



# QUANTIFICATION OF GREENHOUSE GAS EMISSIONS FROM RECYCLING AND WASTE MANAGEMENT IN SCOTLAND

Report for: Scottish Environmental  
Services Association

Customer:  
Scottish Environmental Services Association

Customer reference:  
ED16352

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# EXECUTIVE SUMMARY

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The Scottish ESA commissioned Ricardo to understand the recycling and waste sector's emissions generated within Scotland, as part of the emissions generated by the UK's waste and recycling sector, as quantified for the Environmental Services Association in 2021. Ricardo has carried out a study of the emissions emitted within the boundaries of Scotland to allow comparison with the UK data.

The study found that, in the baseline year 2018, the Scottish recycling and waste management sector was responsible for generating **4.5 million tonnes** of CO<sub>2</sub>-equivalent (CO<sub>2</sub>-e) emissions, equivalent to 13% of the sector's total UK emissions. This is also equivalent to approximately 11% of Scotland's total greenhouse gas emissions in 2018.

The largest proportion of these emissions (**2.2 million tonnes CO<sub>2</sub>-e**) occurred due to the recycling processes. The sector was also responsible for avoiding **3 million tonnes** of CO<sub>2</sub>-e emissions through recycling and recovery activities in the baseline year 2018. This is equivalent to approximately 6% of the UK recycling and waste sector's avoided emissions.

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# INTRODUCTION

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In 2020, Ricardo collaborated with the ESA to support the sector's emissions reductions and produce a UK Net Zero agenda. This study quantified the current level of the direct, indirect and avoided greenhouse gas emissions associated with the recycling and waste management sector in the UK. This work established the UK recycling and waste sector's baseline emissions and the actions required to get the sector to net-zero by 2040 at the latest.

The Scottish ESA would like to understand the recycling and waste sector's emissions generated specifically within Scotland. Ricardo has carried out a study of the emissions generated within the boundaries of Scotland to allow comparison with the UK data.



## 2. APPROACH

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In order to quantify the level of greenhouse gases associated with Scotland's recycling and waste management sector, Ricardo took the following steps as shown in Figure 1 below.

### 2.1 SCOPE OF THE STUDY

The assessment considered the same waste streams included in the ESA's Net Zero study. This includes municipal, commercial, hazardous, and clinical waste arisings. This means that it does not cover industrial or agricultural wastes.

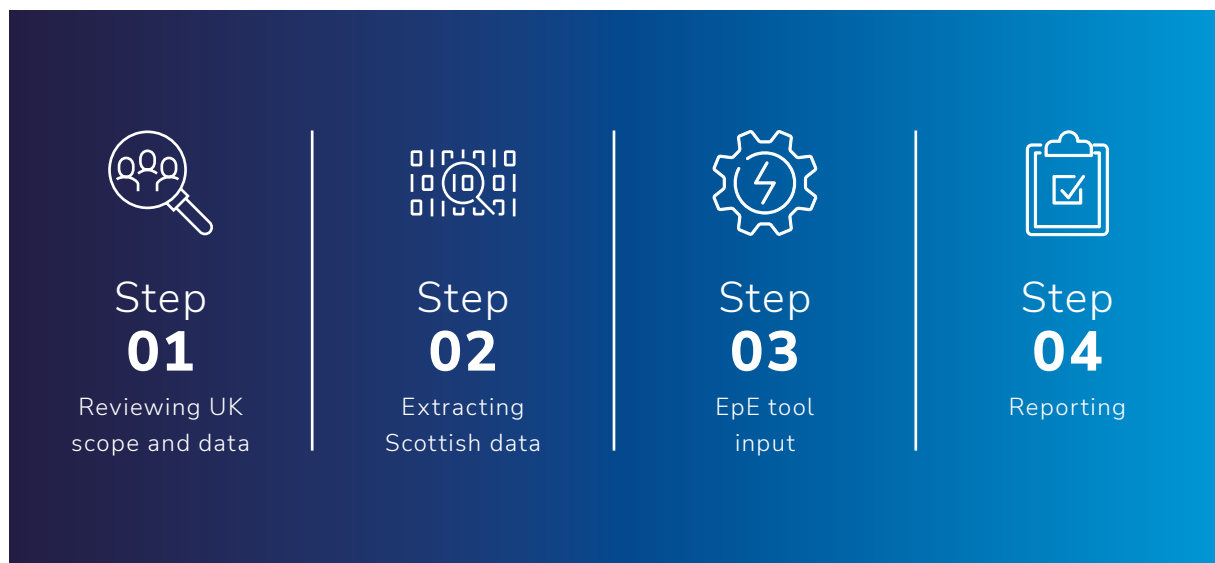
The recycling and waste management activities in scope are:

- Collection and transportation
- Transfer of waste
- Mechanical pre-treatment (dismantling)
- Sorting, recycling, and material recovery
- Biological treatment (composting, anaerobic digestion)
- Landfilling
- Thermal treatment

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FIGURE 1 DESCRIPTION OF APPROACH TAKEN TO DETERMINE THE CARBON IMPACT OF SCOTLAND'S WASTE MANAGEMENT SECTOR

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The study excluded the following activities due to lack of data:

- Physico-chemical treatment
- RDF production
- Mechanical biological treatment (MBT)

Waste generated in Scotland but treated elsewhere has been included for completeness. These emissions would be included in the total emissions of the UK as generated in one of the other countries, most probably England.



## 2.2 MODELLING

Since the scope of the assessment was to compare against the baseline for the UK, the same methodology for the quantification of the emissions as for the ESA Net Zero Strategy (see Appendix 1) was followed. Based on number of sites and tonnages generated in Scotland and using benchmarks obtained from sources, such as WRATE and Ecoinvent, the activity data was calculated. The activity data collected was used to calculate emissions in each of the following three categories:

- **Direct GHG emissions** occur from process or equipment owned or controlled by the entity. Example: emissions from combustion installations, landfills (fugitive emissions), company-owned vehicles, etc. In accordance with the GHG Protocol, direct emissions are also known as 'Scope 1' emissions.
- **Indirect GHG emissions** are emissions that are consequences of the activities of the entity but that physically occur at sites or during operations owned or

controlled by an organisation other than the reporting entity. In accordance with the GHG Protocol, indirect emissions can be distinguished into two categories known as scope 2 and scope 3 emissions. Indirect emissions resulting from imports of electricity, heat or steam not self-produced have to be accounted for as scope 2 emissions and all other indirect emissions correspond to scope 3 emissions. It must be noted that other indirect emissions, such as wastewater disposal and business travel, are not included in this study, as that would require significant amount of time and research, including communication with all the waste management companies.

- **Avoided GHG emissions** arise when an activity leads to avoiding emissions that would otherwise have occurred elsewhere. In SESA's case, materials that are diverted to reuse or recycling can offset the need to make new products from virgin materials, and so can be assigned a credit for the emissions avoided by not making those new products.

### 3. RESULTS

The total GHG emissions generated (scope 1 and scope 2) by the Scottish recycling and waste management sector are shown in Figures 2 and 3 below. In total, the industry was responsible for **4.5 million tCO<sub>2</sub>e** of GHG emissions in the baseline year of 2018. This equates to approximately 11% of Scotland’s total greenhouse gas emissions in the baseline year<sup>1</sup>, which is 3% higher than the waste sector’s GHG generation for the UK as a whole. Sorting, transfer and recycling contributes the largest proportion of the carbon emissions

generated due to the high energy requirement and tonnage passing through these facilities. Of these carbon emissions, 2.2 million tCO<sub>2</sub>e were scope 1 and 2 emissions generated in recycling facilities, while 770,000 tCO<sub>2</sub>e occur from process emissions from landfilling. Scope 1 emissions were more than three times higher than Scope 2 emissions, amounting to 3.4 million tCO<sub>2</sub>e. Scope 1 emissions are arguably the most controllable as they are generated principally through plant and equipment owned and/or operated by the sector’s operators.

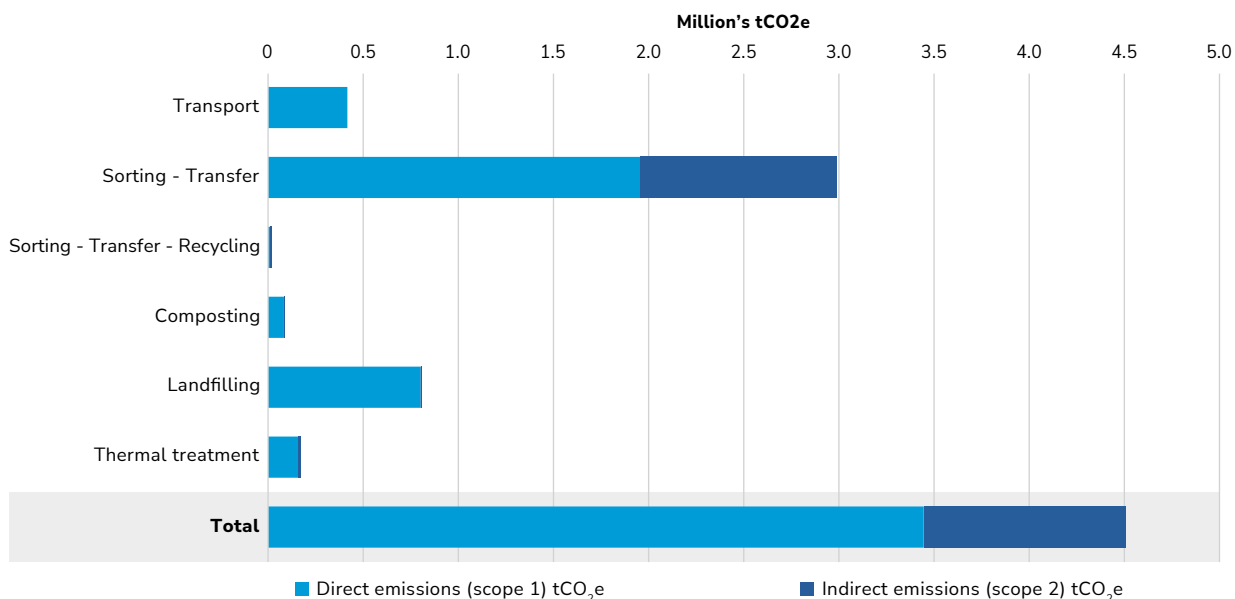
FIGURE 2 TOTAL SCOPE 1 AND 2 GHG EMISSIONS GENERATED BY SCOTLAND’S WASTE SECTOR

Source	Direct emissions (scope 1) tCO <sub>2</sub> e	Direct emissions (scope 2) tCO <sub>2</sub> e	TOTAL tCO <sub>2</sub> e
Transport	415,804	-	415,804
Sorting - Transfer - Recycling	1,970,452	1,031,656	3,002,081
Anaerobic Digestion	11,131	9,842	20,973
Composting	85,003	4,073	89,076
Landfilling	803,439	1,393	804,833
Thermal treatment	159,951	12,123	172,074
<b>Total</b>	<b>3,445,753</b>	<b>1,059,087</b>	<b>4,504,841</b>

1 Scottish Greenhouse Gas Emissions 2018 - gov.scot (www.gov.scot)



FIGURE 3 GRAPH OF SCOPE 1 AND 2 EMISSIONS FOR SCOTLAND'S WASTE MANAGEMENT SECTOR



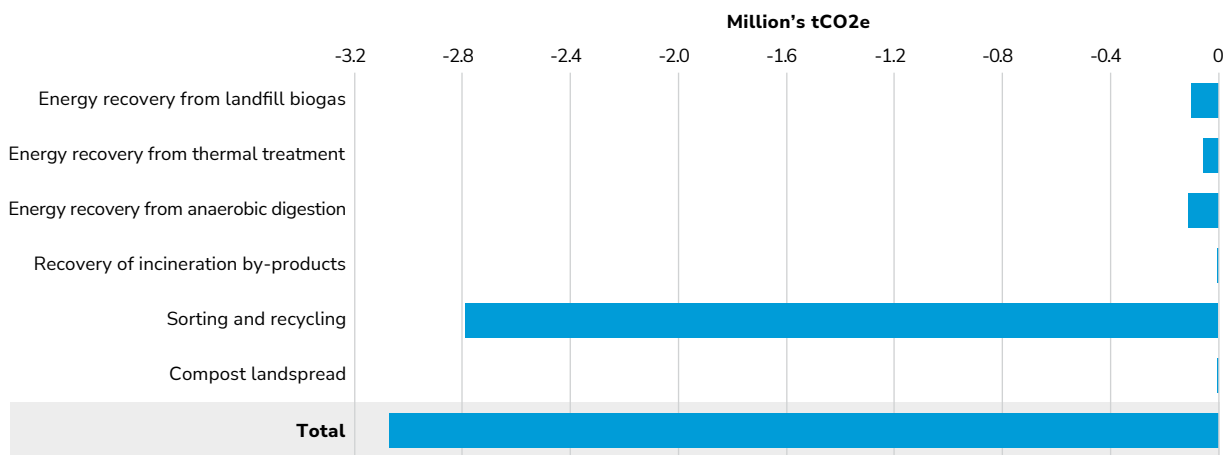
Figures 4 and 5 show the total emissions avoided through material recycling and recovery in Scotland. The total avoided emissions are **3,070,138 tCO<sub>2</sub>e**. Most of these emissions 'savings' are gained through the recycling of waste materials, followed

by the electricity generation from the biogas generated in landfills, due to the high tonnage landfilled in Scotland. In Scotland's case, the total avoided emissions are less than the calculated Scope 1 and 2 emissions.

FIGURE 4 TOTAL AVOIDED EMISSIONS FOR SCOTLAND'S WASTE MANAGEMENT SECTOR

Source	Total avoided emissions tCO <sub>2</sub>
Energy recovery from landfill biogas	-103,488
Energy recovery from thermal treatment	-59,497
Energy recovery from anaerobic digestion	-113,553
Recovery of incineration by-products	-491
Sorting and recycling	-2,789,149
Compost landspread	-3,960
<b>Total</b>	<b>-3,070,138</b>

FIGURE 5 TOTAL AVOIDED EMISSIONS FOR SCOTLAND'S WASTE MANAGEMENT SECTOR



### 3.1 COMPARISON AGAINST UK'S EMISSIONS

When compared to the evaluation of GHG emissions for the UK recycling and waste sector for the same baseline year, 2018, Scotland's waste activities account for approximately 13% of the total UK emissions,

while contributing to 6% of the total UK avoided emissions.

The UK quantification results, showed that total avoided emissions were greater than the combined Scope 1 and 2 emissions, as seen in Figures 6 and 7, while for Scotland this is not the case.

FIGURE 6 TOTAL SCOPE 1 AND 2 GHG EMISSIONS GENERATED BY THE UK'S WASTE SECTOR

Source	Direct emissions (scope 1) tCO <sub>2</sub> e	Direct emissions (scope 2) tCO <sub>2</sub> e	TOTAL tCO <sub>2</sub> e
Transport	4,580,737	-	4,580,737
Sorting - Transfer - Recycling	8,978,747	5,730,016	14,717,764
Anaerobic Digestion	68,894	63,739	132,633
Composting	951,637	47,114	998,751
MBT	9,972	21,202	31,174
Landfilling	10,700,892	23,725	10,724,617
Thermal treatment	4,473,721	104,534	4,578,255
<b>Total</b>	<b>29,764,600</b>	<b>5,999,331</b>	<b>35,763,931</b>

FIGURE 7 TOTAL AVOIDED EMISSIONS FOR THE UK'S WASTE MANAGEMENT SECTOR

Source	Total avoided emissions tCO <sub>2</sub> e
Energy recovery from the produced biogas	-1,435,675
Energy recovery from thermal treatment	-1,907,066
Energy recovery from anaerobic digestion	-767,949
Recovery of incineration by-products	-28,261
Sorting - Transfer - Recycling	-44,752,132
Waste-derived fuel preparation	-969,134
Compost landspread	-44,023
<b>Total</b>	<b>-49,904,238</b>

### 3.1.1 Reasons of disproportionate emissions

The direct, indirect and avoided emissions associated with Scotland’s waste footprint are disproportionately low when compared to the emissions associated with the UK-wide waste footprint. This can be attributed to the following reasons:

- Different sources were used for tonnage data. The data on tonnages used in both studies for Scotland was sourced from SEPA, while the UK-wide study data was based on tonnages reported by the devolved governments. In the case of England, where most of the waste is generated, the tonnages were retrieved from the Waste Data Interrogator (WDI). Data from the WDI is not reported in the same format as the SEPA data, which is reported on a per material and disposal route basis. Hence, editing the WDI tonnages requires a series of assumptions which may not align with the assumptions made by SEPA when collating the tonnages.
- Scotland reports a lower proportion of waste entering energy from waste and recycling facilities and so has less avoided emissions from energy recovery (from thermal treatment and incineration by-products), as well as recycling.
- Waste derived fuel preparation is excluded from this study (as the data was not available), which was included in the UK ESA project and contributed approximately 2% to the UK’s avoided emissions total.
- The composition of waste recycled in the UK and in Scotland differs. Scotland reports high tonnages of soils, paper and card and mineral wastes. However, these materials do not account for high avoided emissions. On the contrary, Scotland reports low quantities of metals (which yield high avoided emissions), when compared to the UK total.

## 4. CONCLUSIONS

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- Scotland's scope 1 and 2 emissions related with waste management activities account for 13% of the UK's corresponding scope 1 and 2 emissions.
- Emissions from Scotland's waste management activities accounted for 11% of Scotland's total GHG emissions in the year 2018.
- Emissions from fuel consumption and processes (Scope 1) account for 76% of the total scope 1 and 2 emissions from waste management in Scotland.
- Most scope 1 and 2 emissions arise due to the recycling processes.
- Scotland's avoided emissions account for 6% of the UK's avoided emissions (compared to 13% scope 1 and 2 emissions). This can be attributed to the fact that the waste tonnages reporting format differs among the nations, Scotland sends less waste to EfW compared to the rest of the UK and the composition of waste recycled does not result in high avoided emissions.
- Most avoided emissions (91%) occur from recycling.





PUBLISHED BY

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