TUNLEY
ENVIRONMENTAL

Report

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TUNLEY ENVIRONMENTAL

CARBON ASSESSMENT REPORT

FOR

THE BRITISH METALS RECYCLING ASSOCIATION

BMRA
BRITISH METALS RECYCLING ASSOCIATION

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Contents

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Nomenclature

Nomenclature	Description
GHG	Greenhouse Gases, gases that trap heat in our atmosphere. GHG include carbon dioxide, methane, nitrous oxides, and fluorinated gases.
Embodied Carbon	The total GHG emissions generated to produce a product; It includes those from extraction, manufacture, processing, transportation, and assembly in every component.
Carbon Equivalent	The effect on global warming of a greenhouse gas (GHG) relative to that of CO_2.
Zero Carbon	The absence of GHG emissions
Greenhouse Gas Protocol	The GHG Protocol Corporate Accounting and Reporting Standard which provides requirements and guidance to prepare a corporate-level GHG emissions inventory.
Net Zero Carbon (NZC)	The sum effect of combining actions to reduce GHG emissions with actions to offset them.
Carbon Offsetting	A reduction in emissions of GHG to compensate for unavoidable emissions.
Global Warming Potential (GWP)	The heat adsorbed by any GHG as a multiple of the equivalent in carbon dioxide.
IPCC	The Intergovernmental Panel on Climate Change. It provides regular scientific assessment on climate change to policy makers.
AR6	The sixth assessment report of the IPCC. The most recent assessment report is 2021.
t CO_2e	Notation for tonnes of carbon dioxide equivalent emissions.
kg CO_2e	Notation for kilograms of carbon dioxide equivalent emissions.
ICE	The Inventory of Carbon and Energy.
Scope 1	Direct GHG emissions are those that occur from sources that are owned or controlled by the company such as emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc., emissions from chemical production in owned or controlled process equipment.
Scope 2	Indirect GHG emissions account for GHG emissions from the generation of imported energy such as purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.
Scope 3	Other indirect GHG emissions. The GHG Protocol Corporate Accounting and Reporting Standard defines Scope 3 as an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services. BS EN ISO 14064 separates out Scope 3 emissions into categories 3 to 6 covering indirect emissions from transportation, products used, use of products from the business and other sources respectively.

Executive Summary

The British Metals Recycling Association (BMRA), in collaboration with Tunley Environmental, has undertaken the first industry-wide carbon footprint assessment of the United Kingdom's (UK) metals recycling industry for the reporting year 2023. This study provides a comprehensive quantification of greenhouse gas (GHG) emissions across the value chain, offering an insight into the industry's carbon footprint and its role within the UK's transition to net zero.

Using the Greenhouse Gas Protocol categories, emissions were evaluated across Scope 1 (direct emissions), Scope 2 (purchased electricity), and Scope 3 (all other indirect emissions, including upstream/downstream transport and downstream processing). The assessment was based on data from four BMRA members, covering a range of facility sizes and extrapolated using the Environment Agency (England), Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW), and the Northern Ireland Environment Agency (NIEA) tonnage data to reflect the UK metals recycling industry.

The total estimated carbon footprint of the UK metals recycling industry was 10.96 million t CO_2e. Approximately 97% of this stems from Scope 3 activities, particularly the downstream processing of sold products (such as smelting and refining) often carried out by third-party entities outside the UK. These figures are based on modelling assumptions and industry averages. As such, they should be interpreted with caution. However, they reflect the full footprint of recycled materials, not emissions solely under the direct control of recyclers and underline the broader systems-level impact of the industry and the need for collaborative, supply chain-wide decarbonisation efforts.

The estimated Scope 1 and 2 carbon footprint of the UK metals recycling totalled 284,640 tonnes of CO_2e (t CO_2e), as highlighted in Figure 1 (page 5). These emissions related to those under the direct control of recyclers, such as fuel use in operations and electricity consumption. This accounts for approximately 0.07% of the UK's total territorial emissions, which were approximately 385 million t CO_2e in 2023, highlighting the sector's relatively low contribution to the overall GHG inventory of the UK.

The Scope 1 and 2 emissions intensity per tonne of metal recycled was calculated to be 0.025 t CO_2e per tonne of metal recycled. When upstream transport is included, this rises to 0.050 t CO_2e per tonne.

A series of reduction initiatives has been suggested, prioritising the decarbonisation of operational emissions (Scope 1 and 2) through renewable electricity procurement, electrification of equipment and vehicles, switching to low-carbon fuels such as hydrotreated vegetable oil (HVO), and improved energy efficiency in buildings. If fully implemented, these measures could deliver a 93% reduction in Scope 1 and 2 emissions by 2050, with the remaining emissions offset at a projected annual cost of £336,960.

In parallel, the industry can play a vital enabling role in reducing Scope 3 emissions by working with downstream partners, such as smelters, to prioritise lower-carbon processing routes, particularly through the adoption of electric arc furnace (EAF) technology.

This report marks a step toward transparency, accountability, and climate leadership for the UK's metals recycling industry. It provides robust data-driven insights from which BMRA and its members can engage stakeholders, track progress, and support national decarbonisation goals while reinforcing the industry's role in the circular economy.

While this assessment focuses on quantifying the industry's emissions using the GHG protocol framework, we also briefly discuss the avoided emissions and environmental benefits delivered through metals recycling in this report.

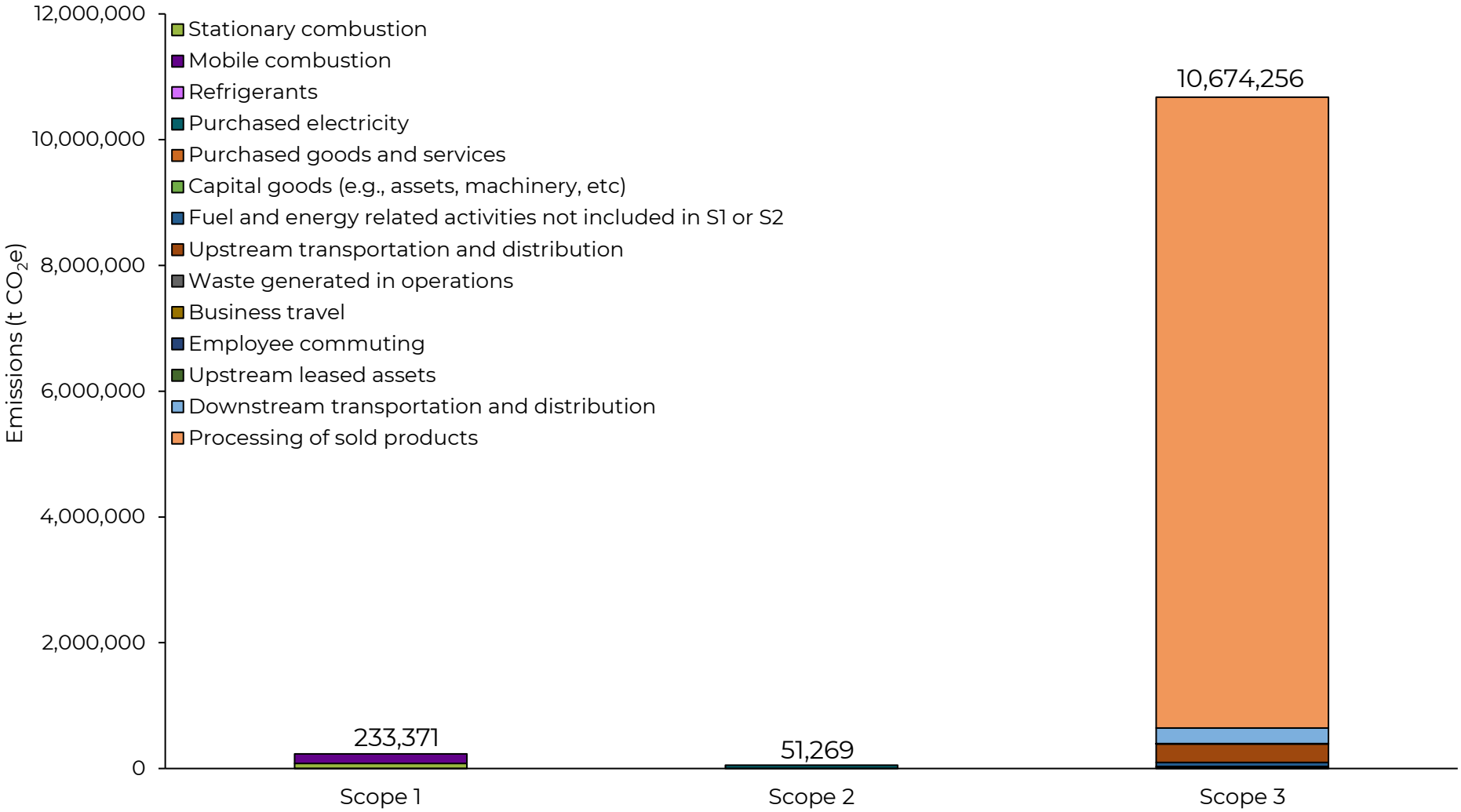

Figure 1. The British metal recycling industry's estimated greenhouse gas emissions for Scopes 1, 2 and 3

Introduction

Climate change presents an urgent global challenge, necessitating coordinated mitigation efforts across international, national, and local levels. Greenhouse gas (GHG) emissions, often referred to as carbon emissions, are the primary drivers of global warming, impacting natural ecosystems, businesses, and communities alike. The UK Government has committed to reaching net zero carbon emissions by 2050, and understanding sector-specific contributions is essential to meeting this target.

In this context, Tunley Environmental has worked with the British Metals Recycling Association (BMRA) to assess the carbon footprints of four metal recycling companies. The objective of this study is to deliver a reliable estimate of GHG emissions emitted by the broader metals recycling industry by extrapolating the results of member organisations, thereby producing an emissions profile for the industry as a whole. While this assessment focuses on quantifying the industry's emissions using the GHG protocol framework, we also briefly discuss the avoided emissions and environmental benefits delivered through metals recycling, detailed later in this report.

The UK's metals recycling industry is a vital component of the circular economy, significantly reducing the demand for primary metal extraction. The industry handles millions of tonnes of scrap metal annually, supporting both environmental and economic objectives. For this assessment, members were selected based on their annual processing tonnage, covering a representative spread: one recycling less than 5,000 tonnes, two recycling from 15,001–25,000 tonnes and one recycling 250,001–1,000,000 tonnes.

The GHG emissions of all members were quantified using the methodology outlined in Appendix A, following the GHG Protocol's three-scope approach (Figure 2):

- **Scope 1:** Direct emissions from owned or controlled sources (e.g., fuel used in on-site machinery or vehicles).
- **Scope 2:** Indirect emissions from the generation of purchased electricity.
- **Scope 3:** All other indirect emissions across the value chain, including emissions from purchased goods and services, capital goods, upstream and downstream transport, waste generated in operations, processing of sold products, business travel, and employee commuting.

The data used for this study covers the 2023-2024 reporting year. It was provided by the participating metal recyclers and supplemented with tonnage information from the Environment Agency's 2022 Waste Data Interrogator (WDI), which details materials received and removed by metals recycling facilities across England, alongside the Scottish Environment Protection Agency waste sites and capacity data tool(2023), National Resources Wales Waste Permit Returns Data Interrogator (2023) and tonnage data requested from the Northern Ireland Environment Agency (2023). This data enabled Tunley Environmental to extrapolate emissions profiles from the sample businesses to the broader industry, providing insights into overall industry performance.

Tunley Environmental has conducted this assessment using background data which adheres with recognised carbon accounting protocols, making informed assumptions where data was limited, based on internal expertise and reputable external sources. Particular attention has been given to identifying the major contributors to emissions across all scopes, supporting BMRA and the metals recycling industry in identifying opportunities to reduce their carbon footprint and align more closely with national net zero objectives.

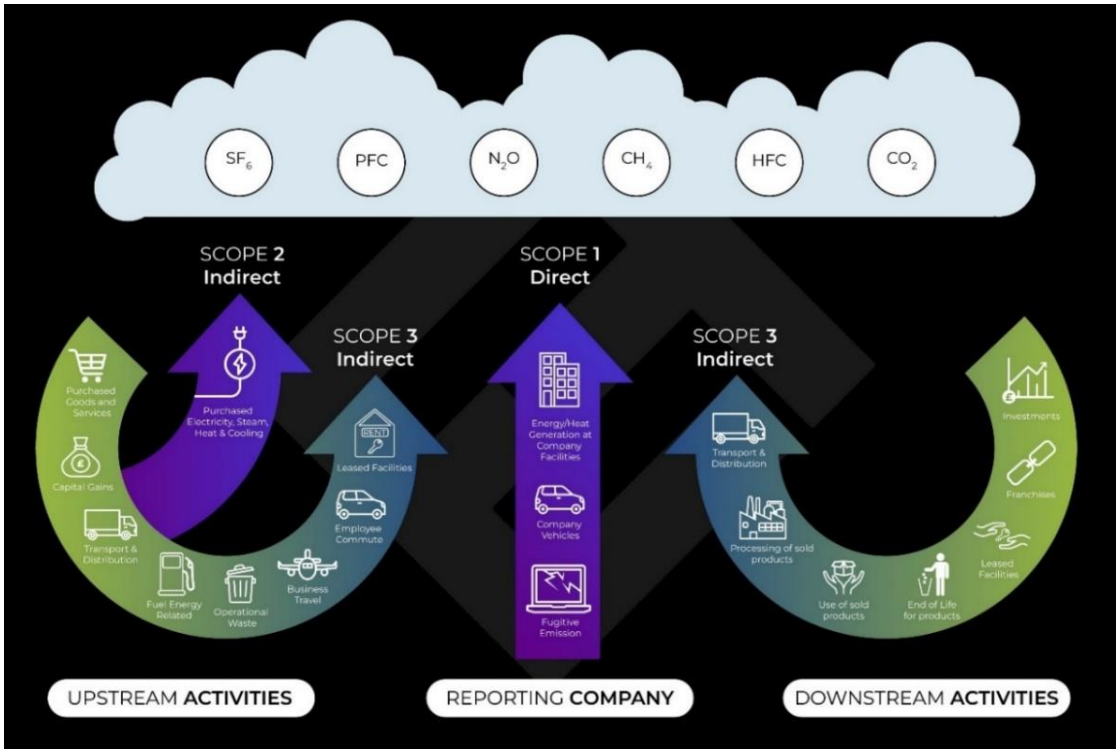

Figure 2. An overview of the GHG Protocol scopes and emissions across an entire value chain.

Study Boundaries

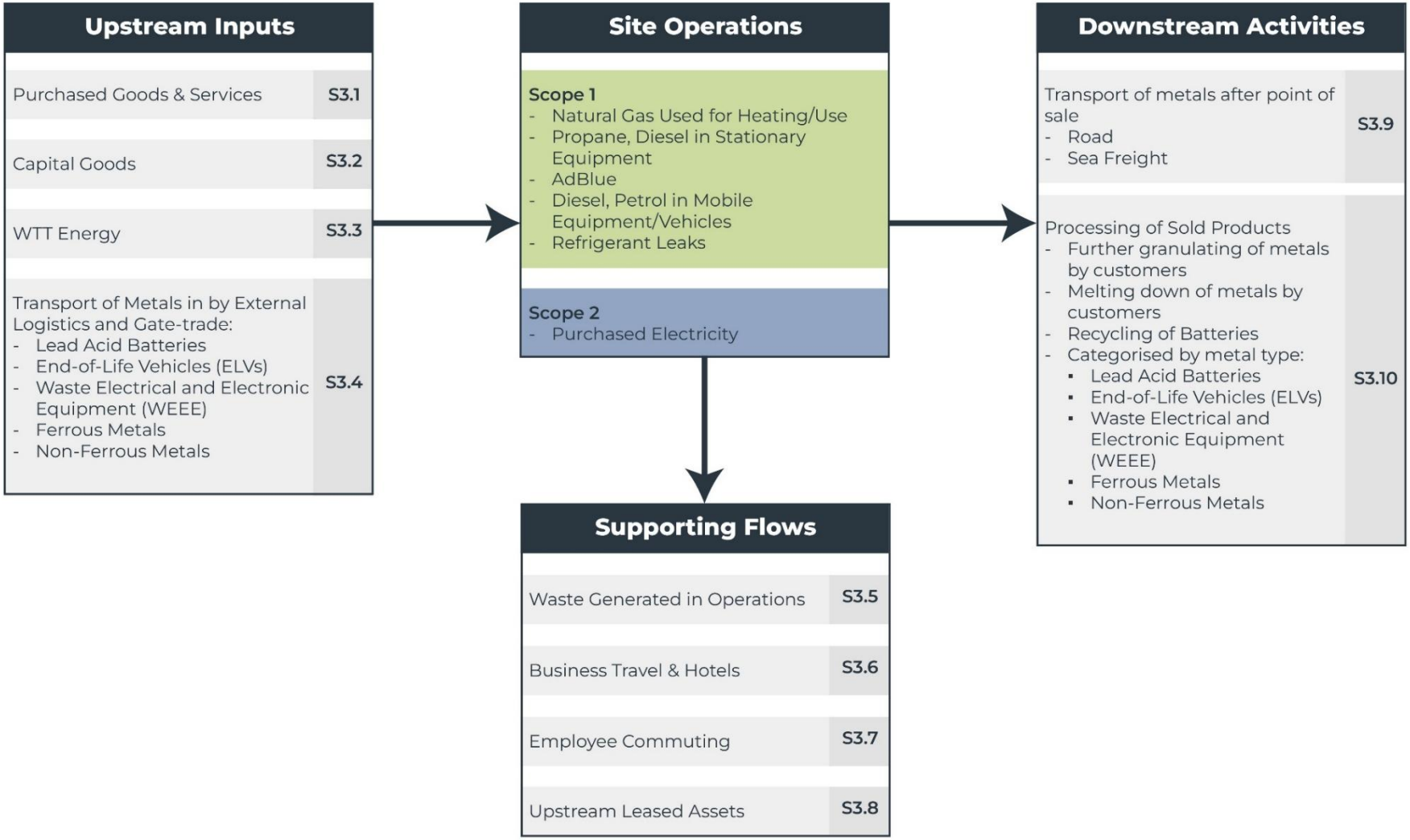

Figure 3. Operational boundary and mapped emission sources (GHG Protocol).

The organisational boundary used within this study is the operational control approach. Data used in this assessment were derived from four BMRA member organisations representing distinct operational scales: one processing less than 5,000 tonnes, two processing 15,000-25 000 tonnes, and one processing 250,000-1,000,000 tonnes per year. Activity data from these members were converted to emissions intensities (t CO_2e per tonne of metal recycled) and extrapolated to industry scale using national tonnage datasets from the Environment Agency (England), Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW), and the Northern Ireland Environment Agency (NIEA).

This boundary therefore captures, as far as best estimated, all material direct and indirect emission sources associated with the operational activities of the UK metals recycling industry and its immediate upstream and downstream activities.

In accordance with the GHG Protocol and ISO 14064-1:2019, the operational boundary defines the emission sources, activities, and value-chain stages included in the greenhouse gas inventory within the established organisational boundary. This study defines the operational boundary as the metals recycling industry, located within the geographic boundary of the UK. The boundary identifies which emission sources fall under Scope 1 (direct emissions), Scope 2 (indirect electricity emissions), and Scope 3 (other indirect emissions), and how these are distributed across the metal recycling value chain. Figure 3 highlights the boundary across four domains: Upstream Inputs, Site Operations, Downstream Activities, and Supporting Flows.

Scope 1 includes all direct emissions from sources owned or controlled by the recycling companies. These encompass the combustion of fuels such as diesel, propane, and natural gas in stationary plant (e.g., shear-balers and fragmentisers) and mobile equipment or vehicles, the use of AdBlue in diesel vehicles, and minor fugitive releases of refrigerants from air-conditioning systems. These emissions occur within the physical boundaries of the recycling facilities and are entirely under the organisation's operational control.

Scope 2 covers indirect emissions from the generation of purchased electricity consumed by recycling facilities. In line with ISO 14064-1 and the GHG Protocol Scope 2 Guidance, emissions are reported using both the location- and market-based approach.

During data collection, three of the four participating organisations reported purchasing electricity on Renewable Energy Guarantees of Origin (REGO)-backed tariffs. Recognising that this sample may over-represent companies which are further along in their sustainability journeys, the BMRA conducted a follow-up member survey (n = 11) to establish a more representative industry average. The survey indicated that 27.27% of respondents purchase REGO-backed electricity, while 72.73% do not. To correct for potential participation bias, market-based Scope 2 emissions were re-weighted according to this distribution, using supplier-specific emission factors for REGO electricity and the UK residual-mix for non-REGO electricity.

Scope 3 encompasses all other indirect emissions that occur in the value chain of metal recyclers, both upstream and downstream of their direct operations. Within this study, Scope 3 has been included comprehensively where relevant to the industry, covering GHG Protocol categories 3.1-3.10:

- Upstream Inputs (S3.1-S3.4): emissions from purchased goods and services, capital goods, well-to-tank (WTT) energy, and inbound transport of scrap metals, including gate-trade from the public and logistics by third parties.
- Supporting Flows (S3.5-S3.8): waste generated in operations, business travel and accommodation, employee commuting, and upstream leased assets.
- Downstream Activities (S3.9-S3.10): transport of sold metals to customers (road and sea freight) and the processing of sold products by third-party facilities, such as the granulation, smelting, or recycling of batteries and metal fractions. This latter category represents the largest share of the industry's overall carbon footprint and largely occurs outside recyclers' direct operational control.

Excluded from the boundary are Scope 3 categories considered immaterial or outside operational influence.

Overview of Industry-wide Emissions

The analysis of emissions data collected from BMRA members for the 2023 reporting year and then extrapolated provides insight into the carbon footprint of the British metals recycling industry (Table 1). The emissions are categorised according to the GHG Protocol into three main areas: Scope 1, Scope 2, and Scope 3.

Scope 1 emissions which are direct GHG emissions from activities owned or controlled by metal recyclers (such as fuel used in vehicles and equipment) account for 2.1% of the total carbon footprint, equivalent to ~233,371 tonnes of CO_2 equivalent (t CO_2e).

Scope 2 emissions, which account for emissions from purchased electricity, are calculated in two ways:

- Market-based Scope 2 emissions are 51,268.8 t CO_2e (0.4%). Our original member sample contained three companies on REGO-backed tariffs, likely inflating green-tariff prevalence. A BMRA survey (n=11) found 27.27% REGO adoption. We therefore applied a 27.27% REGO / 72.73% non-REGO weighting to derive industry market-based Scope 2.
- Location-based Scope 2 emissions, which use the UK's national average emissions from electricity generation, were higher at ~70,495 t CO_2e. This approach gives a better sense of emissions if no green energy purchasing is assumed.

Scope 3 emissions, which cover all other indirect emissions across the metals recycling value chain (such as emissions from suppliers, transport, and processing) were the largest contributor. These amounted to 10,674,256.4 t CO_2e, accounting for 97.4% of total emissions.

In total, the carbon footprint of the UK metals recycling industry for 2023 was estimated at 10,958,896 t CO_2e.

Table 1. Quantified annual emissions of the metals recycling industry using operator data from the 2023 reporting year, categorised according to The Greenhouse Gas Protocol Scopes.

Scope	Emissions (t CO_2e)	Percentage
Scope 1	233,371	2.1%
Scope 2, Market Based	51,268.8	0.5%
Scope 2, Location Based†	70,495	-
Scope 3	10,674,256	97.4%
Total	**10,958,896**	

†**Footnotes:** Location-based Scope 2 emissions are calculated using the average emissions intensity of grids (i.e., regional, or national) on which the consumption occurs, thereby reflecting the average carbon intensity of energy supplied in a specific location. In contrast, market-based Scope 2 emissions consider the specific greenhouse gas emissions from the electricity that a company has chosen to purchase, which may include renewable energy contracts or certificates, thus reflecting the choices a company makes about its energy sourcing. The market-based approach is exclusively integrated into the total carbon footprint calculation, as it provides the most accurate reflection of a company's strategic initiatives to mitigate carbon emissions. Market-based Scope 2 totals reflect a weighting from a BMRA member survey (n=11): 27.27% REGO-backed, 72.73% non-REGO, applied to electricity consumption. The REGO share uses supplier-specific factors (often ~0 g CO2e/kWh); the non-REGO share uses the UK residual mix.

To accurately assess the carbon footprint of the UK's metals recycling industry, it is essential to differentiate between direct operational emissions and those associated with the wider value chain.

In 2023, the industry's Scope 1 and 2 emissions, which are those under the direct control of metal recyclers, such as fuel consumption in plant operations and vehicles, along with electricity use totalled 284,640 t CO_2e. While this is not negligible in absolute terms, it represents just 0.07% of the UK's total territorial emissions of approximately 385 million t CO_2e in the same year. [1] This relatively small share underscores the industry's limited operational footprint within the broader national context, while also highlighting the real and meaningful opportunities for further emissions reductions, particularly through improved energy efficiency and the shift to electrification.

By contrast, the industry's total estimated carbon footprint (including Scope 3 emissions across its full value chain) was 10.96 million t CO_2e. This represents roughly 2.8% of the UK's total emissions. However, this figure should be interpreted with caution, as the Scope 3 emissions in this context include activities occurring outside the UK, particularly in the processing of sold products category, such as the smelting and refining of recycled metal, often carried out by third parties abroad.

The vast majority (~ 97%) of the industry's emissions fall under Scope 3, with downstream ferrous metal smelting alone contributing more than 8.86 million t CO_2e. This overlaps with emissions typically attributed to the UK's steel manufacturing sector, which emits roughly 12 million t CO_2e annually. [2] This overlap reinforces that much of the carbon footprint associated with the metals recycling industry lies beyond the operational control of recyclers themselves.

Table 2 outlines the total carbon footprint for the reporting year, presenting emissions across Scopes 1 to 3. This encompasses indirect emissions, as well as Scopes 1 and 2, which account solely for direct emissions and those associated with energy use. These figures are used to calculate emissions per tonne of metal recycled during the reporting period. For each emissions intensity ratio, Tunley Environmental has provided values based on total emissions (Scopes 1–3) and separately for Scopes 1 and 2. While both sets of metrics offer valuable insight, the intensity ratio which uses Scopes 1 and 2 is particularly reflective of the core operational activities of the metals recycling industry.

The Scope 1 and 2 emissions intensity is 0.025 t CO_2e per tonne of metal recycled. When upstream transport is included (i.e. Scope 1 & 2 plus Scope 3 – upstream transport), this figure increases to 0.050 t CO_2e per tonne of metal recycled. The upstream transport boundary encompasses all upstream transport activities calculated under Scope 3. For further details, refer to the section titled 'Granularity – Upstream Freight'.

Table 2. Quantified annual emissions and intensity ratios for the metals recycling industry using operator data from the 2023 reporting year, categorised by GHG Protocol Scopes 1, 2, and 3.

Item	Study Year (2023)
Total Emissions, Scopes 1 - 3 (t CO_2e)	10,958,896
Metal recycled in Year (tonnes)	11,425,579
Intensity Ratio (t CO_2e/tonne metal recycled):	**0.96**
Total Emissions, Scopes 1 & 2 (t CO_2e)	284,640
Scopes 1 & 2 Intensity Ratios:	
Scope 1 & 2, Intensity Ratio (t CO_2e/tonne metal recycled)	**0.025**
Scope 1 & 2 + 3, Upstream Transport, Intensity Ratio (t CO_2e/tonne metal recycled)	**0.050**

To further contextualise the emissions intensity per tonne of recycled metal, Tunley Environmental have provided Table 3 (page 14). The table presents emissions intensity ratios for a range of recycled metal types, incorporating Scope 1 and 2 emissions alongside all Scope 3 emissions from upstream and downstream transport (reported as separate items). These values reflect the carbon footprint per tonne of recycled metal, providing insight into the relative impact of different material streams.

In this context, the upstream transport boundary includes all transport activities associated with each specific metal, as calculated under Scope 3. For additional information, see the section titled 'Granularity – Upstream Freight'. Conversely, downstream transport refers to the emissions generated from transporting the specified metal, after it has been sold by the metal recycling industry, up to the point where it arrives at a facility capable of melting it into a semi-finished or finished product.

Emissions intensities vary significantly across categories. For example, WEEE (Waste Electrical and Electronic Equipment) and end-of-life vehicles (ELV) exhibit comparatively high intensity ratios, particularly for downstream transport (0.102 and 0.080 t CO_2e /tonne, respectively), likely due to the complex logistics and processing requirements associated with these materials.

Both non-ferrous and ferrous metals display similar upstream transport emission intensities, at 0.052 t CO_2e per tonne and 0.051 t CO_2e per tonne, respectively. Their downstream transport emissions are reported at 0.045 t CO_2e per tonne of ferrous metals, and 0.46 t CO_2e per tonne of non-ferrous metals. The slightly higher upstream values, relative to ELV, WEEE, and lead-acid battery streams, likely reflect the transport characteristics of these metal types, which rely more heavily on gate trade than other scrap categories.

Source data linked to gate trade indicates a highly fragmented and inefficient logistics pattern. Transport distances vary widely, and material is often moved in small quantities using light commercial vehicles or even private cars. Low load factors, combined with the use of smaller and generally less fuel-efficient vehicles (e.g., diesel vans and passenger cars), lead to significantly elevated emissions per tonne-kilometre. Anecdotal observations from the dataset further suggest that some transport activity may be opportunistic, informal, or ad hoc, involving small-scale collections that further reduce overall transport efficiency.

It is important to recognise that the gate trade contribution is based on data from a single participant and may therefore not reflect broader industry practice. As such, the resulting figure should be interpreted with caution. Investigation and research identified that the composition of the mixed-metal stream entering through gate trade is approximately 20 wt% non-ferrous and 80 wt% ferrous. This split was therefore applied when modelling gate trade within the dataset.

Conversely, materials such as lead acid batteries display relatively low emission intensity across both upstream and downstream transport, indicating more localised sourcing and/or streamlined processing and distribution.

It is also notable that for several materials such as WEE and ELV, the downstream transport emissions exceed upstream, reflecting the increased energy demands of delivering processed outputs to end-users.

Table 3. Quantified intensity ratios per metal type for the metals recycling industry using operator data from the 2023 reporting year. Upstream and downstream are reported as separate items.

Scrap Type	Scope 1 & 2 + 3, Upstream Transport, Intensity Ratio (t CO_2e/tonne metal recycled)	Scope 1 & 2 + 3, Downstream Transport, Intensity Ratio (t CO_2e/tonne metal recycled)
Lead Acid Batteries	0.027	0.025
WEEE	0.037	0.102
ELV	0.039	0.080
Ferrous Metals	0.051	0.045
Non-Ferrous Metals	0.052	0.046

Building on the upstream and downstream transport emission intensities, we have also calculated an overall emissions intensity that aggregates all sources across Scopes 1, 2, and 3. These results are presented in Table 4 and Figure 4 (page 15), where emissions are grouped into operator-controlled activities and wider value chain contributions. The analysis shows that only 3.6% (0.03 t CO_2e per tonne) of total emissions are attributable directly to a metal recycling operator.

In contrast, the value chain contributes 96.4% (0.93 t CO_2e per tonne) of the total emissions intensity. These emissions arise from activities occurring both upstream and downstream of the operator, including third-party freight movements and, most significantly, metal smelting. Smelting alone accounts for the largest single contribution to emissions intensity. Third-party transport also contributes materially to the overall intensity. Taken together, this highlights the relatively limited direct carbon impact of recycling operators when compared to the broader industrial processes required to return secondary metals to market. The results highlight that the majority of decarbonisation opportunities lie upstream and downstream, particularly in smelting technologies.

Table 4. Emissions intensity contributions across operational and value-chain activities to produce one tonne of recycled metal by a UK metal recycling operator, based on data from the 2023 reporting year.

Category	Emissions Intensity (t CO_2e/tonne metal recycled)
Metal Smelting	0.8779
Third-party Transport	0.0471
Operator, Transport	0.0134
Operator, Other	0.0092
Operator, Processing	0.0115
Operator Contribution	**0.03**
Value Chain Contribution	**0.93**

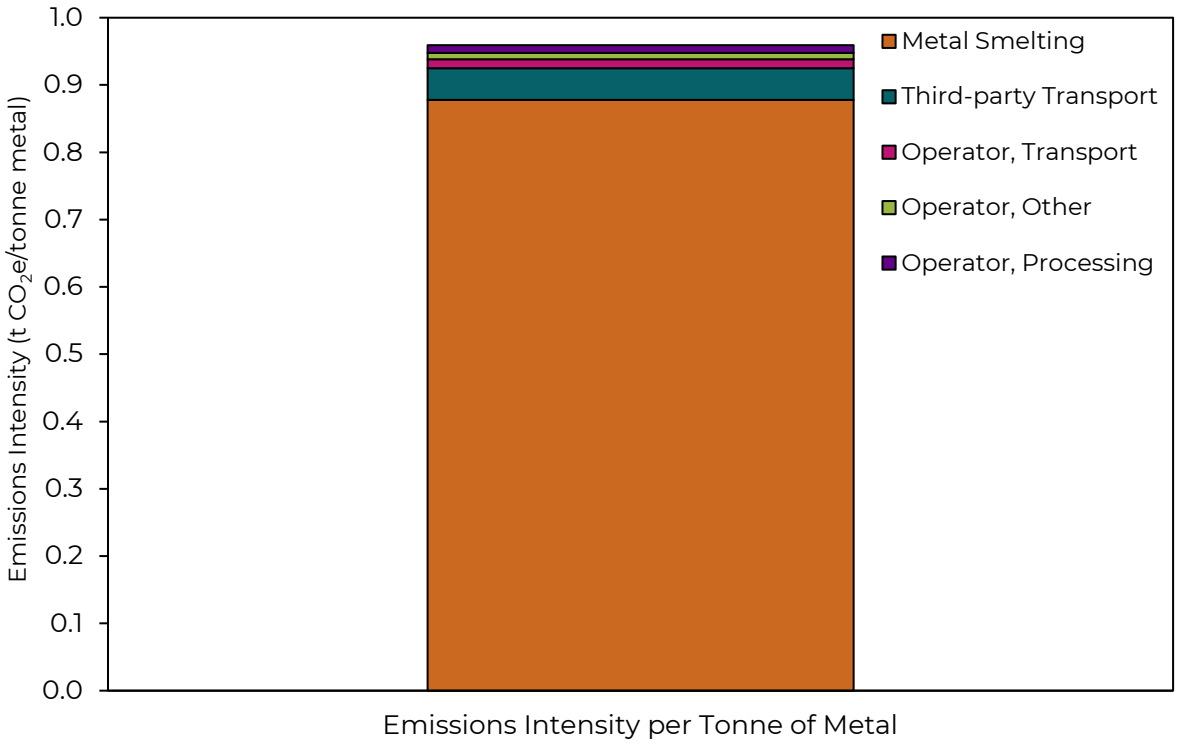

Figure 4. Stacked emissions intensity profile for the average production of one tonne of recycled metal by a UK metal recycling operator, based on data from the 2023 reporting year.

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A Note on Avoided Emissions: Benefits of Metals Recycling

Recycling, and specifically metals recycling, is regarded with paramount importance in the UK, as without it we would need to produce more new materials or, more likely, import them to meet our needs. Metals recycling therefore allows the UK to be more self-sufficient in an increasingly volatile trading environment.

Metals recycling also has great environmental benefits: it conserves natural resources, minimises waste generation, protects biodiversity and encourages a circular economy. For this report in particular, it is notable that recycling avoids the generation of additional greenhouse gases.

So, whilst a GHG Protocol/ISO 14064 approach to measuring an industry's footprint does not take into consideration the environmental benefits of recycling, it would be remiss of this paper to fail to shine a light on the unique benefits of the UK metals recycling industry.

In 2016, the Bureau of International Recycling (BIR) produced *Environmental Benefits of Recycling*. This study represents the latest global lifecycle analysis of the global recycling sector. It builds on BIR's 2008 edition using operational data, including the use of a novel "front-end" tool for "normalisation" of industry-acquired data in terms of energy requirements and associated CO_2 emissions.

In total, the study examines four materials, but our focus lies with the three metallic materials examined: aluminium, copper and ferrous. The study compares two scenarios: the production of metals within a "primary" or virgin value chain, and the production of metals via "secondary" or fully recycled processes.

The study finds that aluminium and steel exhibit the most significant reductions in CO_2 emissions, while copper and aluminium provide the greatest energy savings in comparison to the primary benchmark due to the energy-intensive processes involved in primary production, such as bauxite mining and copper ore smelting. Recycling aluminium avoids 63 million tonnes (Mt) of CO_2e emissions – equivalent to the annual emissions of 14 million petrol cars. Steel recycling saves 504 Mt CO_2e – equivalent to 155 million return flights between Paris and Beijing.

There are also significant energy savings for the metals studied. Aluminium recycling achieves energy savings of 4,434 terajoules (TJ) against the primary benchmark, whilst copper achieves 1,033 TJ and ferrous 206 TJ.

For every metal across the two environmental indicators measured – emissions and energy savings – recycling provides major environmental benefits.

This evidence demonstrates that recycling is already an essential tool in the fight against climate change. The benefits metals recycling provides will continue to grow as the industry reduces its Scope 1 and 2 emissions to align with net zero.

Industry-wide Emissions: GHG Emissions Categories

Table 5 and Figure 5 (page 18) provide the emissions for the UK metals recycling industry for 2023. The largest quantified emissions category is attributed to the processing of sold products, amounting to 10,958,896.0 t CO_2e. This category pertains to the sale of recycled metal by the metals recycling industry. The supply chain involved is extensive and complex, comprising a network of interconnected metal recycling companies. Metal is frequently subject to additional processing by larger recyclers within this chain who may further refine the material (accounted for in Scopes 1 & 2), and/or export it for remelting into new products by third-parties, or for domestic use in smelting operations by third-party customers.

The processing of sold products category specifically includes only the emissions associated with the further processing of scrap by entities outside the core metal recycling industry. Examples include on-site granulation of metals by metal producers, the melting of recycled metal to create new products, and emissions linked to battery recycling activities.

The second largest source of emissions arises from upstream transportation and distribution, amounting to 292,050.9 t CO_2e. This category covers emissions generated during the transport of materials into the metal recycling value chain by third parties. These third parties may include freight and logistics companies, members of the public delivering scrap directly (known as gate trade), or the transfer of materials between different metal recycling businesses by third parties.

Please note that, due to the interconnected nature of the metals recycling industry, emissions associated with both upstream and downstream transportation and distribution have a margin or uncertainty. While Tunley has made efforts to avoid double counting emissions between recycling facilities, the lack of detailed data means that some duplication may persist.

Table 5. Emission data for the metals recycling industry using operator data from the 2023 reporting year, categorised according to The GHG Protocol.

Scope	Category	Emissions (t CO_2e)	Percentage
S1.1	Stationary combustion	80,320.9	0.7%
S1.2	Mobile combustion	153,048.5	1.4%
S1.3	Refrigerants	1.4	0.0%
S2.2	Purchased electricity	51,268.8	0.47%
S3.1	Purchased goods and services	21,991.2	0.2%
S3.2	Capital goods (e.g., assets, machinery, etc)	11,091.9	0.1%
S3.3	Fuel and energy related activities not included in S1 or S2	65,760.5	0.6%
S3.4	Upstream transportation and distribution	292,050.9	2.7%
S3.5	Waste generated in operations	1,249.9	0.01%
S3.6	Business travel	464.4	0.004%
S3.7	Employee commuting	1,118.8	0.01%
S3.8	Upstream leased assets	2,986.3	0.03%
S3.9	Downstream transportation and distribution	245,903.6	2.2%
S3.10	Processing of sold products	10,031,638.8	91.5%
	Total (t CO_2e):	**10,958,896.0**	

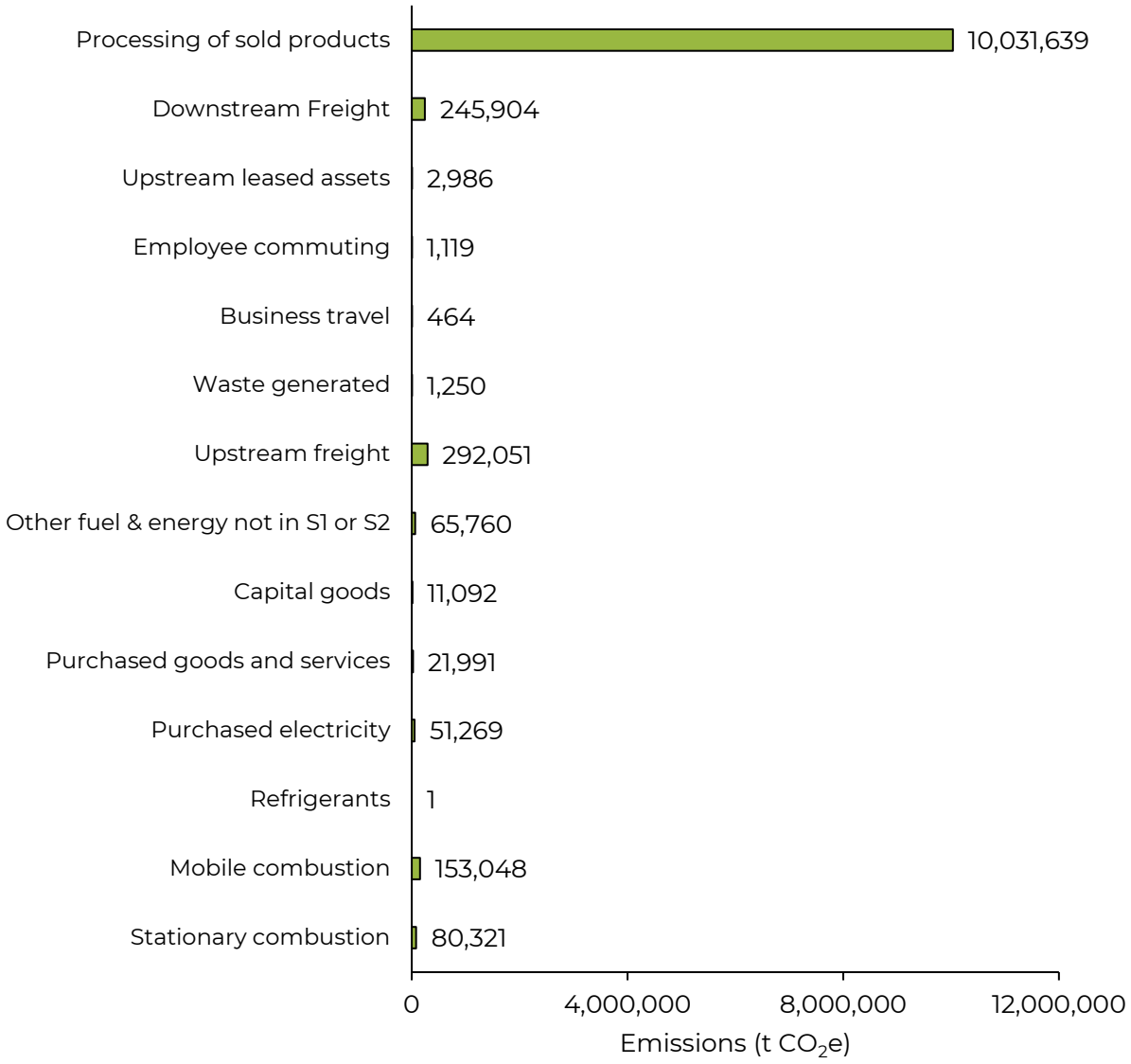

Figure 5. Graphical representation for the quantified emission categories (GHG Protocol) for the metals recycling industry using operator data from the 2023 reporting year.

Industry-wide Emissions: Granularity of Scopes 1 & 2

Since Scope 1 and 2 directly reflect the operational activities of the UK metals recycling industry, it is essential to examine these emissions in greater detail. It is important to note that the percentages discussed in this section relate solely to Scopes 1 and 2, not to the industry's complete carbon footprint which includes Scope 3.

Table 6 presents a detailed breakdown of Scope 1 and 2 emissions. The data reveals that the primary source of Scope 1 emissions is the diesel used within mobile equipment/vehicles (classified under Scope 1.2), which accounts for 152,658.4 t CO_2e, equivalent to 53.6% of total Scope 1 and 2 emissions. This relates to the use of both vehicles used on site within the metals recycling process and the use of company owned vehicles (e.g., HGVs) to transfer metal within the industry.

The second most significant contributor is diesel used in stationary plant equipment (Scope 1.1), responsible for 79,844.3 t CO_2e, or 28.05% of combined Scope 1 and 2 emissions. This relates to machinery used within the metal recycling process, for example, shear balers and fragmentisers. Other sources, such as propane consumption, natural gas use, and Ad-Blue, represent a very small proportion of the total, each contributing less than 1%.

This analysis highlights the dominance of fossil fuel usage (particularly diesel) in the operational carbon footprint of the industry and underscores the importance of targeting vehicle and plant fuel efficiency or investigating alternative fuels / electrification in any decarbonisation strategy.

Table 6. Granular analysis of Scope 1 and 2 emission data for the metals recycling industry using operator data from the 2023 reporting year.

Scope	Item	Emissions (t CO_2e)	Percentage (Scope 1 & 2)
S1.1	Natural Gas Used for Heating	55.9	0.02%
S1.1	Propane Consumption in Stationary Plant Equipment	213.7	0.08%
S1.1	Diesel Consumption in Stationary Plant Equipment	79,844.3	28.05%
S1.1	Natural Gas Use	207.0	0.07%
S1.2	Diesel Consumption for Mobile Equipment/Vehicles	152,658.4	53.63%
S1.2	Petrol Consumption in Mobile Plant Equipment	2.4	0.001%
S1.2	Ad-Blue Used in Diesel Vehicles	70.8	0.02%
S1.2	Uknown Fuel Consumption in Vehicles	316.9	0.11%
S1.3	Refrigerant Leaks	1.4	0.000%
S2.2	Purchased Electricity*	51,268.8	18.01%
	Total (t CO_2e):	**284,639.6**	

***Note:** "Purchased Electricity" (S2.2) reflects market-based accounting weighted by survey-observed REGO adoption (27.27%) and non-REGO (72.73%).

Industry-wide Emissions Granularity of Processing of Sold Products

Processing of sold products is the largest source of emissions for the British metals recycling industry and falls within the Scope 3 category. This category pertains to the sale of recycled metal by the metals recycling industry. The supply chain involved is extensive and complex, comprising a network of interconnected metal recycling companies. Metal is frequently subject to additional processing by larger recyclers within this chain who may further refine the material (accounted for in Scopes 1 & 2), and/or export it for remelting into new products by third-parties, or for domestic use in smelting operations by third-party customers.

In this context, the processing of sold products category specifically includes only the emissions associated with the further processing of scrap by entities outside the core metal recycling industry. Examples include on-site granulation of metals by metal producers, the melting of scrap to create new products, and emissions linked to battery recycling activities.

Figure 6 offers a breakdown of the category of metals contributing to emissions from the processing of sold products. Ferrous Metals are the largest contributor, accounting for 9,348,845 t CO_2e, due primarily from the emissions associated with the melting of metals into new products. This is followed by the processing of Non-Ferrous Metals and WEEE, which contribute 494,045 t CO_2e and 116,021 t CO_2e, respectively. Other emissions from the processing of sold products include ELV, which contribute 72,077 t CO_2e (Figure 6).

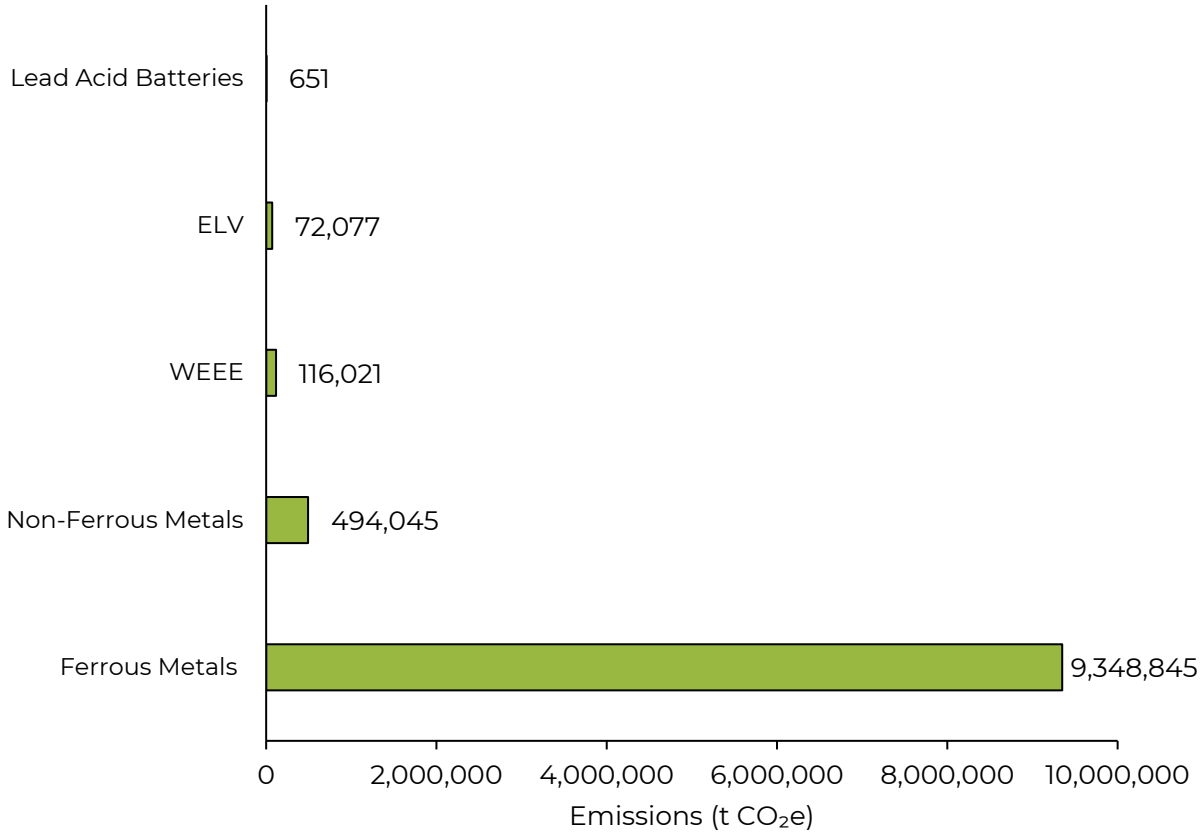

Figure 6. Granular analysis of the metals recycling industry's processing of sold products Scope 3 category using operator data from the 2023 reporting year.

To provide additional context for the category of 'processing of sold products', Figure 7 offers a detailed analysis of emissions sources, categorised according to each category of sold product by the metals recycling industry. The figure highlights that the most significant contribution to this category comes from the melting down of sold metal products for transformation into new products by third parties (10,015,201 t CO_2e). For all metal products, this is the largest contributor, with Ferrous Metals accounting for the largest aspect of the footprint, as previously discussed. This is followed by the granulating of larger metal products into smaller, more manageable fragments by third parties outside the industry, usually metal producers, which contributes a total of 15,787 t CO_2e.

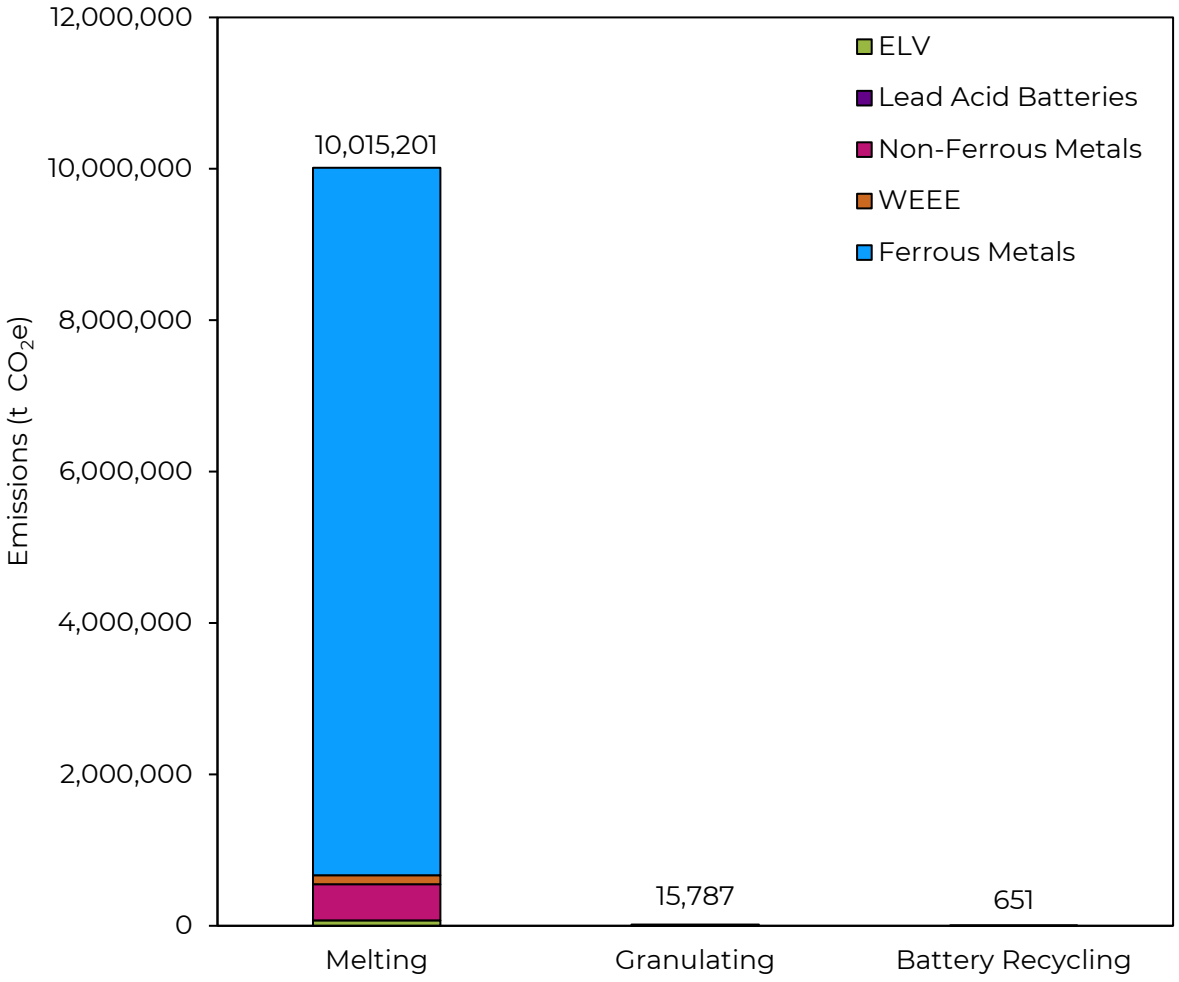

Figure 7. Granular analysis by emissions source of the metals recycling industry's processing of sold products Scope 3 category using operator data from the 2023 reporting year.

Granularity – Upstream Freight

Upstream transportation and distribution, also known as upstream freight, is the second largest contributor to the UK metals recycling industry's carbon footprint and falls under the Scope 3 category. This covers emissions generated during the transport of materials into the metals recycling value chain by third parties. These third parties may include freight and logistics companies, members of the public delivering scrap directly (known as gate trade), or the transfer of materials between different metal recycling businesses using external companies.

Tunley Environmental have provided more detailed information in Figure 8. This shows that the most significant source of emissions within the upstream freight category is the transport of Ferrous Metals, which accounts for 207,985 t CO_2e. The next largest contributors are Non-Ferrous Metals and WEEE, generating 80,870 t CO_2e and 2,282 t CO_2e, respectively.

Please note, a stacked bar chart granular analysis has not been provided due to poor granularity of this category.

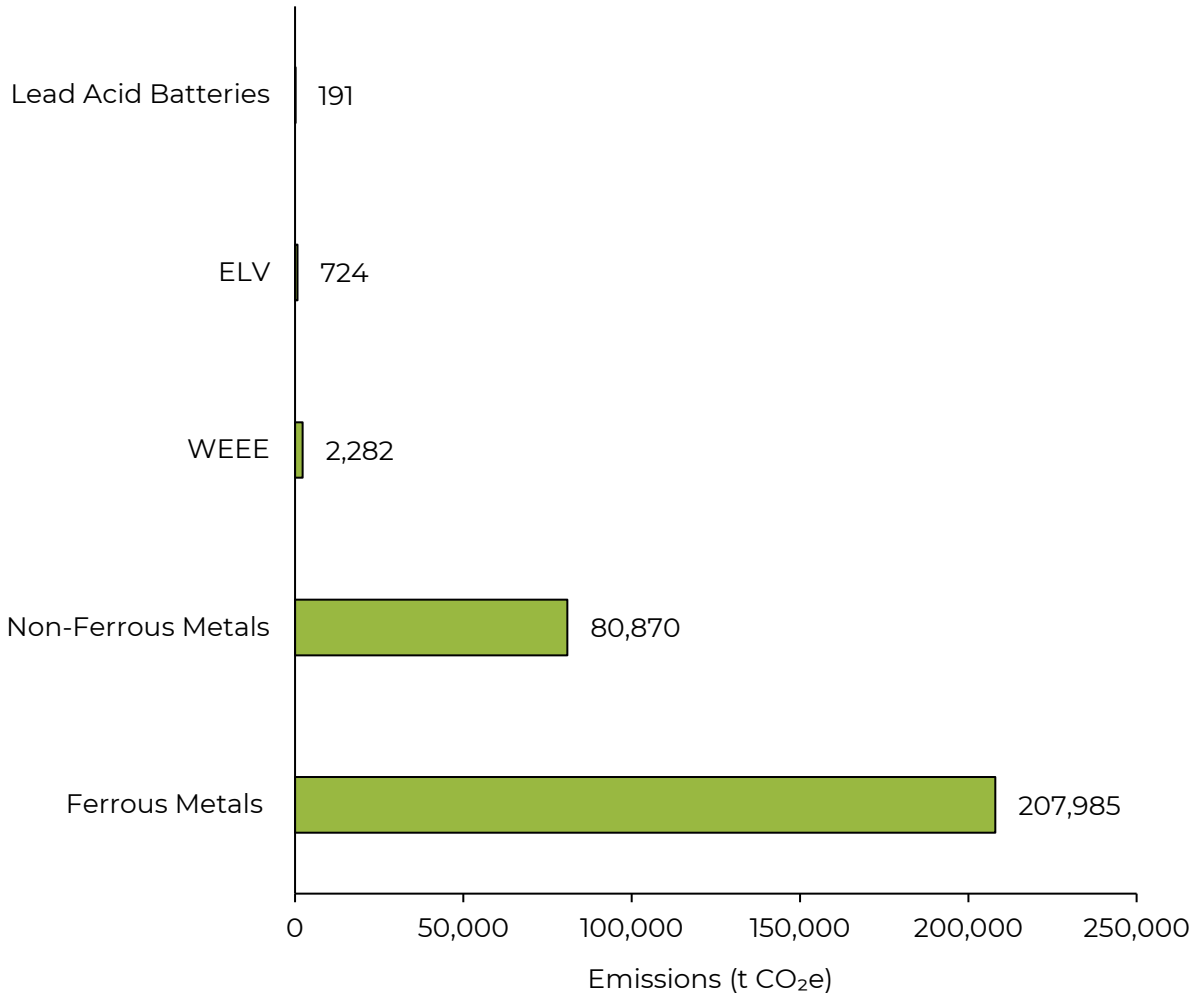

Figure 8. Granular analysis of the metals recycling industry processing of upstream transportation and distribution Scope 3 category using operator data from the 2023 reporting year.

Granularity – Downstream Freight

Downstream transportation and distribution, also known as downstream freight, is the third largest contributor to the UK metals recycling industry's carbon footprint and falls under the Scope 3 category. This relates to emissions from the transport of metals which have been sold by the metal recycling industry to third parties up until the metal reaches a facility where it can be melted down into a semi- or finished- product. Tunley Environmental have provided more detailed information in Figure 9.

This shows that the most significant source of emissions within the downstream freight category is the transport of Ferrous Metals, which accounts for 166,069 t CO_2e. This high impact is due to the volume of these materials being transported resulting in greater transport-related emissions. The next largest contributors are Non-Ferrous, generating 62,508 t CO_2e, followed by WEEE at 14,561 t CO_2e, also due to the large volumes involved.

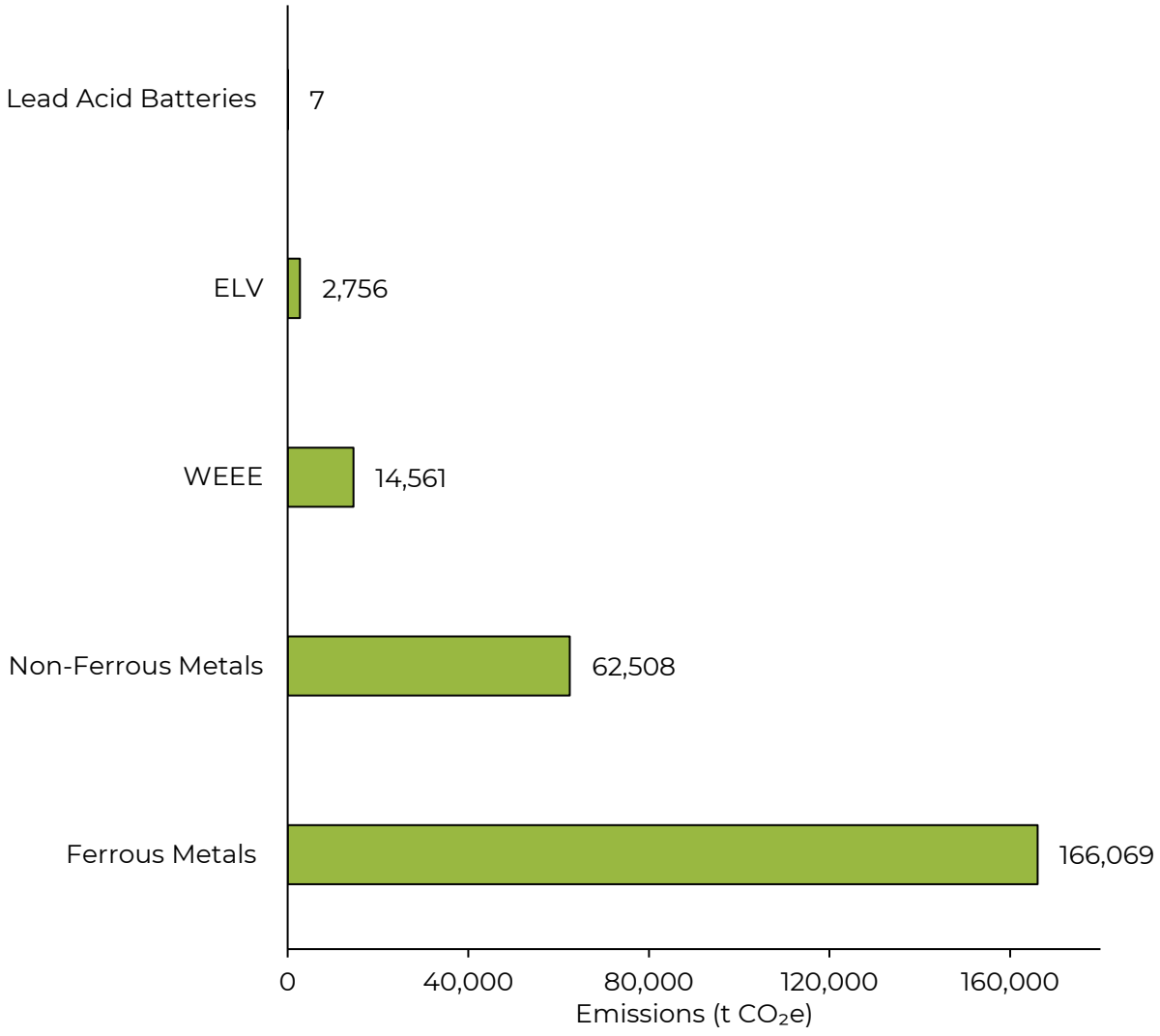

Figure 9. Granular analysis of the metals recycling industry processing of downstream transportation and distribution Scope 3 category using operator data from the 2023 reporting year.

To provide further context for the 'downstream transportation and distribution' category, Figure 10 presents a detailed breakdown of emission sources, organised by the type of metal product.

Emissions associated with exports are the largest contributor to this category. The emissions are modelled based on the use of HGV road transport combined with roll-on/roll-off ferry services, or, where applicable, bulk carriers / container ships and road transport from the nearest port, if the destination country is landlocked. For non-landlocked countries, export emissions are calculated exclusively using bulk carrier or container ship transport, factoring in the distance from the UK to the country's main port. The model is informed by a dataset provided by the British Metals Recycling Association (BMRA), which provided a breakdown of UK recycled metal exports for 2023, including destination countries. The resulting emissions related to exports were calculated to be 123,267 t CO_2e.

The emissions associated with road transport within the UK are the second largest contributor, although roughly in line with those which stem from export. The resulting emissions sum to 122,634 t CO_2e across all metal types. This includes the transport of materials from metal recyclers to UK melting facilities, ports, or melting facilities abroad.

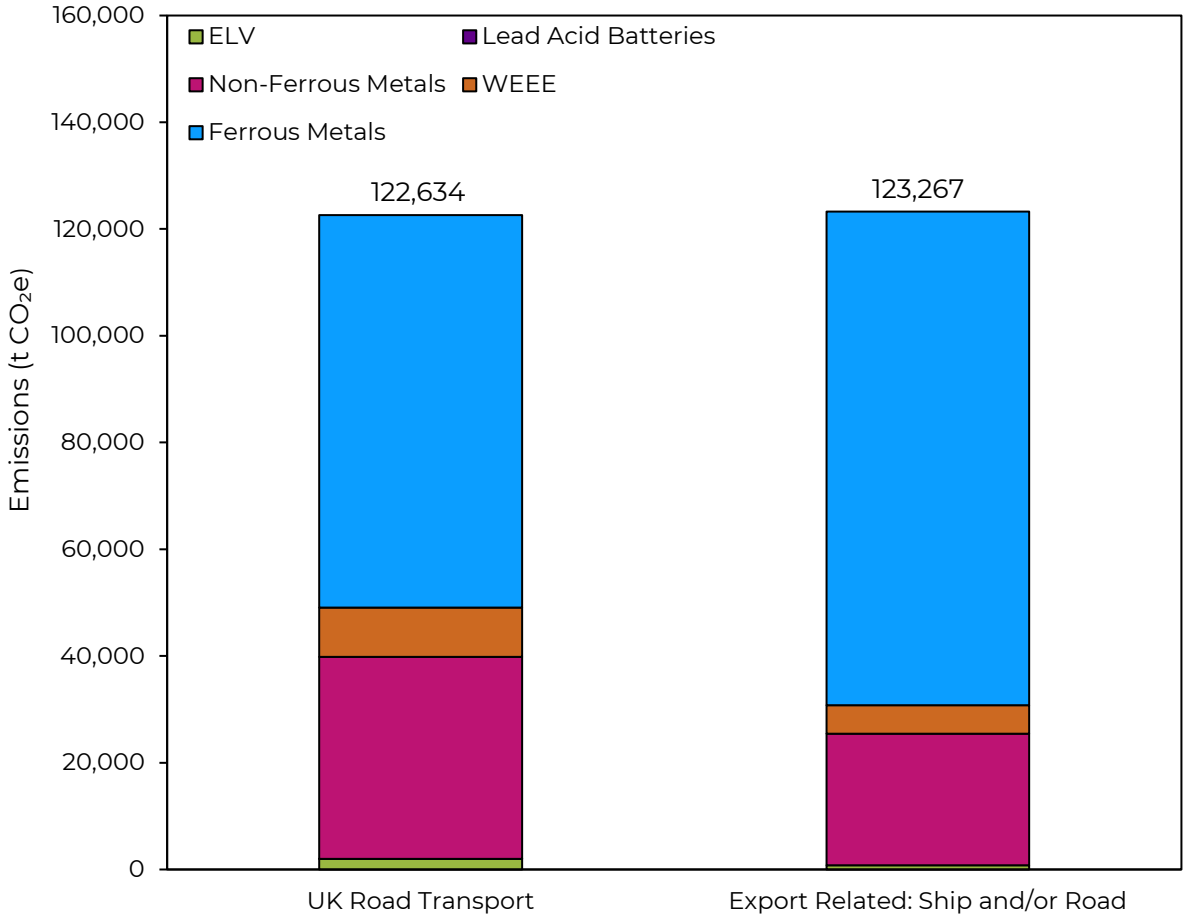

Figure 10. Granular analysis of the downstream transportation and distribution Scope 3 category from 1 January 2023 to 31 December 2023.

Roadmap Towards Net Zero

Tunley Environmental recommends that the UK metals recycling industry adopt a long-term strategy for carbon reduction. To support this, Tunley Environmental have outlined a series of suggested initiatives aimed at decreasing the industry's carbon footprint. Our initial focus is to minimise Scopes 1 and 2 emissions as much as possible, with the goal of offsetting the remaining 18,719.9 t CO_2e in 2050 (a 93% reduction compared to baseline), at an estimated annual cost of £336,960, to achieve operational carbon neutrality within these scopes (see Figure 11 on page 26).

When considering Scope 3 emissions, the implementation of the strategies in the roadmap could lead to a reduction of 7,701,811 t CO_2e (70%) by 2045 (see Figure 12 on page 27). However, since the processing of sold products is the primary source of these emissions and depends largely on reductions made by third party supply chain partners, direct actions by the metals recycling industry alone will not suffice. Instead, reductions in this category will require collaborative efforts and broader market changes.

While Tunley Environmental acknowledges that Net Zero frameworks encourage the greatest possible reduction in all emission scopes prior to offsetting (e.g., 90% under the SBTi framework), the modelling undertaken for this assessment indicates that reductions in Scope 3 emissions beyond approximately 70% are unlikely to be achievable under current technological, economic, and supply chain conditions. This is primarily because the majority of Scope 3 emissions stem from the downstream processing of sold products and upstream supply chain activities, many of which occur outside the UK and within less economically developed countries where access to low-carbon technologies and renewable energy infrastructure remains limited. These activities fall largely beyond the direct control of the UK metals recycling industry, meaning that further reductions depend heavily on progress made by third parties (such as international metal producers, logistics providers, and energy suppliers) in their own decarbonisation efforts. As such, the 70% reduction modelled represents an ambitious, yet possible target based on current global market, technological, and policy outlooks.

This section provides the UK metals recycling industry with a range of initiatives to help reduce its GHG emissions.

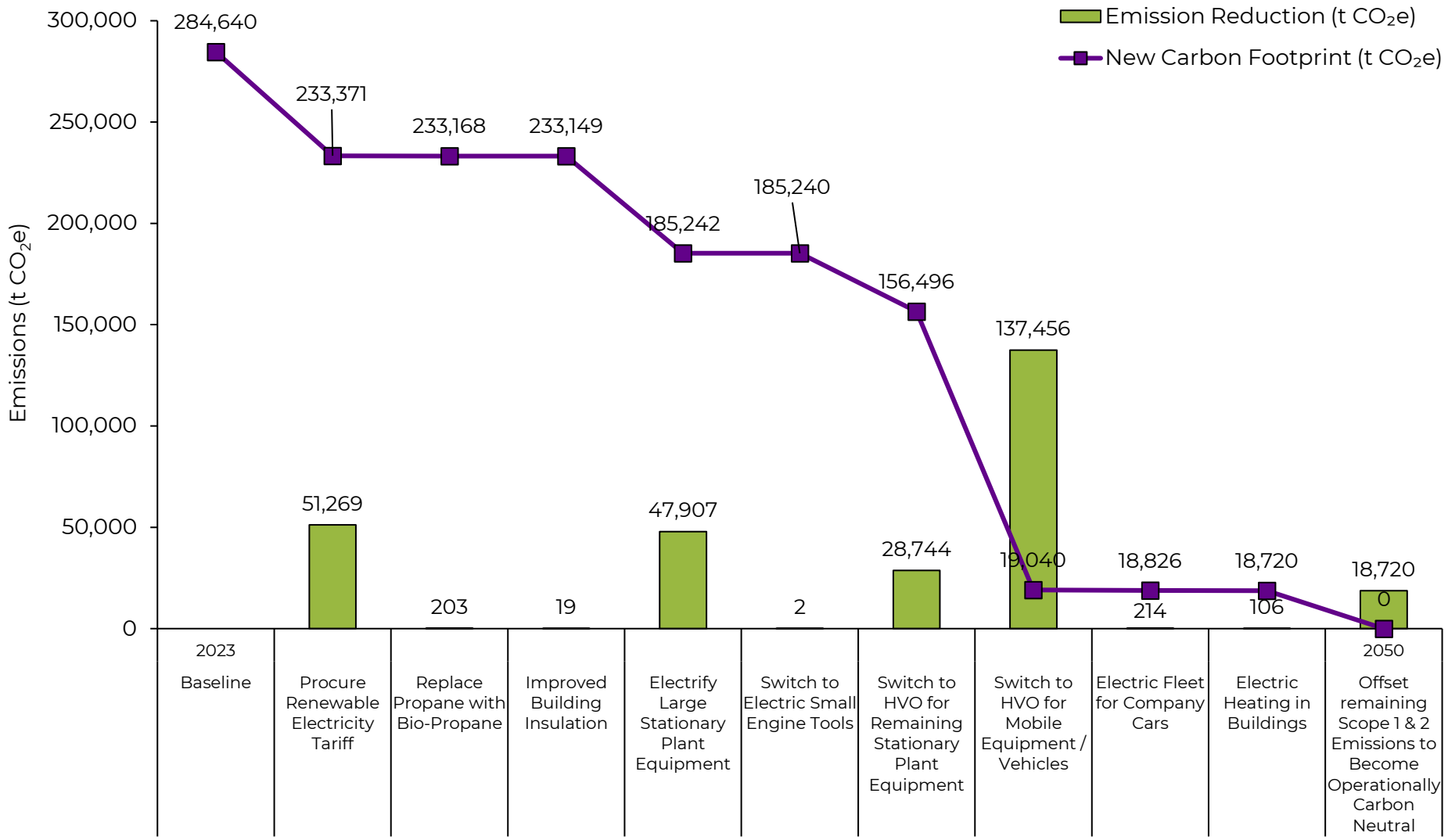

Figure 11. Roadmap towards operational carbon neutrality only for Scope 1, 2 emissions by 2050.

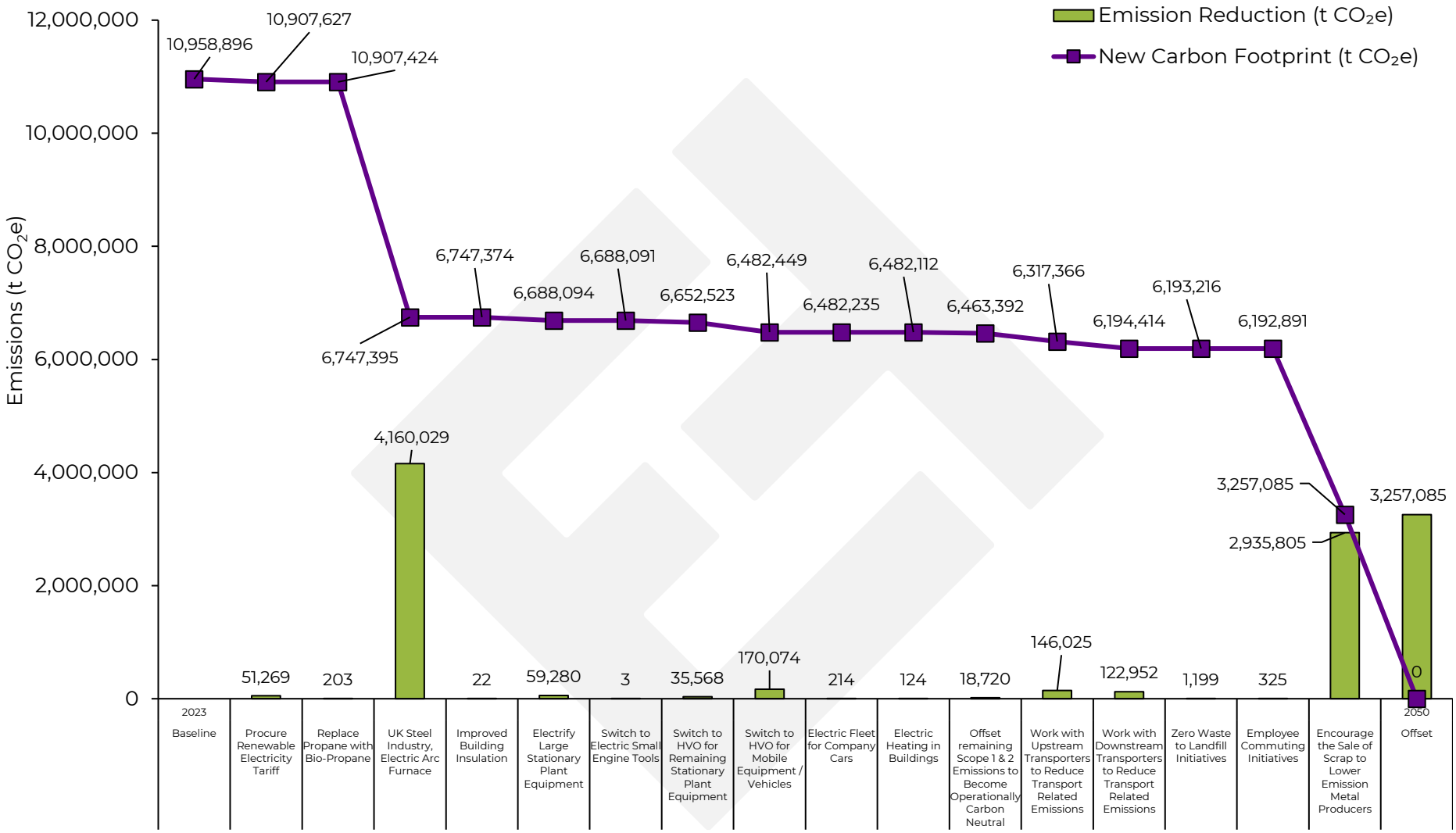

Figure 12. Roadmap to towards Net Zero in Scope 1, 2 & 3 emissions by 2050.

Procure Renewable Electricity Tariff

Companies within the UK metals recycling industry can switch to using renewable electricity by opting for an Ofgem-certified green electricity tariff (Renewable Energy Guarantees of Origin, REGO). The best way to choose a renewable electricity tariff is by using comparison websites and assessing the renewable origin guarantee information provided. At present, most electricity suppliers offer at least one 100% renewable electricity option. Implementing a green electricity tariff will reduce emissions by 51,268.8 t CO_2e per year.

Moreover, the supply of electricity could be supplemented through the installation of on-site renewable energy sources such as photovoltaic (PV) cells or wind turbines. A combination of both wind and solar power is recommended to ensure the security of supply. This initiative would result in a decrease in grid dependency, yielding a dual advantage: it would not only cut down on electricity costs but also mitigate location-based Scope 2 and electricity related Scope 3 emissions. Furthermore, there is the potential advantage of selling excess electricity generated back to the grid.

Replace Propane with Bio-Propane

Many metal recyclers currently use propane for hot-work cutting, which contributes to its Scope 1 emissions. To support the goal of eliminating both Scope 1 and 2 emissions, switching to bio-propane can achieve an annual reduction of 203 t CO_2e. Bio-propane is chemically identical to conventional LPG (propane), ensuring the same level of performance and energy efficiency. It can be seamlessly used as a direct replacement for propane without the need for any modifications to existing equipment. Produced as a co-product of biodiesel production, bio-propane is readily available in the United Kingdom (UK).

UK Steel Industry, Electric Arc Furnace

The transition to electric arc furnaces (EAFs) in the UK steel industry presents an opportunity for further emissions reductions, specifically within the Scope 3 category of 'processing of sold products'. This includes both Tata Steel's and British Steel's transition to electric arc furnace technology which is expected by 2030. By supplying recycled steel that is melted using EAFs rather than blast furnaces, a potential reduction of 4,160,028.6 t CO_2e could be realised by 2030.

Improved Building Insulation

Metals recycling companies can engage a consultant to conduct a feasibility analysis for enhancing the insulation in the roofs and walls of existing buildings. Heat loss from buildings accounts for a substantial portion of the energy demand in commercial properties. By upgrading the insulation across all buildings, an estimated annual emissions reduction of 21.8 t CO_2e can be achieved, including energy-related Scope 3 emissions.

Electrify Large Stationary Plant Equipment

Replacing large diesel-powered machinery, such as shear balers, with electrically powered alternatives can significantly enhance efficiency. Industry data provided to Tunley Environmental indicates that an electric baler can reduce the carbon footprint by 49.2% compared to a diesel-powered equivalent. If powered by renewable electricity, such as an Ofgem-certified REGO tariff, the emissions from this process could be reduced even further. Should the metals recycling industry choose to electrify their large equipment, emissions reductions of up to 59,279.8 t CO_2e per year could be achieved.

It is important to note, however, that installing large electrically powered equipment may require additional connections to the electricity grid, which could prove costly or challenging depending on the local grid's capacity.

Switch to Electric Small Engine Tools

By transitioning from petrol-powered small engine tools, such as Stihl saws and other hand tools, to electrically powered alternatives, the UK metals recycling industry can achieve an annual reduction of 3.1 t CO_2e.

Alternative Fuels and Electrification of Equipment and Vehicles

The use of diesel in vehicles and plant equipment can be targeted to reduce emissions. An ideal substitute for diesel is HVO. HVO is a type of renewable diesel produced from vegetable oils and animal fats. Unlike traditional biodiesel, HVO undergoes a hydrotreatment process, which removes impurities, resulting in a fuel that is structurally similar to diesel with high energy content and good cold performance. This allows HVO to be used as a direct replacement for diesel, without requiring any modifications. Moreover, HVO can be purchased as a carbon-neutral product. By replacing 100% of diesel usage over a staggered period of time with alternative fuels such as HVO, emissions savings of 205,641.73 t CO_2e can be achieved.

Moreover, electric vehicles (EVs) can be implemented which produce zero tailpipe emissions, making them a favourable choice for businesses looking to reduce their carbon footprints. Their operation relies entirely on electricity, which can also be generated from renewable sources. Furthermore, the efficiency of electric vehicles far surpasses that of conventional internal combustion engine vehicles, resulting in lower energy consumption for the same distance travelled. If all company cars were replaced with EVs, an emission reduction of 213.8 t CO_2e is expected.

Lastly, it is worth noting that whilst these changes can bring about significant emission reductions, they are part of a broader strategy. Conservation measures should be implemented. These may include more efficient use of resources, regular maintenance to ensure optimum performance, and staff education on energy-saving practices. All these steps collectively will ensure a substantial reduction in the UK metals recycling industry's carbon footprint.

Electric Heating in Buildings

If the existing gas heating systems within the buildings of metal recyclers were replaced with electric heating systems such as heat pumps or infrared heating systems, then an annual emission reduction of 123.7 t CO_2e may be attained.

Work with Upstream and Downstream Transport Suppliers to Reduce Emissions

The environmental impact of the UK metals recycling industry extends beyond the sectors immediate operations and into the broader supply chain. Tunley Environmental believes that the supply chain is an important aspect of reducing a carbon footprint. Many institutions now place great importance on emissions associated with their supply chain, for example, the NHS now requires all its suppliers with large contracts (> £5 million) to have their carbon footprint quantified and a roadmap to Net Zero in place.

To address the emissions associated with the supply chain of the UK metals recycling industry, Tunley Environmental proposes focusing on encouraging all upstream and downstream partners to conduct emissions quantification (e.g., using the BMRA calculator) and hotspot analysis, alongside encouraging the use of alternative fuels, optimised logistics and emerging technologies for transporting goods. By working collaboratively to help them reduce emissions by improving transport and distribution (e.g., removing the last mile emissions), The sector can achieve reductions upwards of 268,977.24 t CO_2e. This could be achieved through a range of measures, such as sourcing from suppliers with robust environmental policies, encouraging suppliers to quantify their emissions, adopting cleaner technologies, and reducing the distance goods need to travel by opting for local customers and suppliers.

Zero Waste to Landfill Initiatives

Zero landfill policies aim to minimise or eliminate the disposal of waste in landfills, which significantly reduces the generation of methane, a potent greenhouse gas. When organic waste is diverted from landfills and processed through composting or anaerobic digestion, it prevents the release of methane during decomposition, thereby lowering greenhouse gas emissions. Additionally, the practice of recycling and reusing materials under zero landfill policies reduces the energy and emissions associated with the production of new goods, further contributing to the reduction of GHG emissions. Therefore, if a zero-landfill policy was implemented via a waste processing supplier then the UK metals recycling industry could reduce their annual greenhouse gas emissions by 1,198.8 t CO_2e.

Employee Commuting Initiatives

Addressing the carbon footprint associated with employee commuting presents a significant challenge, particularly given the limited control and direct influence an organisation typically has over its employee's transport choices. However, with the GHG impact calculated to be 464.4 t CO_2e, it is evident that implementing strategies to mitigate this is not just beneficial, but essential.

Promoting car-sharing is one such strategy. By encouraging contractors to share vehicles, the number of vehicles on the road decreases, resulting a decreased carbon footprint. The positive knock-on effects also include potential cost savings for the employees. Another strategy is the implementation of vehicle salary sacrifice schemes whereby employees can opt to hire vehicles. By offering salary sacrifice schemes for low-emission vehicles, employers can encourage staff to switch from higher-emission personal cars to cleaner alternatives, making sustainable choices more accessible and financially appealing.

We calculate that reductions of upwards of 325.1 t CO_2e could be achieved through the implementation of these strategies.

Supply Chain: Encourage the Sale of Recycled Metal to Lower Emission Metal Producers

The British metals recycling industry has an important opportunity to collaborate with the production industries to reduce emissions associated with melting recycled metal into new products. This could be achieved through relatively simple measures, such as sending more recycled metal for domestic smelting when the UK expands its capacity with new electric arc furnaces coming online. Additionally, recycled metal could be selectively exported to countries with greener electricity grids and the infrastructure to support fully electric furnace technologies.

Globally, the shift towards electrification within the metal production sector is gathering pace, driven by the need to cut carbon emissions and comply with increasingly stringent environmental regulations. Electric furnaces offer clear advantages over their fossil-fuel-based counterparts, delivering improved energy efficiency and the potential for near-zero emissions when powered by renewable electricity.

This move towards electrification forms a vital part of broader decarbonisation efforts across heavy industries worldwide, as governments and businesses strive to meet ambitious climate goals. Transitioning to electric furnace technologies is a key element in these strategies, with leading players in the metal industry already pledging to replace traditional furnaces over the coming decades.

Our analysis suggests that implementing these measures could lead to emissions reductions of more than 2,935,805.1 t CO_2e.

Offsetting

Although the pinnacle objective of decarbonisation is to minimise emissions, the practicality of achieving this for every emission source may not always be plausible. In these instances, offsetting against the carbon emissions is necessary. Therefore, the remaining carbon emissions will have to be offset with bona fide suppliers. To offset against the emission for the whole period of 2023 for Scope 1 and 2 (265,920 t CO_2e) at an estimated cost of £18/t CO_2e would cost a total sum of £5,123,520. If reduction opportunities to reduce scope 1 and 2 were undertaken, the predicted remaining 18,719.9 t CO_2e could be offset at a cost of £336,960 to achieve operational carbon neutrality by 2050.

Conclusions

This report presents the first industry-wide carbon footprint assessment of the UK metals recycling industry, underpinned by detailed analysis of four metals recycling organisations and extrapolated using tonnage databases from organisations such as the EA, NRW, SEPA, and NIEA. For the 2023 reporting year, the industry's total estimated carbon footprint was 10.96 million tonnes of CO_2e, with approximately 97% attributable to Scope 3 emissions. These are predominantly linked to downstream processing activities, such as smelting by third-party operators, often located overseas.

While the headline figures offer a comprehensive view of the industry's emissions profile, it must be interpreted in the context of necessary assumptions, extrapolations, and acknowledged data limitations.

Limitations of the Data

Tunley Environmental have been supplied with an array of verifiable industry datasets in order to extrapolate the BMRA sample into industry-wide findings. These sources include: the EA, SEPA, NIEA and NRW for waste movements received and removed from sites permitted as either metal recycling or WEEE treatment sites.

For the export of recycled metal, two datasets were used: Global Energy Monitor and International Steel Statistics Bureau.

Whilst every transfer of waste metal from permitted operators has been captured, there is a degree of uncertainty in the extrapolation's accuracy as a result of the limited sample size. Collectively, the sample are responsible for processing 5% of all the metal recycled in the UK.

Every effort has been made to capture the varying forms of mechanical treatment used within the metals recycling industry. This includes hand-fed separation equipment, a baler, a shear-baler, a granulator and a fragmentiser with downstream separation equipment. However, it is unlikely every mechanical treatment technology used by the UK metals recycling industry has been assessed at a site-specific level using activity data.

As such, metal recycling companies should not rely solely upon the report or the accuracy or completeness of any conclusions in any evaluation of their own operations. More specialised plants, including sites operating a fragmentiser with an adjacent or combined downstream separation plant may find their results vary from this study.

Additional operational data from a larger sample of metal recycling organisations could improve the accuracy of the extrapolation and enable a more granular breakdown of the emissions associated with downstream processing and the recovery of non-metallic materials.

Related industries, including waste management, vehicle recycling and vehicle salvage may find this report worthwhile. But it is important to note activity at permitted sites in related industries has not been assessed in this study. Discreet transfers of non-metallic waste received by operators permitted as either a metal recycling or WEEE treatment sites has also been excluded from this research.

The information and data contained in this report was taken over the course of several months and the subsequent analysis is reflective of this. This report may not reflect circumstances after the publication of the report.

The report should not be used as a replacement or as a substitute for a company's own assessment of its greenhouse gas emissions in accordance with the GHG Protocol or ISO14064-1.

Data Quality and Opportunities for Improvement

The dataset supporting this assessment combines activity-level data from the participating businesses with national tonnage figures. While this methodology provides a credible industry-level estimate, data quality varied across emission categories. Core operational metrics (such as fuel and electricity consumption) were generally robust, whereas categories like employee commuting, gate-trade logistics, and downstream processing relied more heavily on assumptions or incomplete reporting.

Future assessments could be strengthened by:

- Broader member participation to increase representativeness;
- Improved granularity (e.g. transport distances by material type, mileage logs);
- Transitioning from spend-based to activity-based data, especially for purchased goods;
- Enhancing upstream and downstream partner engagement;
- Using standardised, industry-wide emissions reporting frameworks to enable consistency and year-on-year comparability and quantification tools such as the BMRA calculator.

Key Findings and Strategic Implications

Scope 1 and 2 emissions account for just 2.6% of the total footprint and offer the most immediate opportunities for emissions reductions. Key contributors include diesel use in mobile and stationary equipment, and electricity consumption. The industry's operational carbon intensity is relatively low at 0.025 t CO_2e per tonne of recycled metal.

Opportunities for near-term reductions include:

- Switching to renewable electricity tariffs or on-site generation;
- Electrification of plant and vehicle fleets or transition to HVO;
- Enhanced energy efficiency through improved insulation and low-carbon heating;
- Substituting fossil-based fuels with bio-based alternatives such as bio-propane.

If fully implemented, these measures could reduce operational emissions (Scope 1 and 2) by up to 93% by 2050, leaving a residual footprint that could be addressed via offsetting.

Longer-Term Decarbonisation: The Role of Scope 3 and Collaboration

The majority of emissions lie within Scope 3, particularly from the processing of sold products, which are activities outside the operational boundaries of most recyclers. These emissions reflect the lifecycle impact of recycled materials and underline the importance of collaboration across the supply chain. Encouraging the use of electric arc furnace (EAF) technology, supporting lower-emission metal producers, and prioritising exports to greener regions are key strategic levers.

Industry-wide advocacy, informed procurement, and transparent reporting will be vital in enabling emissions reductions beyond recyclers' immediate control.

Barriers to Progress

Despite a clear pathway for emissions reductions, several barriers must be addressed to enable the sector to realise its full decarbonisation potential:

- High capital costs associated with electrification of equipment, transition to alternative fuels, and the installation of on-site renewable energy systems;
- Regional grid constraints, which may limit the capacity to support widespread electrification of heavy plant and infrastructure;
- Limited influence over Scope 3 emissions, particularly downstream activities such as smelting, which require coordinated action across complex, often global, supply chains;
- Lack of comprehensive and consistent regulatory incentives, including clarity around future carbon pricing, procurement standards, and emissions reporting requirements;
- Insufficient access to funding and government support, especially for small and medium-sized recyclers who may struggle to invest in decarbonisation initiatives without grants, subsidies, or low-interest financing.
- Gaps in carbon literacy and emissions-related training, which can hinder progress in embedding carbon awareness into operational practices, procurement decisions, and planning.

Final Reflections

This assessment demonstrates that the UK metals recycling industry is already contributing to emissions reduction by avoiding emissions which would be produced via additional primary metal production, but significant further gains are possible. With a targeted operational roadmap and stronger supply chain engagement, the industry can make meaningful strides toward net zero while reinforcing its role in the circular economy. Continued measurement, improved data collection, and collective action will be critical to achieving this.

Tunley Environmental Report Emission Statement

Tunley Environmental GHG emissions from completing this assessment were 6.79 kg CO_2e.

Appendix – A: Methodology and Quantification Standards

Tunley Environmental calculated the carbon footprints of four metals recycling operators for the 2023 reporting year. The assessment was undertaken in accordance with the international standard BS EN ISO 14064-1, a similar methodology to following that of the World Resources Institute GHG Protocol - A Corporate Accounting and Reporting Standard, Revised Edition (the GHG Protocol)

Emission factors and carbon equivalent conversion data were primarily drawn from the UK Government's publication Greenhouse Gas Reporting: Conversion Factors 2023 (published by the UK Government Department for Business and International Trade and the UK Department for Environmental Food and Rural Affairs), hereafter referred to as Conversion Factors 2023. For complex materials and additional activities not covered in this dataset, Tunley Environmental referred to academic literature and the Inventory of Carbon and Energy (ICE). Global Warming Potentials (GWPs) were taken from the IPCC Sixth Assessment Report (AR6, 2021). Further technical details on the member-level assessments are provided in Appendix B.

From Member-Level Assessments to Industry-Level Extrapolation

Each of the four operators represented a distinct tonnage band based on the volume of metal recycled: one each 0–5,000 t and 250,001–1,000,000 t, and two 15,001–25,000 t. Emission data were collected at the activity level for each site and then categorised into standardised emissions categories to allow for consistent treatment across different operations.

These categories included, but were not limited to:

- Fuel and energy use (e.g., diesel for mobile equipment, propane for stationary plant, purchased electricity)
- Operational emissions (e.g., refrigerant leakage, water use, paper consumption)
- Purchased goods and services (e.g., tyres, PPE, oils and greases)
- Capital goods (e.g., new machinery, electrification equipment)
- Waste generation
- Business travel and employee commuting
- Upstream and downstream transport
- Processing of sold products, categorised by metal type (e.g., iron and steel, aluminium, WEEE, ELVs, lead, zinc, mixed ferrous/non-ferrous metals)

The initial four-member sample included three firms on REGO-backed tariffs. To mitigate participation bias and improve representativeness, BMRA conducted a short member survey (11 responses) asking: (i) REGO participation, (ii) coverage share, and (iii) use of 100% renewable tariffs without REGO. Survey results indicated 27.27% REGO participation, 72.73% non-REGO.

We therefore computed market-based Scope 2 as:

$$Scope\ 2_{MB} = (0.2727 \times EF_{REGO}) + (0.7273 \times EF_{non-REGO})$$

where EF_{REGO} uses supplier-specific emission factors (reported as ~0 kg CO_2e/kWh), and $EF_{non-REGO}$ uses the UK residual mix.

To support extrapolation to the wider UK industry, each activity was categorised by GHG Protocol scope, ISO 14064 category, and metal type, where applicable. Emissions intensities were then calculated as t CO_2e per tonne of metal processed for each category.

Using these emission intensity values, the results were scaled up using tonnage data from the EA's 2022 Waste Data Interrogator (WDI), alongside tonnage databases from NRW (2023), SEPA (2023), and the NIEA (2023). The WDI dataset provides annual data on the volume of materials received and removed by metals recycling facilities across England, while others provide data for Scotland and Wales. A weighted average approach was applied to ensure appropriate representation of the sample businesses across tonnage bands, with calculations structured to maintain consistency with the original member-level results.

Robust validation procedures were followed throughout to ensure the logic of the scaling approach. Specifically, scaled emissions were tested against the original data for the four assessed operators, confirming alignment across all categories. This allowed for a confident extrapolation of industry-wide emissions from the representative sample.

Data Licensing Note: The extrapolation process made use of Environment Agency data licensed under a Conditional Licence. In accordance with the licence conditions, the data is properly attributed and is used in compliance with the stated terms. This report includes the following acknowledgement: "Contains Environment Agency information © Environment Agency and/or database right."

Key Assumptions and Limitations

This assessment represents the first industry-wide carbon footprint analysis of the UK's metals recycling industry and is based on data provided by four metals recycling organisations. While care has been taken to follow internationally recognised methodologies, the findings should be interpreted in light of the following assumptions and limitations:

1. **Extrapolation from Sample to Sector:**
   - Emission data was gathered from four organisations of differing sizes and extrapolated to reflect the broader British metals recycling industry.
   - Extrapolation was performed using EA Waste Data Interrogator (WDI) 2022 tonnage data alongside tonnage databases from NRW (2023), the NIEA (2023), and SEPA (2023). This was weighted by tonnage bands to account for industry diversity.
   - The scaling assumes that the sampled sites are broadly representative of operational practices across their respective categories. While this offers a robust approximation, it may not capture all operational variances or differences in practice.

2. **Data Completeness and Quality**
   - Emissions data quality varied across categories. Core operational data (e.g., fuel use and electricity consumption) were generally strong. However, several Scope 3 categories relied on assumptions or lacked granularity:
     - Employee commuting, business travel, and refrigerants were often incomplete or missing.
     - Transport data, especially for gate trade and fragmented logistics patterns, were based on limited or anecdotal records.
     - Purchased goods and capital goods were in some cases calculated using spend-based rather than activity-based data, which may reduce precision.
   - A materiality assessment (Appendix B) indicates lower data confidence for some categories.

3. **Scope 3 Emissions Modelling**
   - ~97% of total emissions fall within Scope 3, particularly the 'processing of sold products' category, which includes downstream emissions such as smelting and refining by third parties.
   - These emissions were modelled using secondary data and industry averages, often for facilities outside the UK, and should be interpreted as indicative rather than exact values.
   - Assumptions were also made regarding export routes, modes of transport, and destination processing technologies.

4. **Uncertainty in Gate Trade Transport**
   - The emissions intensity for gate trade showed high values driven by small vehicle loads and informal transport patterns.
   - This data was drawn from a single organisation and may not be representative of the industry as a whole. As such, caution should be exercised in interpreting these findings.
   - Investigation and research identified that the composition of the mixed-metal stream entering through gate trade is approximately 20 wt% non-ferrous and 80 wt% ferrous. This split was therefore applied when modelling gate trade within the dataset.

5. **Attribution and Double Counting**
   - Due to the interconnected nature of the industry, where materials are traded between facilities prior to final sale or processing, some overlap and potential double counting may occur in both upstream and downstream transport categories.
   - While efforts were made to minimise this (e.g. deduplication and logical testing in scaling), absolute elimination of overlap cannot be guaranteed.

6. **Time Period and Temporal Consistency**
   - The primary reporting year used was 2023–2024. However, some data sources (such as the WDI) are from the 2022 calendar year.
   - This temporal mismatch may slightly impact representativeness but is unlikely to significantly distort industry-level trends.

7. **Exclusions and Scope Boundaries**
   - Several emissions categories under the GHG Protocol, such as use of sold products, end-of-life treatment, downstream leased assets, and investments, were excluded on the basis of relevance.
   - Processing emissions (e.g., from smelting) were attributed to the recycling industry, even though they are typically associated with the manufacturing sector in national inventories. This was done to reflect the full lifecycle impact of recycled material.

These limitations highlight the need for continuous improvement in data collection, methodological consistency, and sector-wide engagement. Future assessments would benefit from wider member participation, the establishment of standardised reporting protocols, and closer collaboration with value chain partners to improve data quality, particularly for Scope 3 emissions. By addressing these gaps, the British metals recycling industry can build a more accurate, transparent, and actionable picture of its climate impact, thereby strengthening its contribution to national decarbonisation goals and reinforcing its leadership within the circular economy.

Appendix – B

Materiality Assessment & Data Categories

Below Tunley Environmental provide all of the GHG emissions scope categories alongside data improvement recommendations (Table A1). These are related to data source and emission factor point based allocation discussed below.

Table A1. Materiality assessment for the metal recycling industry using operator data from the 2023 reporting year

Category	In Scope?	Justification if out of scope	Data Score Average	Data Improvement Recommendations
Stationary combustion	In		6	More granular data for each member, by machinery type
Mobile combustion	In		7	More granular data for each member, by machinery and vehicle type
Refrigerants	In		12	Lack of comprehensive data
Purchased heat	In		N/A	More granular data
Purchased electricity	In		6	
Purchased goods and services	In		11	Move away from spend-based for several items, use mass-based activity data
Capital goods (e.g., assets, machinery, etc)	In		8	Move away from spend-based for several items, use mass-based activity data
Fuel and energy related activities not included in S1 or S2	In		8	
Upstream transportation and distribution	In		8	More granular data by metal type and method of transport
Waste generated in operations	In		8	More granular data
Business travel	In		8	
Employee commuting	In		8	
Upstream leased assets	In		12	
Downstream transportation and distribution	In		8	More granular data by metal type and method of transport. Move away from assumptions during transport to metal melting facilities
Processing of sold products	In		8	More granular data by metal type, better supply chain statistics
Use of sold products	Out	Not applicable	N/A	
End of life treatment of sold products	Out	Not applicable, overlap with processing of sold products	N/A	
Downstream leased assets	Out	Not applicable	N/A	
Franchises	Out	Not applicable	N/A	
Investments	Out	Not applicable	N/A	

Data Accuracy Assessment

All the raw data provided to Tunley Environmental were broken down into accuracy levels reflective of the data sources provided (Table A2 – A4). That allows for inaccuracy and uncertainty to be accounted for in this assessment. Both activity data (*e.g.*, quantities of material, usage of electricity, *etc*) and emission factors are scored using the same band-based system, with 1-6 corresponding to the highest and lowest levels of accuracy, respectively.

Emission factors are to be evaluated using the following five indicators:

1) Technological relevance.
2) Temporal coverage.
3) Geographical coverage.
4) Completeness.
5) Reliability (e.g., peer-reviewed source, reproducible, low uncertainty in the information provided).

Table A2. Accuracy bands assigned to data, description of data assignment, adjustment factor provided increase to CO_2 emission calculations.

Accuracy Score	Description
1	Activity data accurately measured, fully accounted for and/or reported. Emission factor satisfies all five indicators.
2	Activity data provided directly by company/organisation; some generalisations made. Emission factor satisfies four indicators.
3	Activity data produced based on information provided by company/organisation. Emission factor satisfies three indicators.
4	Activity data assumption based on similar product/event reports by the same company/organisation. Emission factor satisfies two indicators.
5	Activity data assumption based on product/event reports by a similar company/organisation. Emission factor satisfies one indicator.
6	Activity data assumption made based only on publicly available information. Emission factor is estimated using the data available for a broader data category to which the emission source belongs, the estimated emission factor does not meet the indicators' requirements.

Table A3. Overall error score matrix for accuracy assessment.

Error Score	Action
1 - 2	Use the data, no further action required.
3 - 4	Can use the data, **recommended** to **improve data** quality by e.g., i) checking raw data with client (assessing recollection need) and ii) sourcing different emission factors or averaging several data points, required to declare this in the report.
5 - 10	**Strive** to **improve data** as a **priority** and only use the data when no further improvements can be made (see above)
12 - 25	**Required** to **improve data** quality (see above).
30 - 36	**Do not use the data**, discuss with the client and the carbon team to improve data quality and/or to assess whether the data can be used and the approach to report this.

Table A4. Actions to improve data quality and reduce uncertainty.

Error Score		Emission Factor					
		Five indicators	Four indicators	Three indicators	Two indicators	One indicator	No indicators
Data	Excellent	1	2	3	4	5	6
	Very good	2	4	6	8	10	12
	Good	3	6	9	12	15	18
	Relevant	4	8	12	16	20	24
	Acceptable	5	10	15	20	25	30
	Poor	6	12	18	24	30	36

Appendix – C

Scope 1 and 2 GHG Emissions

The following is specified in ISO14064-1 "The organization shall quantify direct GHG emissions separately for CO_2, CH_4, N_2O, NF_3, SF_6 and other appropriate GHG groups (HFCs, PFCs, etc.) in tonnes of CO_2e.". Therefore, where possible Scope 1 and Scope 2 emissions are separated into known GHG emissions (Table A5). This enables further understanding for the British metals recycling industry on their direct GHG emissions.

Table A5. Direct GHG emissions detailed separately for Scope 1 and Scope 2 showing CO_2, CH_4, N_2O emissions in tonnes of CO_2e.

Item	Emissions (t CO_2e of CO_2)	Emissions (t CO_2e of CH_4)	Emissions (t CO_2e of N_2O)
Natural Gas Used for Heating	55.83	0.09	0.03
Propane Consumption in Stationary Plant Equipment	213.35	0.18	0.12
Diesel Consumption in Stationary Plant Equipment	78,789.27	9.26	1,045.79
Natural Gas Use	206.58	0.32	0.10
Diesel Consumption for Mobile Equipment/Vehicles	150,641.17	17.70	1,999.50
Petrol Consumption in Mobile Plant Equipment	2.37	0.01	0.01
Ad-Blue Used in Diesel Vehicles	70.80	0.00	0.00
Uknown Fuel Consumption in Vehicles	314.72	0.36	1.85
Refrigerant Leaks	1.37	0.00	0.00

Emission Data Report to ISO 14064-1

To encourage completeness, consistency, and readability ISO 14064-1 recommends that the GHG quantification should be reported using the full descriptive categories provided. Therefore, this is fully displayed and categorised in Table A6.

Table A6. Complete ISO14064-1 data categorisation table.

Category	Description	Emissions (t CO_2e)
1	**Direct GHG emissions & removals in t CO_2e**	233,370.8
1.1	Direct emissions from stationary combustion	80,320.9
1.2	Direct emissions from mobile combustion	153,048.5
1.3	Direct process emissions and removals arising from industrial processes	0.0
1.4	Direct fugitive emissions arising from release of GHGs in anthropogenic systems	1.4
1.5	Direct emissions and removals from land use, land use change, and forestry	0.0
2	**Indirect emissions in t CO_2e**	51,268.8
2.1	Indirect emissions from imported electricity	51,268.8
2.2	Indirect emissions from imported energy	0.0
3	**Indirect GHG emissions from transportation**	539,537.7
3.1	Emissions from upstream transportation and distribution	292,050.9
3.2	Emissions from downstream transportation and distribution	245,903.6
3.3	Emissions from employee commuting & teleworking	1,118.8
3.4	Emissions from client and visitor transport	0.0
3.5	Emissions from business travel	464.4
4	**Indirect GHG emissions from products used by the organisation**	103,079.9
4.1	Emissions from purchased goods	87,751.7
4.2	Emissions from capital goods	11,091.9
4.3	Emissions from the disposal of solid and liquid wate	1,249.9
4.4	Emissions from the use of assets	2,986.3
4.5	Emissions from the use of services that are not described in the above subcategories	0.0
5	**Indirect GHG emissions associated with the use of products from the organisation**	10,031,638.8
5.1	Emissions or removals from the use stage of the product	0.0
5.2	Emissions from downstream leased assets	0.0
5.3	Emissions from end-of-life stage of product	10,031,638.8
5.4	Emissions from investments	0.0
6	**Indirect GHG emissions from other sources not specified**	0.0

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B	Updated dataset with new insights, grammatical changes	NW	23/11/2025	ADN	25/11/2025
C	Updated Figure 4 and Table 4	NW	28/11/2025	GD	01/12/2025
D	Scaling within Scope 2 fixed. Report updated accordingly	NW	09/12/2025	TG	09/12/2025

References

[1] "2023 UK Greenhouse Gas Emissions, Final Figures," Feb. 2025. [Online]. Available: https://www.ipcc-nggip.iges.or.jp/public/wetlands/index.html;

[2] Briefing for BEIS Select Committee, "Written evidence submitted by UK Steel (ETS0001)," https://committees.parliament.uk/writtenevidence/14920/html.

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