling' of EPS performance through waste prevention

The following table shows two scenarios where the same service change is applied: waste prevention of an inert material or one of low carbon impact (say of food waste or glass). For the purposes of this illustration, suppose this material has no net overall carbon impact. In Scenario A, the baseline EPS score is above zero, whilst in Scenario B, the baseline EPS score is below zero (i.e. there is a net emissions saving). The impact of the change is to 'scale' the current score – making the positive score more positive, and the negative score more negative.

Scenario A		Scenario B	
Baseline	**Waste Reduction**	**Baseline**	**Waste Reduction**
Total Waste: 1000 Net Carbon: 100 EPS Score: 0.1	Total Waste: 900 Net Carbon: 100 New EPS Score: 0.11	Total Waste: 1000 Net Carbon: -100 EPS Score: -0.1	Total Waste: 900 Net Carbon: -100 New EPS Score: -0.11
Impact: No change in overall carbon emissions 0.01 **increase** in EPS Score (10% scaling up) - an increase in net emissions per tonne.		**Impact:** No change in overall carbon emissions 0.01 **decrease** in EPS Score (10% scaling up) – an increase in net emissions savings per tonne.	

The opposite change – an increasing the tonnage of a low carbon impact material – has the opposite effect, making a positive score less positive and a negative score less negative. This is referred to as 'scaling down'.

3.0 The EPS Performance Calculation

The EPS performance methodology effectively calculates the carbon intensity of different waste management methods in kg CO_2e per tonne of waste managed. The methodology for undertaking these calculations was first published in 2011, and some methodological updates together with full assumption data tables are provided in the 2017 update report.[2,3] The key calculation methodology is outlined in brief here to demonstrate how changes in inputs in the Ready Reckoner relate to EPS performance changes.

The model calculates tonnages of specific material streams that are:

- Reused;
- Recycled; and
- Disposed of via residual treatment.

It calculates carbon impacts by multiplying the tonnes of waste by per-tonne carbon factors associated with:

- Reuse of each tonne of material by main material type;
- Recycling of each tonne of material by main material type, either
  - collected through recycling collections; or
  - extracted from residual waste (through a residual MRF, for instance).
- Residual treatment of each tonne of material (MBT/Energy from Waste /Landfill)

Residual treatment tonnages include tonnes collected for recycling but not finally recycled (excluding any mass or moisture loss from sorting stages).

Recycling carbon factors for some materials differ when the recycling is extracted from residual waste – fibres are not assumed to have any carbon benefit as the quality is low, and the benefit from plastics recycling is reduced to account for higher ratios of plastic film. Fuller commentary on carbon factors applied can be found in appendix A.1.0.

Also included are:

- transport emissions, covering collection & transport to treatment/disposal; and
- sorting emissions from material processed via a MRF and material sorted via MBT or residual waste MRF (R-MRF).

The EPS performance (in terms of **kgCO2e/t**) is then calculated by adding up all carbon impacts (from multiplying tonnages recycled/treated by carbon impacts of that

[2] Eunomia Research & Consulting (2011) Development of a Greenhouse Gas Emissions Performance Standard for London’s Municipal Waste – Revised Report, Final Report for the GLA, June 2011
[3] Eunomia Research & Consulting (2018) Greenhouse Gas Emissions Performance Standard for London’s Local Authority Collected Waste – 2017 Update, March 2018

recycling/treatment), and dividing this total carbon impact by the total amount of waste managed.

The carbon impact of residual waste treatment routes are dynamic, and impacted by:

- the composition of waste into the facility (amount of recycling, particularly plastics extracted in pre-sorting); and
- the heat and electrical generation efficiency of the facility.

Therefore key ways to improve carbon performance include:

- increasing capture of materials with high carbon impact for recycling; and
- capturing materials with high carbon content before incineration (particularly plastics).

Box 1: Biogenic and Non-biogenic Carbon Emissions

The carbon emissions associated with the burning of carbon from non-fossil-fuel sources (in food and garden waste, paper and wood) are termed 'biogenic' CO_2 emissions. These emissions are not included in the Ready Reckoner calculator by carbon accounting convention. Most of the carbon contained in these materials was recently sequestered into these products during plant growth; as a consequence, the net release of the same carbon (as biogenic CO_2) a short period of time after the initial sequestration would result in no net contribution to global climate change emissions. Biogenic CO_2 emissions can result as a consequence of natural organic carbon decay (e.g. of plant matter on the forest floor), from landfill degradation, and from burning organic waste in an incinerator.

In landfill, however, some biogenic carbon is also released in the form of methane, which is a more potent greenhouse gas than CO_2. Such impacts are included in emissions inventories (and are therefore included in the Ready Reckoner) as they only occur as a result of anthropogenic activity. Other direct emissions arising from waste management activities principally relate to the emission of CO_2 from fossil carbon sources (i.e. derived from fossil fuel) as a consequence of the combustion of these materials - the main source of this material in the residual waste stream being plastics.

Therefore, the following general rules apply to minimise carbon emissions from residual waste treatment and disposal:

- Materials with high fossil (non-biogenic) carbon content should not be incinerated
- Materials with high natural (biogenic) carbon content should not be landfilled

3.1 The CIF Performance Calculation

The CIF measures the carbon intensity of electricity generated from waste, in **g CO_2e/kWh** of electricity. The GHG emissions in the scope of the CIF calculation include:

- impacts associated with fossil CO2 emissions from the energy generation process;
- emissions associated with energy use at the incinerator (the ‘parasitic load’); and
- any *avoided* emissions associated with the utilisation of generated heat.

The kWh of electricity generated is calculated as the gross energy efficiency of the facility multiplied by the energy content in the waste (the net calorific value of material streams multiplied by the input composition).

The main ways to improve CIF performance at the facility level are:

- increased extraction for recycling of high fossil carbon materials (plastic and textiles) prior to incineration; and
- utilising (through heat networks) heat generated by the facility in CHP mode.

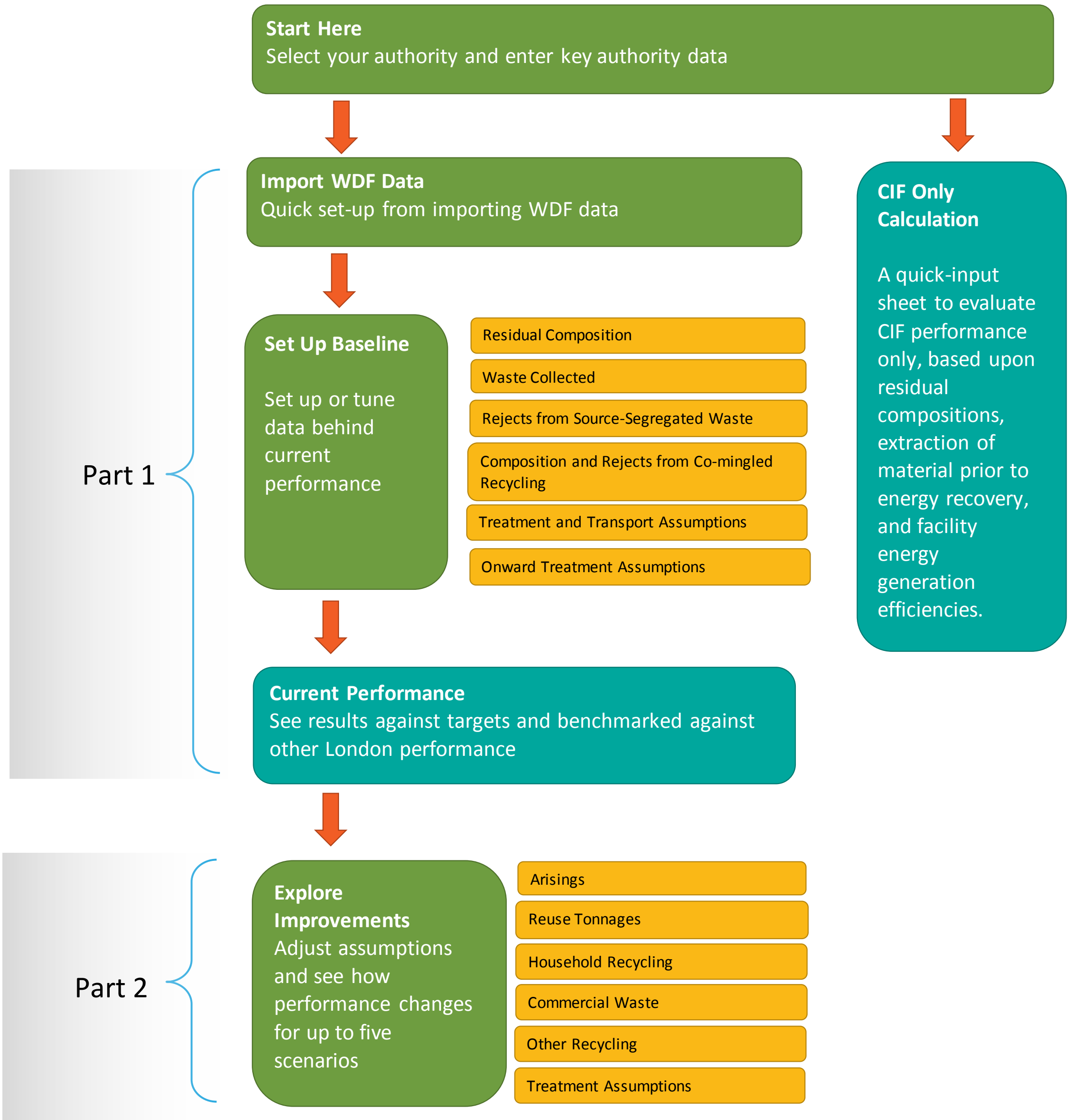
4.0 How to use the tool

The Ready Reckoner tool is divided into two parts:

- **Part 1:** Establish baseline or current performance
- **Part 2:** Explore impact of potential interventions

The sheets are displayed in Figure 4-1.

Figure 4-1: Model Structure



4.1 Note on Scope of Wastes

For the purposes of modelling forward arisings and recycling projections, the Ready Reckoner separates out waste into three streams:

- 'Waste from Households' following Defra's application of the definition to WasteDataFlow data;[4]
- Commercial Waste – waste collected from commercial premises recorded in WDF Q11 (recycling collections) and Q23 (residual collections);
- Other Wastes – wastes not included in either of the above categories.

The 'Waste from Households' is different from the older 'Household Waste' definition used in the calculation of the NI192 indicator, excluding in particular street cleansing waste and recycling from street bins. The ready reckoner also takes a more simplified approach to back-allocating recycling extracted from residual waste between WfH and commercial waste recycling. As such, there will be some differences between the forward recycling projections for Waste from Households compared to projected NI192 recycling rates.

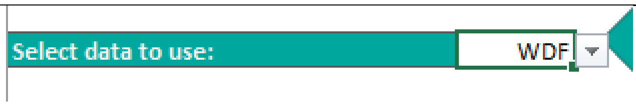
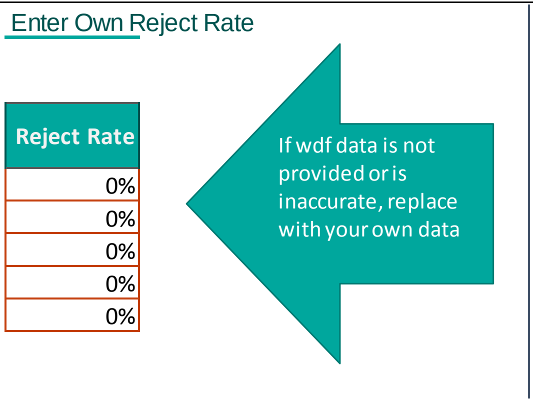
4.2 Part 1: Establishing Current/Baseline Performance

The Ready Reckoner allows you to either rely on Waste Data Flow (WDF) data or use your own data as your baseline. The easiest option is to download data from WDF as the Ready Reckoner is set up to automatically import the data and populate tables throughout the model, whereas your own data will have to be entered manually in each sheet. Instructions for importing WDF data are included in the "Import WDF data" sheet of the model. You can also edit or enter your own data on subsequent sheets if WDF data is not available. Throughout the model there are green arrows to highlight where you have the opportunity to enter your own data.

The 'Set up Baseline' sheet provides an overview of the data that has been entered.

[4] http://www.wastedataflow.org/Documents/GuidanceNotes/WastefromHouseholds/Guidance_-_waste_from_households.pdf

User Tips:

Quick links at the top of the spreadsheets (see image to the right) allow you to move between sheets.	
Drop-down boxes allow you to switch between data sources	
Green arrows provide further guidance	

4.2.1 Set up Baseline

The sheets in this section are used to select or enter data relating to each part of your waste collection and management. This data subsequently feeds into the calculation of the EPS.

For the data entered for each area of waste management the 'Set up Baseline' sheet displays:

- whether the model has identified potential data errors, through a series of automatic checks;
- which data source is used in the model (i.e. whether it uses data from WDF, data that the user has entered, or an alternative provided assumption); and
- Quick links which will jump you to the relevant sheet.

If the notice 'high reject rates – check' appears in cell D25, this is a flag that there are materials for which the quantity collected for reuse or the quantity collected for recycling in WDF is significantly different from the amount recorded as reused or recycled in WDF Q100. This does not mean that the data is inaccurate, it is just drawing this sheet to your attention. See the notes in the following table regarding this section.

On this sheet, you can also view a summary of the tonnage data that has been loaded into the model.

The subsequent sheets for editing baseline performance data are listed in Table 4-1.

Table 4-1: Data-Input Sheets in Part 1 of the Model

Sheet	Description
Residual Comp	Allows you to enter your own residual waste composition data for kerbside residual waste, commercial residual waste and HWRC residual waste. These compositions are combined using data in the sheet 'Collections' to create an overall residual composition. **This step is important, since it establishes the quantity of carbon-intensive materials remaining in residual waste in the baseline. Replace this data with your own composition if you have one. The most important data from a carbon perspective is the quantity of plastic and textile waste in the residual waste stream.** If you just have a kerbside residual composition, you can input this in the user cells and copy and paste down the other residual compositions.
Collections	Allows you to view data from WDF or enter your own data on different materials collected for reuse and recycling, and residual waste collected from different sources: • Kerbside, • HWRC, • Other Household (for recycling, this includes bring sites, voluntary/community collections; for residual, this includes other household residual waste categories) • Streets (for recycling, this is any recycling from litter bins; for residual, this is street sweepings) This data will be automatically pulled from WDF, or you can enter your own data. You can switch between these sources by changing the selection box under the section title (labelled 'select data to use:') This sheet also displays a summary of the data entered in higher level categories (e.g. total dry recycling, total food waste, etc) and in kilograms per household per year.
Rejects (SS)	If you have not entered WasteDataFlow data, use this section to set reject rates (the proportion of the collected

Sheet	Description
	waste that does not end up recycled) for source separated collected material. If you have entered WasteDataFlow data, this section shows the differences between material streams reported as collected and material streams reported as recycled. These differences can be due to rejected material*, but it can also be due to differences in categorisation of waste between the collection and waste management questions*. As some examples: • Textile waste collected for reuse can end up as recycling, leading to a reduction in reuse compared to collections but an increase in recycling compared to collections; • Garden waste collected but registered in Q100 as *other compostable waste* would show up in the *mixed food and garden waste* EPS material category, leading to reduced garden waste tonnage but more mixed organics recycled than collected (and therefore an apparent negative 'reject rate'). A full breakdown by WDF material category of material collected for recycling and reuse and eventually reused or recycled is displayed below for reference The most critical figures to check are the 'Net Changes' figures for reuse, dry recycling, organics and overall. ***It is up to you whether to:*** • ***use WDF data, which will ensure performance matches more closely that reported by Q100 and the London-wide EPS; or*** • ***base performance on collected materials, and to set rejects rates matching the material reported as collected.***
Co-mingled Comp	Select or enter a composition for your co-mingled dry recycling to estimate different materials recycled from co-mingled recycling collections. If you have entered WDF data, you should be able to see and opt to use the output composition implied by this data.

Sheet	Description
	Input cells are also provided for calculating this composition based upon: • the input composition from the MF portal; combined with • the reject rate (amount of material not recycled), as reported by WDF.
Treatment and Transport	Allows you to set assumptions on a variety of treatment and transport assumptions as described below. **Residual Treatment Initial Destinations** – select or enter the initial treatment destinations of the residual waste collected, choosing from: • WDF Q100 data (if entered); • WDF data scaled to match tonnages of residual waste collected; • data on the relevant Waste Disposal Authority (WDA) residual treatment routes (if entering data for a waste collection authority); or • your own data. **Data can sometimes range from one year to the next due to stocking issues – if this difference is significant, it is likely to be more accurate to scale data to match tonnage collected.** **Energy efficiencies of incineration** – You can split residual waste sent for incineration between up to two different incinerators with different efficiencies. You can also set the efficiencies for incinerators for the output waste from R-MRF/RDF/MBT facilities. Incinerators can be selected from a drop-down list. If your incinerator does not appear on the list, details can be entered on the Carbon Assumptions sheet from row 99. Enter the name of the facility in column B and the Gross electricity generation % and Heat generation % in the corresponding rows for columns Q up to AH. Gross electricity generation figures are used since the calculation attributes separate emissions to the energy used by the incinerator. The heat generation figure should relate to heat utilised for heating which displaces other fuel used for heating (which is assumed to be gas). The model calculates the energy content of waste based on the net calorific value (in line with other tools such as

Sheet	Description
	WRATE); this assumes there is no recovery of the energy released in the evaporation of moisture in waste. The latter may occur in some CHP or district heating systems; where this is the case, the model user should take this into account when calculating the gross electrical efficiency (by excluding the additional energy recovered through the moisture from the output of the energy balance). **Transport distances and methods** to each main residual and organic treatment type. You can model an alternative transport method for a portion of the waste (e.g. if 60% is sent via rail and 40% via road a difference distance). You can also model the transport stages to incineration following pre-sorting/treatment/preparation at R-MRF, RDF/Autoclave and MBT facilities, setting up to three consecutive transport stages including international shipping. **Destination of MRF rejects** (whether to incineration, gasification, MBT, or landfill) **Extraction for recycling or IBA and metals** from incineration. This does not impact on EPS performance, however, since these are dynamically linked to the residual composition (post any pre-treatment sorting).
Onward Treatment	Use this sheet to set extraction rates for recycling from your residual waste facilities, and to set the destination of the remaining fraction of the waste. The facilities covered include: • Residual MRFs, • RDF/Autoclave/MHT or similar, • MBT, and • Other (for instance, a street sweeping facility). There are two slots for 'high performing' facilities, both R-MRF and MBT, to allow the modelling of improved extraction in future scenarios. These are filled with default values based on knowledge of sorting efficiencies in European mixed waste sorting facilities such as the RoAF facility near Oslo, Norway.

Sheet	Description
	Where WDF includes data on waste sent to these facilities, this information is pulled from WDF, otherwise London default assumptions are used. Alternatively, you can choose to use your own assumptions.

When you have selected or entered data for each of these sheets, return to the 'Set Up Baseline' page to check whether there are any errors detected in data entry. The lack of errors detected does not guarantee that the right data has been entered, just that the automatic validation is not detecting specific issues relating to a lack of data or data outliers.

4.2.2 Current Performance

The Current Performance sheet displays the carbon impact of waste management, as calculated by the Ready Reckoner, both overall and per tonne of waste managed. This is determined using the same methodology and calculation as are applied in the overall London EPS. See section 2.0 above for more detail, and for further information on the methodology employed for the carbon calculation.

The sheet compares results in key areas that typically have a significant impact on the carbon intensity of waste management, and that local authorities are in a position to affect, against London Benchmarks (performance across the range of London's local authorities). Based on this comparison, the model highlights target areas that a local authority can examine in order to improve performance.

This sheet provides three key output tables as per Table 4-2.

Table 4-2: Key Output Tables in "Current Performance" Sheet

Total Carbon Impacts	Performance Against Targets	Potential Target Areas for Improvement
Shows total carbon impact	Shows performance	Shows a range of areas that are known to impact on EPS performance and provides an indication of interventions that might be explored.

Subsequent data tables on this sheet compare performance against London benchmarks in more detail. These comparisons are made on;

- carbon impacts per tonne across the different waste management categories;
- kerbside dry recycling yields (kg/hhld/yr);
- yield of recyclable material (per hhld) from households (note that this includes HWRC and bring site yields);

- estimated percentage of commercial waste arising in the borough that is collected by the local authority provided service (Note that the data on borough-specific commercial waste arisings is highly uncertain), and the recycling rate of collected commercial waste;
- reject rate from the MRF (if one is used);
- percentage of residual waste sent to some form of pre-treatment before incineration or landfill; and
- the percentage of recycling extracted from residual waste by pre-sorting.

4.3 Part 2: Assessing Future Performance

This second section of the Ready Reckoner allows you to explore the impact of changes in collections and waste management on EPS and CIF performance. You can vary assumptions for up to five scenarios within one workbook.

If you are wanting to model more than five scenarios, a sheet is provided to allow you to combine the results from two different workbooks and present the results in the same chart.

The "Explore Improvements" sheet contains;

- a table that allows you to give each scenario a name describing the change you wish to model (e.g. 'New Energy from Waste contract' or 'Introduce separate food waste collection').
- links to subsequent sheets in which relevant assumptions can be varied;
- tables of results showing key metrics and a breakdown of CIF performance; and
- a graphical representation of the results (with the option to include/exclude each scenario from the graph).

The subsequent sheets are used to vary key assumptions to reflect the scenarios you choose to model. Table 4-3 details what key assumptions can be varied in these sheets. Once you have named your scenarios in the "Explore Improvements" sheet, navigate to the relevant subsequent sheet and alter the assumptions as desired.

The 'Combine Results' sheet can be used to integrate results from a second workbook to display in one output table and graph.

Table 4-3: Data-Input Sheets in Part 2 of the Model

Sheet	Description
Arisings *Use this page to model expected changes in waste*	Edit scenario assumptions relating to waste arisings from households - for instance, estimating impact of waste prevention on carbon performance.

Sheet	Description
arisings by material, or the impact of waste prevention initiatives.	Inputs are in tonnes of waste arising by material stream. You will need to add in factors and calculations manually into these cells. **Note that if you are introducing or changing a garden waste service, this is likely to have an impact on overall garden waste arisings (with more or less being home composted instead). You will need to account for this in this table (as well as in the household recycling sheet) by adding the change in garden waste arisings tonnage into the relevant cell in the garden waste row in this table.** **For the purposes of a 'ready reckoner', there is no need to model changes in arisings over time due to household growth or waste composition change.** These inputs cells however allow you to do bespoke modelling of either of these things if you wish.
Reuse Tonnages *Use this page to model increases in reuse tonnages collected through specific planned initiatives*	Edit scenario assumptions relating to reuse, both household and commercial waste. **Inputs are tonnes reused (not tonnes collected for reuse).**
Household Recycling *Use this page to model the impact of improving household recycling collections to capture more material.*	Edit scenario assumptions relating to increased yields of target materials recycled from households. You can 'stack' up to five different changes in yields, each entered **as a change from baseline performance** in either: • kilograms per household, or • tonnes. If entering waste changes in kg/hh terms, you need to also set the proportion of households this change applies to. In this way, you can model the net impact of a combination of different service changes in one scenario. To model a switch from a mixed organics collection to separate collections of food and garden waste:

Sheet	Description
	• Enter in the mixed food and garden waste scenario cell the negative quantity of waste in the baseline, so this tonnage nets to zero. • Enter the expected additional yields of separate food and garden waste into their respective cells
Commercial Waste *Use this page to model the impact of changes to commercial waste service.*	Edit scenario assumptions relating to commercial waste collected of different streams. **Inputs are in tonnage changes from the baseline**. If entering co-mingled waste, the baseline composition of co-mingled waste will apply. The simplified assumption is made that commercial residual waste does not significantly change in composition even if recycling services grow.
Edit Recycling Captures *Use this page to model the impact of improving recycling collections to capture more material.*	Edit scenario assumptions relating to capture for recycling of materials, both household and commercial waste. Inputs are entered as a capture rate for final recycling – so 50% input indicates that 50% of the arisings of that material are being captured for recycling. **The tables below the waste from households capture rate table translate the capture rates inputs into kilograms per household (kg/hhld) captured for recycling.** **If you have an estimate of the impact of a particular change in terms of a kg/hhld increase in food waste or dry recycling, you can therefore tune the capture rate inputs to create the target change in kg/hhld**.
Other Recycling *Use this page to model increases in recycling from street bins or other not-from-household sources.*	Edit changes in tonnages of materials captured for recycling from other non-household wastes - street bins, soil, rubble and plasterboard, parks and municipal wastes. **Inputs are in tonnage changes from the baseline**.
Capture Rate Review *Use this page to model increases in recycling from*	Based on the residual composition entered, capture rates for each material stream in the baseline are calculated for overall LACW, Waste from Households Commercial Waste, and Other waste. The tables show how capture rates (via recycling collections) change over

Sheet	Description
street bins or other not-from-household sources.	time based upon the inputs you have set up on previous sheets. These cells are editable so it is possible to override the inputs in the previous sheets and manually change capture rates over time (inputs are entered as a capture rate for final recycling – so 50% input indicates that 50% of the arisings of that material are being captured for recycling.). **This, however, will break the functioning of the previous inputs on the sheets 'household recycling', 'commercial waste', and 'other recycling', so it is not recommended unless you are comfortable with how to use these cells and how to set the formula back up.**
Adjust Assumptions *Use this page to model changes in residual waste management, levels of rejects, or increases in reuse tonnages collected through specific planned initiatives*	Allows you to enter a range of other assumptions that have different impacts on performance. These are all independent variables (none of them have an automatic impact on any other). The assumptions that can be adjusted include: • the amount of material collected co-mingled and processed through a MRF; • the reject rate at the MRF (amount of material collected as co-mingled recycling but that is rejected at the MRF) and reject rates from source-segregated collections; *Note that changing MRF reject rate inputs here will not increase recycling performance. To model the impact of reducing the reject rate by improving captures (not just reducing contamination), also adjust capture rates on the sheet 'edit recycling capture rates' (this material is in addition to recycling captures)* • destination of rejects from the MRF and source-segregated collection; • the operating mode and efficiencies of the AD facility used (if applicable); • initial destinations of residual waste; • incinerators used, including the gross electrical efficiency and the heat efficiency modelled following the methodology set out in Table 4-1 (as before, you can set up new incinerators in the sheet 'carbon assumptions'); and

Sheet	Description
	• whether and how much waste going to an R-MRF or MBT facility goes to a 'high performance' facility. The recycling performance of these 'high performance' facilities can be set in the 'onward treatment' sheet, and can be used to model a significant change in recycling extraction performance from the baseline facility.

Once you have finished adapting the key assumptions to reflect your scenarios, return to the 'Explore Improvements' sheet to review the table and graph of impacts on EPS and CIF performance, which will display the performance under the modelled scenarios relative to the baseline.

4.4 CIF Only Input Sheet

The Ready Reckoner additionally allows the user to separately evaluate the performance of residual waste treatment options against the CIF. Up to three different energy from waste facilities can be set up, as well as up to three different MBT facilities. Inputs are:

- input tonnages;
- the composition of input residual waste;
- any pre-treatment extraction of material for recycling;
- the (gross) efficiency with which the facility generates electricity;
- the efficiency of generation of utilised heat.

Combinations of different facilities can be combined into an overall combined CIF value.

5.0 Lifecycle CO_2eq Emission KPIs

Key Performance Indicators (KPIs) are measures used to evaluate success in meeting performance objectives. Within contracts, payment deduction mechanisms can be included where KPIs show the contractor has failed to meet objectives, for example recycling rate targets or vehicle emissions reduction targets. The approach ensures that contractors continue to work to meet these targets throughout the duration of the contract. These can either be set to target the direct change or improvement identified (e.g. KPIs regarding recycling rates or overall fuel use), or can be translated into an equivalent lifecycle GHG metric (i.e., by combining different expected improvements into a combined CO_2eq metric target).

KPIs for recycling rates and vehicle GHG emissions have been included with contracts to date, but lifecycle GHG KPIs are an evolving area. Potential metric options are described below including key considerations for their development, and the more complex metrics would require more detailed specification as part of the development of contract documentation.

To establish what suitable KPIs or mix of KPIs might be applicable for a given contract:

- Consider the main sources of lifecycle CO_2eq emissions resulting from the operation of the contract – energy or fuel use, captures for recycling, emissions from treatment, generation of utilised energy or heat etc;
- Identify which areas the contractor has ongoing influence over and the scope for improvement over the contract period;
- Consider appropriate KPIs in these areas, which would help commit the contractor to specific emissions reduction actions, recycling targets for high-carbon-impact materials or overall GHG impact reduction goals.

Targeting the direct change, rather than the overall GHG impact, can be a more precise way to incentivise specific improvements. Creating a lifecycle GHG KPI, along with a methodology for tracking progress over the contract duration, would keep the focus on the net GHG impact of the contract. Care needs to be taken over the scope of emissions impact included within this CO_2eq metric, since the metric is less useful and applicable if changes in performance of those metrics are outside of the control of the contractor.

Example KPIs and metrics for recycling rate, recycling GHG benefit, and fuel GHG impact are shown below, in Table 5-1 through to Table 5-4. Advice should be sought as part of the contract documentation development process to ensure these metrics are defined appropriately for specific contexts. This should also cover setting the baseline performance of the metric, setting appropriate targets and monitoring/calculation procedures - thereby ensuring the use of the metrics is helpful in practically incentivising a reduction in the carbon impact of waste management.

An example of a KPI for recycling rate performance is set out in Table 5-1.

Table 5-1: Recycling Rate KPI Description

	Description
KPI:	Recycling Rate
Metric Components:	**Numerator:** Waste handled in the contract sent for recycling **Denominator:** Waste handled in the contract
Calculation:	**Numerator:** Tonnages of wastes sent for recycling (i.e. collected wastes adjusted for rejects or sorted/extracted recycling) **Denominator:** Measured quantities of waste collected.
Measurement:	Measurement of tonnages

	Description
Example:	A recycling rate target (measured by tonnages collected for recycling) incorporated into Camdens' collection contract. This will help incentivise the contractor to maximise recycling collections and increase the carbon benefit from resulting recycling.

For a kerbside collections contract, the metric components could refer (in the numerator) to waste collected and sent for reuse or recycling (adjusted for e.g. rejects at the MRF) from kerbside dry recycling and organics collections, divided by all kerbside waste collected.

A variation for a MRF contract would be to adjust the definition of the denominator to be 'all targeted waste handled in the contract', measured by input sampling. The aim would be to exclude non-recyclable and non-target material from the denominator, so that 100% would represent all targeted recyclable waste entering the MRF being sent to recycling.

An example of a KPI for the GHG benefit from recycling is set out in Table 5-2.

Table 5-2: Recycling GHG Benefit KPI Description

	$C0_2$eq emissions potentially included within lifecycle CO_2eq KPI
KPI:	Recycling GHG Benefit, as % of maximum available benefit
Metric Components:	**Numerator:** t CO_2eq benefit from waste collected and/or sent for reuse or recycling **Denominator:** maximum t CO_2eq benefit from reusing/recycling all waste handled in the contract
Calculation:	**Numerator:** Wastes collected and/or sent for reuse/recycling by material type multiplied by carbon factors for each material type. **Denominator:** Total breakdown composition of waste handled multiplied by carbon factors for each material type.
Measurement:	Measurement of collected tonnages Composition data/assumptions for co-mingled wastes collected for recycling (accounting for non-recyclable and non-target material) Composition data/assumptions for wastes not collected for recycling

Using a recycling GHG benefit KPI would place an emphasis on maximising capture of metals, plastics and textiles, and more directly link to EPS performance.

For the metric described above, an agreed approach to establishing how the residual/overall composition by waste stream would need be established and projected into the future. It should be noted that waste composition is beyond the control of the contractor to a significant extent.

A simpler version of the metric, in the absence of good ongoing residual composition data and assumptions, may be to calculate the metric as a total or per household (therefore excluding the denominator from the metric calculation), rather than as a percentage of the maximum benefit. This would just require a breakdown by material of any co-mingled collected wastes.

An example of a KPI for vehicle GHG emissions is set out in Table 5-3.

Table 5-3: Vehicle GHG Emissions KPI Description.

	$C0_2eq$ emissions potentially included within lifecycle CO2eq KPI
KPI:	Vehicle GHG emissions
Metric:	t CO_2eq emitted by vehicles in servicing the contract
Calculation:	Fuel use of different fuel types multiplied by fuel use carbon factors
Measurement:	Measurement/recording of fuel use
	Targets for GHG emissions from collection vehicles have been incorporated into Brent and Camden's collection contracts

Target setting for vehicle emissions should consider how the fleet might be expected to increase in fuel efficiency over time, e.g. with reference to plans set out in the contractors' proposals.

An example of a KPI for the performance of waste treatment facilities is set out in Table 5-4.

Table 5-4: Lifecycle Treatment CO_2eq KPIs Description

	Description
KPI:	Lifecycle treatment GHG emissions
Metric:	t CO_2eq emissions from treatment per tonne of waste received for treatment

	Description
Calculation:	CO_2eq emissions impact from waste sent to recycling + CO_2eq emissions from facility fuel use (and embodied emissions) + CO_2eq emissions from waste transportation + CO_2eq emissions offset by usable output products (compost) or energy (electricity or heat) + CO_2eq emissions from any landfill of wastes
Measurement:	As with the EPS metric methodology, develop a list of measurable sub-metrics (tonnages of waste to recycling, fuel use in transport, output products/energy) and apply agreed carbon factors with defined baseline performance over time.

Carbon factors used for the setting of targets and measuring against these should also take account of ongoing changes in lifecycle CO_2eq emissions change from year to year due to the decarbonisation of the grid (and therefore the changing CO_2eq benefit of generating electricity).

If there is significant variation in input waste composition over time beyond the contractor's control, some adjustment to the target may be needed to take account of changes in performance due to this compositional change. The targets could be periodically 'rebased' to account for this compositional change.

A further important consideration in respect of the implementation of KPIs within contracts is that any deductions from contract payments related to missed KPIs should in principle relate to costs incurred as a result of the failure to meet the targets. For a recycling rate target, the deduction could be calculated based on the difference between residual and recycling disposal costs. For vehicle emissions reduction targets, this could be a value per gram or kilogram that the target is exceeded. A cost can in principal be attached per tonne of CO_2eq emissions above the target.

A.1.0 Carbon Factors Used in the Ready Reckoner Model

The following tables outline the emissions factors ('carbon factors') – net greenhouse gas emissions in tonnes of CO_2 eq. per tonne of waste reused, recycled, treated or disposed. The tables outline the sources of these factors and the text provides some supporting commentary.

Table 5-5: Dry Recycling and Reuse

EPS element	Material / treatment system	Carbon impacts, tonnes CO_2 eq. / tonne of waste	Notes
Recycling	Paper and card	-0.34	Scottish Carbon Metric[5]
	Plastic	-1.17	
	Glass	-0.20	
	Steel	-1.83	
	Aluminium	-8.70	
	Textiles	-5.99	
	Wood	-0.41	
	WEEE	-0.18	
	Other	-0.14	Based on assumed compositional mix
Re-use	Textiles	-5.99	Same source as recycling benefit
	Furniture	-0.22	WRAP Case Studies[6]
	WEEE	-3.26	

Table 5-6: Specific Factors for Dry Recycling from Residual Waste

EPS element	Material / treatment system	Carbon impacts, tonnes CO_2 eq. / tonne of waste	Source
Recycling	Paper and card	-0.00	Negligible benefit due to relatively poor quality
	Plastic	-0.65	Adjusted for assumed film content
	Glass	0.00	Assumed sent for aggregate
	Textiles	0.00	Assumed not suitable for textile recycling
Notes: In the case of metals recycling, benefits are assumed to be the same as those set out in Table 5-5			

[5] Data is available from http://www.zerowastescotland.org.uk/our-work/carbon-metric
[6] WRAP (2011) Benefits of Reuse Case Studies

Table 5-7: Organics Treatment

EPS element	Material / treatment system	Carbon impacts, tonnes CO_2 eq. / tonne of waste 2017/18	Carbon impacts, tonnes CO_2 eq. / tonne of waste 2030/31	Notes
Composting / AD	Windrow composting		-0.052	Eumonia LCA model
	In-vessel composting	-0.025	-0.030	Eunomia LCA model. Change over time reflects decrease in carbon intensity of process electricity use
	Anaerobic digestion	-0.110	-0.054	Dynamically modelled depending on operating mode and heat offtake. Default value assumes 25% of full potential CHP offtake. Change over time due to reduced carbon impact from displacing grid electricity as grid decarbonises.

Organics carbon factors, set out in Table 5-7 above, include the energy and fuel used in the processes, benefits from avoided production of compost/fertiliser, and any benefit from energy produced (electricity to the grid, utilised heat offtake, or biogas used for heating).

Table 5-8: Residual Treatment

EPS element	Material / treatment system	Carbon impacts, tonnes CO_2 eq. / tonne of waste 2017/18	Carbon impacts, tonnes CO_2 eq. / tonne of waste 2030/31	Notes
Residual	Sorting in MBT/R-MRF/RDF	0.015	0.008	Based on electricity consumption assumptions (reducing in impact over time as grid decarbonises) and diesel.
	'High Performance' Sorting in MBT/R-MRF	0.017	0.009	
	Landfill	0.19	0.20	Eunomia LCA model. Change over time primarily reflects reduced methane emissions due to compositional change (change in organic waste to landfill) and reduced carbon benefit from electricity generation from landfill gas.

EPS element	Material / treatment system	Carbon impacts, tonnes CO_2 eq. / tonne of waste 2017/18	Carbon impacts, tonnes CO_2 eq. / tonne of waste 2030/31	Notes
	Incineration	0.13	0.24	Dynamic calculation, taking account of process electricity use, direct carbon emissions and carbon benefit from displacing electricity and heat. Default value in 2017/8 assumes average London residual composition, 26% electrical efficiency and 0% heat offtake. Change over time is due to varying composition, decrease in carbon benefits of electricity generation, and an increase in heat generation.
	CLO Output from MBT			Assumed to be 2.5% of the biogenic carbon input to MBT facilities

Points to note in respect of the carbon accounting methodology used within the model include the following:

- The life cycle methodology typically ignores all biogenic CO_2 emissions. Biogenic CO_2 emission are CO_2 emissions occurring from the treatment of organic materials such as food waste and paper. These are assumed (in carbon inventory accounting) to be cancelled out as a result of recent plant growth which has involved the sequestration of carbon from the atmosphere. However, this is problematic when accounting for landfill impacts, as a significant proportion of the biogenic carbon is not released as biogenic CO_2 (or methane) but instead remains sequestered in the landfill. In contrast, for thermal treatments, all biogenic carbon is released in the form of biogenic CO_2, but these emissions were ignored in the analysis informing the LCA methodology used in setting the current EPS. As such, if no adjustment is made, the exclusion of the biogenic CO_2 emissions will overestimate landfill impacts relative to other forms of treatment where all of the biogenic carbon is released as CO_2 into the atmosphere. As such, our landfill model includes a sequestration credit to account for the un-emitted biogenic carbon in landfill that would otherwise be emitted as biogenic CO_2, in line with the approach set out by Gentil et al (2009).[7]

[7] Christensen, T., Gentil, E., Boldrin, A., Larsen, A., Weidema, B. and Hauschild, M. (2009) C balance, Carbon Dioxide Emissions and Global Warming Potentials in LCA-modelling of Waste Management Systems, Waste Management & Research, 27, pp707-717

- Capture of landfill gas is set at 60%, in line with the central assumptions used in modelling work undertaken by Defra in 2014.[8]

Table 5-9: Transport

EPS element	Material / treatment system	Carbon impacts, tonnes CO_2 eq. / tonne.km 2017/18	Carbon impacts, tonnes CO_2 eq. / tonne.km 2030/31	Notes
Transport	RCV (Collection)	0.220	0.165	BEIS Emissions Factors.[9]Changes over reflect improvements in vehicle fuel efficiency, Eunomia estimates
	HGV (Transport)	0.270	0.203	
	Rail	0.020	0.020	BEIS Emissions Factors.[10]
	Water	0.030	0.030	
	Shipping	0.020	0.020	

[8] Defra (2014) Energy Recovery for Residual Waste – A Carbon Based Modelling Approach, February 2014
[9] DECC (2015) Data Tables Supporting the Toolkit and the Guidance, https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[10] DECC (2015) Data Tables Supporting the Toolkit and the Guidance, https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal