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Status quo of recycling in metal production and processing in Germany

Recycling atlas for metal production

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The Federal Institute for Geosciences and Natural Resources is the central geoscientific authority providing advice to the German Federal Government in all geo-relevant questions. It is subordinate to the Federal Ministry for Economic Affairs and Climate Action (BMWK).

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List of abbreviations

AVV	Waste Catalogue Ordinance
Batt-VO	Batteries Regulation
BGR	Federal Institute for Geosciences and Natural Resources
BMWK	Federal Ministry for Economic Affairs and Climate Action
DERA	German Mineral Resources Agency within BGR
DESTATIS	Federal Statistical Office of Germany
ELV	End-of-life vehicle
EOL	End-of-life (end of product life)
EOL-RR	End-of-life recycling rate
EuRIC	European Recycling Industries' Confederation
HS code	Harmonized System code (international trade codes, customs tariff codes)
IED	Industrial Emissions Directive
KrWG	Circular Economy Act
LIB	Lithium-ion battery
NF	Non-ferrous
OECD	Organisation for Economic Co-operation and Development
OSR	Old scrap rate
PGM	Platinum group metals
RC	Recycled content
RIR	Recycling input rate
RMI	Responsible Minerals Initiative
RMIS	Raw Materials Information System
RR	Recycling rate
REE	Rare earth elements
UBA	German Environment Agency
UNEP	United Nations Environment Programme
WEEE	Waste electrical and electronic equipment, e-waste

Summary

The study “Status quo of recycling in metal production and processing in Germany”, abbreviated to “Recycling atlas for metal production”, was compiled on the basis of the commodity monitoring work carried out by the German Mineral Resources Agency (DERA) at the Federal Institute for Geosciences and Natural Resources (BGR). Its aim was to map the status quo of the German metal recycling industry with regard to current production sites. The study also presents clearly structured information about the individual metals, as well as showing the obstacles to recycling mentioned by the industry itself. An interactive, web-based map on the BGR geoportal and recycling fact sheets complement the study.

The analysis covered recycling capacities and industrial site data for the 14 metals aluminium, cobalt, chromium, copper, iron/steel, gallium, indium, magnesium, manganese, molybdenum, nickel, lead, tin and zinc. A second study that will include additional metals is planned for 2024.

For this study we decided to collect exclusively data from installations and processes for functional metal recycling. Sites for reprocessing only – treatment plants, in legal terms – are therefore not included.

We used data from a wide range of publicly available sources (among them company websites, scientific papers from journals and data collections from trade associations) and, in direct surveys of recycling companies, we collected company-specific data.

Additional basic information on material flows, processes, methods and sites for the 14 metals initially considered was obtained from a comprehensive review of the specialist literature. This also allowed us to compile production and usage data, recycling indicators and trade data for the relevant secondary raw materials.

As part of our methodological work, we compiled a glossary. This comprises a list of basic recycling-related terms and indicators, as well as showing possible calculations based on a simple material flow model. For each material, the study discusses, classifies and compares the ratio of primary to secondary output, and the related recycling indicators.

We organised the recycling-related obstacles into topics, namely raw material availability, energy, contribution to climate protection and regulatory requirements. Details of the individual obstacles can be found on the platform for dialogue on secondary raw materials, coordinated by DERA and acatech on behalf of the BMWK (www.recyclingrohstoffe-dialog.de).

A number of obstacles to an expansion of the recycling industry in Germany exist, which are listed here in no particular order of importance or priority. There is, firstly, the lack of availability and inadequate quality of secondary raw materials. Energy prices also affect the economic viability of recycling processes in Germany, which are often energy-intensive. A switch to hydrogen as a fuel and reducing agent is seen as another obstacle due to the high investment costs. The overall situation is complicated by the fact that no financial incentive is given for the sale of metals from secondary production, despite its lower carbon footprint compared to primary production. The recycling companies surveyed also consider extensive regulatory requirements in waste and product legislation to be another obstacle.

The findings from the study are presented on the BGR geoportal in an interactive map of sites, with separate views for the categories aluminium, lead, iron/steel, copper, magnesium, multimetal, multimetal batteries, nickel, zinc and tin. In addition to simple site data, other information such as capacities and recycled content can be accessed, provided companies have made these data available and released them for publication.

For the 14 metals under consideration, we have prepared fact sheets that give the fundamentals of the specific situation regarding production and recycling of each element. The aim is to present both recycling-related data and the basic structures of the industries involved. The information in the fact sheets is divided into the sections Production, Application, Imports/Exports, particularly of secondary raw materials, Recycling rates, Circular flow model, Secondary raw materials, and Recycling methods. The various recycling rates in particular are a measure of the status quo for each metal in the German and European recycling industries.

We surveyed and analysed 278 companies overall, more than half of them from the steel/iron sector. Together, the companies listed have some 215,000 employees at their sites. The study estimates that, in 2022, the main reconditioned metals made from secondary raw materials (Al, Cu, Fe, Mg. Ni, Pb, Sn, Zn, Ag, Au, Pt) were worth around €34bn.

For the base metals in particular, Germany already has an effective recycling sector based on well-established business models and with proven economic efficiency. This is, however, not yet the case for a number of technology metals, as shown by the recycling rates and the related recycling volumes for Europe and Germany presented in this study.

1. Introduction

The German Mineral Resources Agency (DERA), which is part of BGR, carries out commodity monitoring on behalf of the German government. This work includes regular monitoring of price, supply and demand trends for mineral resources, to both raise early awareness of potential price and supply risks or critical developments on the commodity markets among German businesses, and support them in developing suitable alternative procurement strategies. As part of the German government's 2020 Raw Materials Strategy, DERA has been commissioned to expand its commodity monitoring to include secondary raw materials. The aims are to analyse the supply and demand situation and price trends for secondary raw materials, identify price and supply risks for these resources, and to provide information to policy makers and industry stakeholders on new recycling potential in Germany and abroad. Key to this is an inventory of the German recycling sector, with the recycling atlas for Germany supplying a first systematic basis.

As a major industrial economy, Germany is dependent on a secure and sustainable supply of raw materials. In addition to domestic production and imports, the recycling of raw materials will be playing an increasingly important role as a further mainstay of supply. Metal mining in particular is virtually non-existent in Germany today. Raw materials can be produced not just from primary ores extracted from natural deposits, but also by collecting end-of-life products and production waste containing raw materials, which can be extracted and processed using state-of-the-art recycling processes. By expanding its domestic recycling facilities, Germany can significantly reduce its high dependence on imports of metal resources. Although metal recycling has been practised in Germany for centuries, it is not clear to what extent it can cover the overall demand for the metals considered here, at present and in future. In addition to the base metals, for which there are well-established recycling routes, there are many technology metals where this is not yet the case. There is at present insufficient information about what potential recycling technologies are available in Germany, and who operates what plants. But this information is essential for targeted action to close cycles and for the implementation of circular processes on a larger scale.

In this context, we need to answer the following questions: What is Germany's current position in the transition from a linear to a circular economy, and what is the state of technology in recycling, the key process in the circular economy?

Answers to these questions require detailed information about the status quo of the recycling industry for metal resources in Germany. This will permit a better understanding of the contribution that secondary raw materials can make to the supply of metal resources, now and in future. The data on the status quo collected in this study form the basis for future strategies. An important aspect of this is the determination of future development directions, potentials and actions for the expansion of the circular economy in Germany. At present, Germany has no single collection of data on the entire domestic metal production and processing sector, or on existing recycling facilities including their capacities, the metals they process and the technologies they use.

This study has therefore focused mainly on collecting regional data about recycling sites, their capacities, the shares of secondary raw materials in the raw material supply, and the recycling technologies used in Germany.

The aim of the recycling atlas for metal production is to collect and compile these data on the German recycling industry. Its basis is a study on the status quo of recycling in metal production and processing in Germany, commissioned by DERA and carried out by TU Clausthal in 2021.

It has since been deepened and expanded by DERA. The data have been prepared in such a way as to be easily accessible for the public (e. g. stakeholders in politics, industry, NGOs and research institutes), and to permit some regular data updates that reflect data availability. This involved reviewing and collecting basic data on material flows, processes or methods, and facilities or sites.

In our site survey, we relied on registration data from the Industrial Emissions Directive (IED) Registry of companies holding a permit. We also analysed the membership lists of relevant trade associations in the metal industry, and processed data from certification organisations about the metal production and recycling companies certified by them. Many individual items of information were obtained from publicly available sources, such as annual reports from the electronic version of the German Federal Gazette, company websites, and, last but not least, in direct company surveys.

Our scope covered the recycling of metals in metal production and processing in Germany, the latter limited to processing using secondary raw materials. We ensured that all of the companies in our collection engaged in functional recycling (Fig. 1). Companies engaging in reprocessing only ("treatment companies" in legal terms), which essentially mechanically prepare and sort secondary raw materials, are not included in this study. In future, the study could be expanded to include other metals that are relevant for German industry, and its scope broadened to include metal reprocessing companies, which are important for the recycling sector.

Figure 1 shows a simplified illustration of the scope of our investigation.

Information on individual raw materials can be found in fact sheets on material flows and in the appendix, in tables on recycling facilities and sites. A range of site data and facts on specific elements or material flows are also accessible via an interactive map on the BGR geoportal (www.geoportal.bgr), in addition to the fact sheets. The appendix includes instructions for use of the geoportal.

The geoportal provides an overview of German recycling companies, grouped by raw materials or displayed individually, with additional site data. It illustrates clearly which recycling industries are concentrated in certain states and

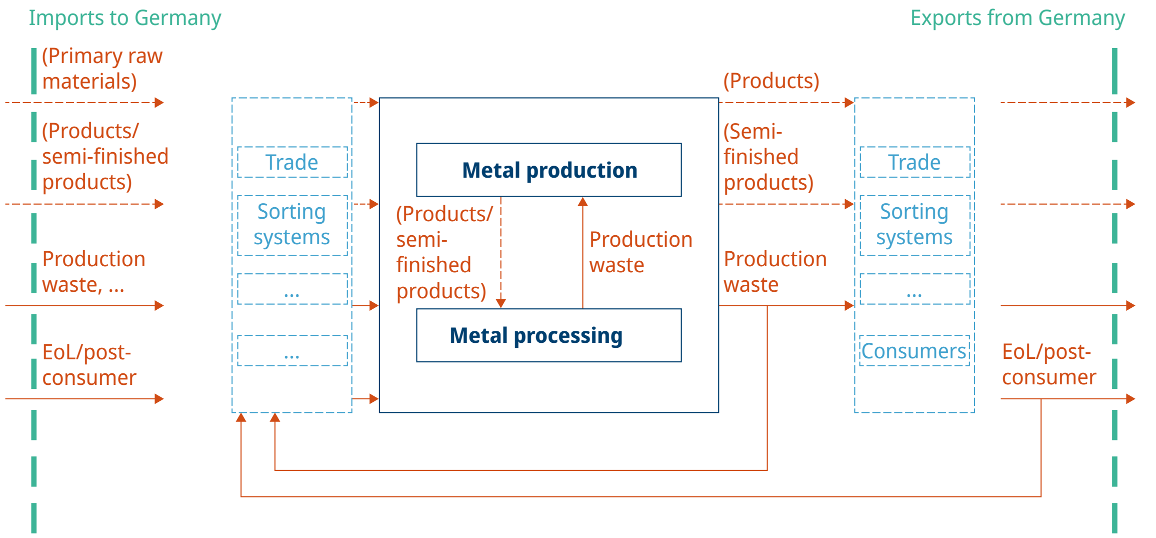


Fig. 1: Simplified illustration of the scope of investigation (dotted lines and items in brackets: outside the scope)

which are distributed more evenly across Germany. The overview is also relevant for local integration of these industries with the individual recycling markets.

The study is aimed at political and administrative institutions at federal and state levels, but also at industrial stakeholders, such as companies linked to the recycling industry, to support them in the diversification of recycling-related material flows. With this comprehensive breakdown of the domestic circular economy, it is also possible to identify gaps and consequently potential new investment opportunities in the German recycling industry. For NGOs concerned with issues such as improving the supply of raw materials and implications for the climate, the recycling atlas also provides in-depth information about the current state of climate-friendly recycling activities and future potential for further expansion.

In its key issues paper of January 2023 on pathways to a sustainable and resilient raw materials supply, the BMWK emphasised once more the strategic importance of closely integrating the circular economy and raw material strategies (BMWK 2023). A complementary building block, to be developed by the German Ministry for the Environment for 2024, is the National Circular Economy Strategy (Nationale Kreislaufwirtschaftsstrategie, NKWS), in which recycling will play a key role (BMUV 2023). The two ministries, BMUV and BMWK, will work closely together and coordinate their processes. DERA's findings will be incorporated in the development of the NKWS, one of the aims being to make the best possible use of synergies.

In the context of efforts in Europe to shape the European Green Deal, the basic findings from this study will be important for Germany's contribution to lowering CO_2 emissions by recycling, particularly for measures under the European Commission's 2020 Circular Economy Action Plan, which has a key role in achieving net zero greenhouse gas (GHG) emissions by 2050. As part of the Critical Raw Materials Act (CRMA) of March 2023, the EU Commission has also proposed increasing the EU's recycling capacity to at least 20 % of annual consumption of every critical/strategic raw material.

Target groups for the recycling atlas for metal production

- Political and administrative institutions at federal and state levels
- Metal recycling industry and linked companies
- Trade associations
- Research institutes
- NGOs

Results

- Fourteen fact sheets summarising recycling-related key data
- Ten metal-specific interactive maps with information on company sites and indicators for the relevant recycling industry
- Study including information on the methodology, a glossary of recycling-related terms, and a summary and discussion of the most important findings

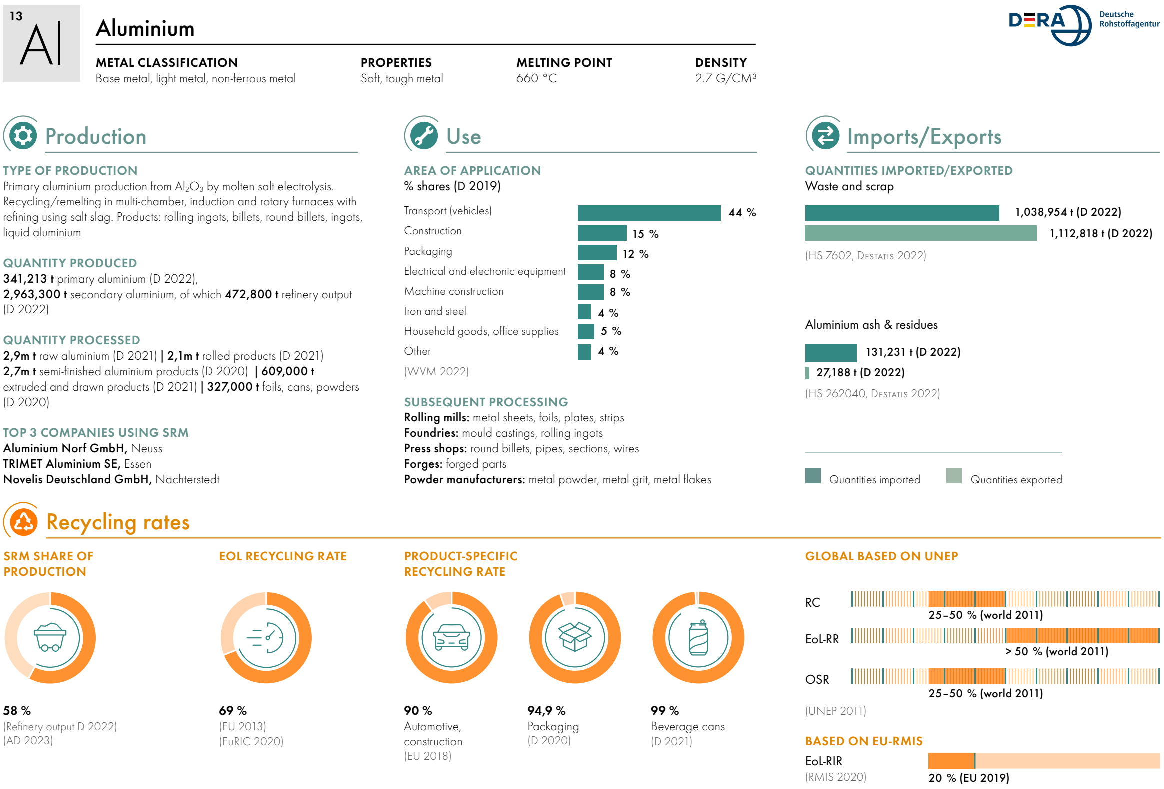


Fig. 2: Sample fact sheet (here: for aluminium)

Fig. 3: Detail of the recycling atlas for metal production on the BGR geoportal

2. Methodology

The following subsections address the different parts of our investigation. We started by determining which metals and groups of metals our search for information would focus on and decided to concentrate initially on the major industrial and base metals. Since they are widely used and a dedicated recycling industry exists, we could expect sufficient facts and data on recycling to be available. However, we also decided to test our methodology on two sample elements for which recycling in Germany is in its infancy (gallium and indium).

In a next step, we compiled the relevant sources for collecting the site data, as well as defining their structure and the data collection sequence. Important aspects were how data would be collected directly from the companies in the survey, and what material flows would be involved. Often, information on material flows are not available for individual elements but for groups of metals or specifications. We therefore had to identify groups of metals that are relevant for Germany, and their material flows. Consequently, this study also discusses the groups of metals studied in detail and shows how we extracted the information about secondary raw materials from the official waste balances compiled by the authorities. The subsection with information on trade in the relevant secondary raw materials completes the information for the data survey. It includes a look at the national and international specifications required for trade.

Table 1: Overview of metals/groups of metals
(green: prioritised; black: to follow in part 2 of the study, expected in 2024; red: no site data available)

Lithium	Beryllium	**Magnesium**
Aluminium	Silicon	Titanium
Vanadium	**Chromium**	**Manganese**
Iron/steel	**Cobalt**	**Nickel**
Copper	**Zinc**	**Gallium**
Germanium	**Rubidium**	**Strontium**
Zirconium	Niobium	Molybdenum
Silver	Cadmium	Indium
Tin	Antimony	Tellurium
Barium	Tantalum	Tungsten
Rare earths (lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium), scandium, yttrium		
Platinum group metals (ruthenium, rhodium, palladium, osmium, iridium, platinum)		
Rhenium	Gold	Mercury
Lead	Bismuth	

2.1 Elements considered

The list of metals and groups of metals in Table 1 formed the basis of our data survey.

2.2 Sites

For the scope reported on here, we researched a large number of sites in Germany that are engaged in the production or processing of metals from primary or secondary sources (see overview, Table 1). For metal processing, we have listed only those sites that use secondary raw materials. Brief descriptions of the metal production and processing plants are included in the list of sites (see Appendix), in terms of their processes, the materials used, and the end products.

In order to obtain a population, we started by identifying databases that make available as many basic data on sites as possible. In addition to a survey of existing databases (see Sections 2.2.1–2.2.3), we carried out an online keyword search, using as search terms the relevant element (see overview in Table 1), metal production, metal processing, metal production or processing methods, and recycling. Our data were completed with direct surveys of the companies. In a final step, we compiled all the data in an Excel spreadsheet for the elements and sites considered. This information forms the basis of the map shown on the BGR geoportal.

However, there is considerable variation in data availability and quality, and consequently in the completeness of entries in the site tables. Figure 4 gives an overview of the data sources and target information. Because of the heterogeneity of the data and, in some cases, the lack of documentation in the data sources, e. g. regarding timeliness of the data, data availability is poor, updating data sets is difficult, and an element of uncertainty is associated with the data sets themselves.

In metal recycling, two basic processes can be distinguished. Functional recycling (see also UNEP 2011) turns metals back into metals (e. g. through reworking or remelting) or uses metal content as an alloy constituent (e. g. in the steel alloying elements chromium, nickel and manganese). This variant is found mainly in metal pro-

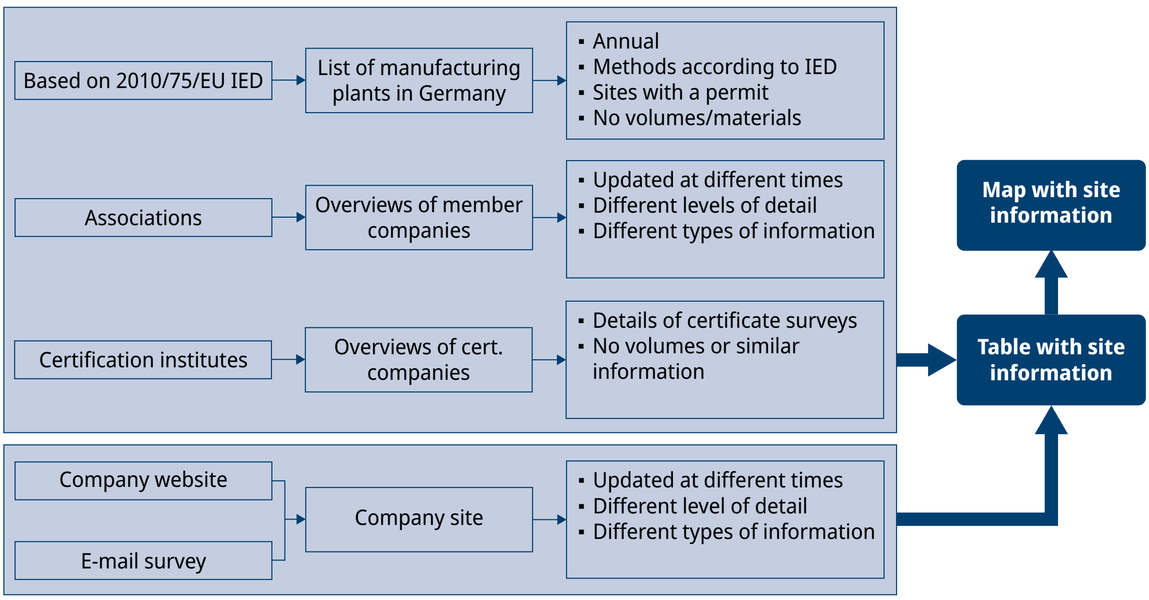


Fig. 4: Approach used in the data survey of the sites

duction and processing. In other recycling processes, metal waste is collected and undergoes mechanical, thermal or metallurgical processes to turn it into preconcentrates, which are not (yet) available again for the original application. These preconcentrates often require additional treatment steps before they can be reused in metal production or processing; they are thus only an intermediate step towards functional recycling.

In our site survey, we focused on companies that carry out functional recycling (see also Section 3. Recycling terminology and definitions). For some products containing metal resources, functional recycling is not carried out across the whole value chain. This applies, for instance, to multi-component or composite products such as batteries, solar panels or magnets. Frequently the reason is that the necessary technologies are still at the development or large-scale implementation stage. For a few metals (e. g. lithium), we therefore included companies that produce preconcentrates (e. g. black mass).

Alloys such as stainless steel or brass were grouped with their respective base metal (here: iron and copper) and only considered in that context.

2.2.1 Information about installations requiring a permit

We collected information about industrial installations requiring a permit based on Directive 2010/75/EU on industrial emissions. The Industrial Emissions Directive (IED) is the European regulatory framework for protection from emissions. It covers the granting of permits for industrial installations and their operation, monitoring and decommissioning. An overview of installations in Germany at Thru.de, a website by the German Environment Agency (UBA 2022), can be filtered, e. g. by activity category (Anlagenliste_EU-Registry). The Thru database provides the following information:

- Year of reporting
- Company/operator of the site and, where applicable, of the parent companies
- Name of the installation
- Reasons for non-disclosure
- Company address
- Type
- Activity
- Information pertaining to the permit
- BAT (best available technology)
- Inspections
- Emissions monitoring
- Authority granting a permit
- Status

Our analysis initially considered the relevant activity in the IED, “Production and processing of metals”, and its subcategories. A review of the entries showed, however, that relevant entries from other categories were not included. We therefore expanded the list of categories to be reviewed with relevant entries based on the columns “Name. Anlage” (name, installation) and “Name. Betrieb” (name, company). Since the labels do not necessarily refer to a material, some entries may have been excluded erroneously. Our analysis is based on the 2019 reporting year. The data status is 15 January 2021 and the data were extracted from the database overview on 19 March 2021.

2.2.2 Details from associations etc.

The membership registers and databases of professional and trade associations etc. that represent metal producers and processors provide another good set of listings for research. But clearly not all companies can be found in these lists, only those that are members of one of the relevant associations. We have included information from the following associations’ databases and/or website information pages:

Aluminium Deutschland e. V. (AD)

Aluminium Germany (formerly the federation of the aluminium industry) is an association of around 140 producers of raw aluminium or aluminium products including composites with other materials. It is possible to search the product and producer database on its website (AD 2022) for entries such as “Produkt – Recycling-Aluminium” (product – recycled aluminium). Entries include the company’s name, address and a link to its website.

Bundesverband der Deutschen Gießerei-Industrie e. V. (BDG)

The federation of the German foundry industry represents the interests of around 600 member companies. On its website, it provides a list of suppliers in the form of a database with filters (BDG 2022). We used the criteria “Guss-Werkstoffe” (foundry materials), “Guss-Erzeugnisse” (foundry products), “Schmelzeinrichtungen” (melter types) and “Form- und Gießverfahren” (moulding and casting processes) to filter this list and exported the results to an Excel spreadsheet.

Kupferverband e. V. (DKI)

As a technical and scientific body, the copper association (formerly the German copper institute professional association) represents the interests of the copper processing industry (around 35 member companies). Its members are listed with their names and a link in the members’ area (DKI 2022).

Entsorgergemeinschaft der Deutschen Stahl- und NE-Metall-Recycling-Wirtschaft e. V. (ESN)

The association of waste management companies for the German steel and non-ferrous metal recycling industry awards the audit certificate “Entsorgungsfachbetrieb” (waste management company). It currently lists around 400 certified company sites from the areas waste management, trade and processing. Entries cannot be sorted by field of activity (ESN 2022).

Fachvereinigung Edelmetalle (FVEM)

On the members page of the precious metals association, its 35 members can be filtered by area of activity and region (FVEM 2022). For our site survey, we filtered the members area using the area of activity “Recycling”. In the results, companies are listed with their names, a brief description, and a link to their website.

Gesamtverband der deutschen Buntmetallindustrie (GDB)

In the members area, the federation of the German non-ferrous metals industry lists its roughly 50 member companies separately by the categories Halbzeug (semi-finished) or Erzeugung (production) and Element (metal), each with its name, site link and product (GDB 2022). The GDB disbanded in 2023. Copper member companies have joined the copper association, and other non-ferrous metal-related companies have joined the trade association for metals. The GDB in its previous form thus no longer exists.

Initiative Zink (IZ)

The zinc initiative is a network that unites producers of zinc, zinc alloys and zinc-based semi-finished products; producers and processors of zinc compounds; zinc recycling companies, zinc reprocessors, and suppliers. Its members area lists brief company profiles sorted by the areas Bauzink (construction zinc), Primärzinkerzeugung (primary zinc production), Verzinken (zinc plating), Zinkdruckguss (zinc die casting), Zinklegierungen (zinc alloys), Zinkoxid & Zinkverbindungen (zinc oxide and compounds) and Zinkrecycling (zinc recycling) (IZ 2022).

Verband Deutscher Metallhändler und Recycler e. V. (VDM)

With more than 230 members at around 700 sites, the association of German metal traders and recycling companies represents about 90 percent of the metal market in Germany and Austria. Members include refineries and smelting plants, trading, recycling and treatment companies, brokers working on the London Metal Exchange, and other experts from the metals industry. In our study, we considered only members working in functional recycling, i.e. not simple treatment companies.

WirtschaftsVereinigung Metalle (WV Metalle)

As an umbrella organisation, the metals trade association looks after the common interests of the non-ferrous metals industry, producers and processors of light metals (aluminium, magnesium etc.), non-ferrous metals (copper, zinc, lead, tin, nickel, etc.) and special metals (gallium, germanium, etc.). Each of these is also organised in a separate industry association, including Aluminium Deutschland e. V., BDG Bundesverband der Deutschen Gießerei-Industrie e. V., GDB Gesamtverband der Deutschen Buntmetallindustrie e. V., Industrieverband Feuerverzinken e. V. (industrial association for hot-dip galvanisation) and Kupferverband e. V. WVMetalle has around 620 member companies.

Wirtschaftsvereinigung Stahl (WV Stahl)

Member companies of the steel trade association are listed on the Internet at stahl-online.de (WVSTAHL 2022) with their company names and a link to their websites. The association has 47 members.

2.2.3 Certification institutes

Certification bodies can provide additional information about sites and companies. The Responsible Minerals Initiative (RMI) addresses issues linked to the responsible sourcing of minerals and their supply chains. Its list of compliant companies comprises smelting plants and refineries that have passed the assessment according to the applicable RMAP standard (Re-

Table 2: Sources of information analysed

Data source, institution	Information on the							
	Operator	Site	Process	Material used	Products	Capacity	Output	Use of SRMs
EU Registry list of installations	yes	yes	(yes)	(yes)	(yes)	no	no	no
BDG	yes	yes	yes		yes	(yes)		
Aluminium Deutschland e. V.	yes	yes			(yes)			(yes)
GDB	yes	yes	no	no	yes	no	no	no
WV Stahl	yes	yes						
FV Edelmetalle	yes	no	(yes)	no	no	no	no	no
Initiative Zink	yes	yes		no	yes	no	no	(yes)
Kupferinstitut	yes	no	no	no	no	no	no	no
ESN	yes	yes	no	no	no	no	no	no
RMI	yes	(yes)	(yes)	yes	yes	no	no	no
Company website	yes	yes	partly	partly	yes	partly	partly	partly

sponsible Minerals Assurance Process) or an equivalent recognised assessment. We considered the metals gold, tantalum, tin, tungsten, cobalt, copper, nickel and zinc (RMI 2022).

2.2.4 Company websites and publications

We used company websites as additional sources of information about sites and companies. Here data availability varies widely, for instance, in terms of the data published, the reference years, and the materials or products used. Brief descriptions of the processes and the materials used can also be found in documents such as the companies' incident reports or sustainability reports.

2.2.5 Company surveys

The companies identified using the approach described were contacted via e-mail, in order to collect additional data in a questionnaire, specifically the following information:

Table 3: Column data in the "Metal production and processing sites" table

Column	Heading	Detailed description
A	Company	Company name
B	Production/processing	Classification of entry as metal-producing or -processing industry
C	Process	Brief description (keywords)
D	Products	List of products
E	Use of SRMs	Entry: yes
F	SRMs used	List of SRMs used
G	Annual capacity or output	Annual capacity or output of the plant or site
H	Details of capacity/output	Details of what "G" refers to
I	Recycled content/recycling rate	Information on the recycled content of a product, in some cases the recycling rate; N/A
J	Contact	Status of contact with the site
K	Publication	Details of the source or the release of data
L	Other metals	Information whether/which other metals are processed at the site
M	No. employees	Current number of employees
N	Location	Town/city
O	Postcode	Postcode
P	Address	Street address and number
Q	IED	Item in the Industrial Emissions Directive (IED) 2010/75/EU
R	Link	Links to other sources of information, generally the company website
S	Comments	For multi-metal pages: Details of the processed metals

k. A.: not specified

- What type of secondary raw materials do you use?
- Do you use both secondary and primary raw materials?
- What is the share of secondary raw materials/recycled content used (metal resources; < 10 %, 10–25 %, 25–50 %, 50–75 %, 75–90 %, > 90 %, 100 %)?
- What is the approximate annual capacity (processing of metal resources in tonnes)?

Since the data are published in a web-based map application on the DERA website and/or on the BGR geoportal, we also asked for consent to their publication.

The direct response rate of the survey across all companies was 11 %. Depending on the industry, it ranged from about 9 % (iron) to 50 % (magnesium).

Using the different survey methods, we identified 278 sites in Germany. They are listed in the table in the appendix with the additional data. Table 3 summarises the information given in the table in the appendix.

2.3 Material flows

We identified relevant material flows of metal for German industry in which recycling could be of importance. The term material flow generally refers to the route a material takes from primary production as a raw material to processing into a product, and to its disposal as waste or recovery and recycling. In order to track the circular flows of materials, it is therefore essential to know not only the elements of the periodic table in a material flow, but also the groups of metals specific to these elements, the types of

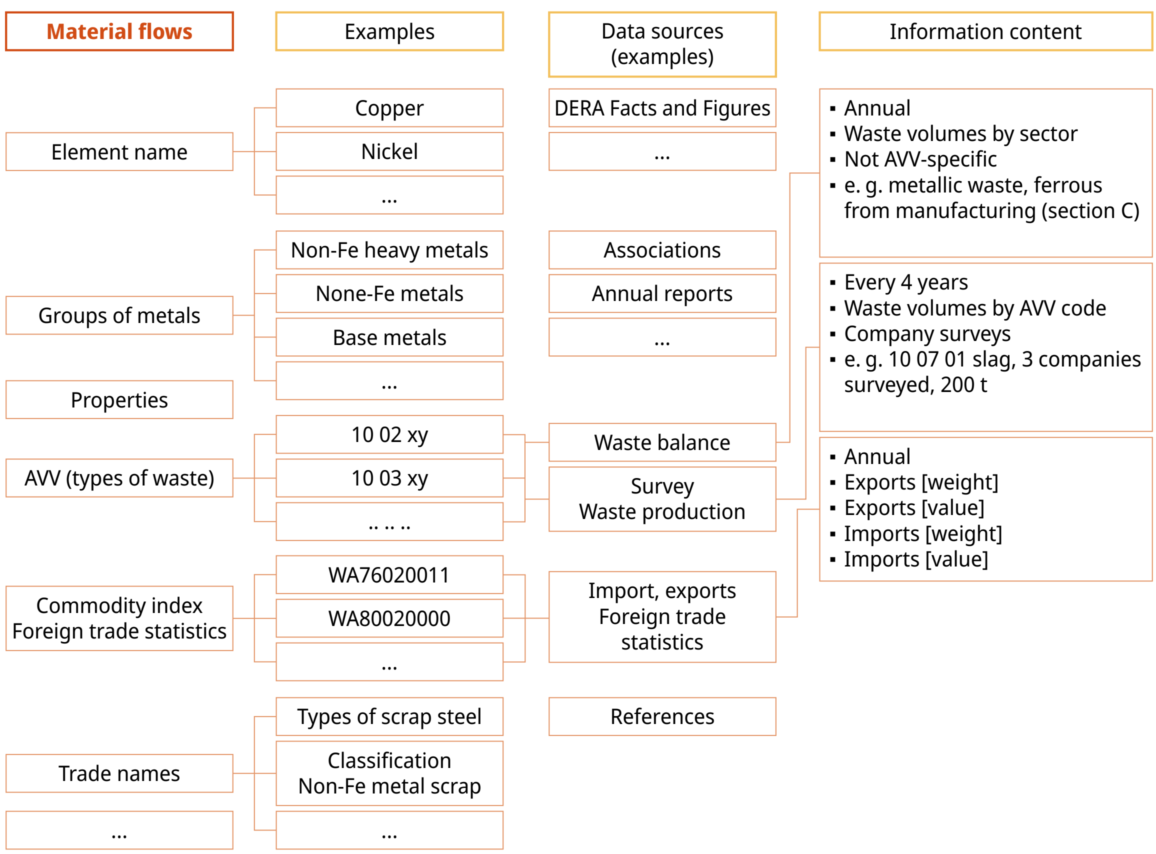


Fig. 5: Research path taken to describe the material flows

waste according to the Waste Catalogue Ordinance (Abfallverzeichnis-Verordnung, AVV), and the trade names (product codes, HS codes; see Sections 2.3.1–2.3.4).

Material flow data are thus often not available for specific elements (copper, iron, aluminium etc.). The level of detail, e. g. in the trade in secondary raw materials or in the reporting required, for instance, under waste disposal legislation, is insufficient and it is therefore necessary to differentiate further. One source that compiles information at the element level are DERA's Mineral Commodity Facts and Figures (e. g. for gallium: BGR 2018).

When considering material flows, one challenge is therefore the way in which they are described. In order to collect comparable material flow data with reasonable effort and repeatedly using the same methods, these criteria must be met: a material flow has been clearly described, there are regular reports on the data to be collected, and all stakeholders mean the same when referring to the name for a material flow. Figure 5 shows the research paths we have taken to describe the material flows.

2.3.1 Groups of metals

Metals with similar properties can be grouped together, for instance, light metals, ferrous metals, alloying elements etc.

However, the names for these groups of metals, or the metals they contain, can be interpreted differently. Table 4 below lists examples of groups of metals, the metals they contain, and sample definitions. Where metals are included in several groups of metals, this may be because they are classified based on their properties or use, or because of legal classifications.

Precise knowledge of the groups of metals is important for the data survey and particularly for assigning elements to specific material flows or cycles, because in recycling, significant quantities of individual metals are often included in the cycles of higher-level groups of metals. The alloying elements manganese, chromium, tungsten and vanadium, for instance, are mostly included in the material flows for iron metallurgy in recycling.

Precise knowledge of the groups of metals involved in recycling is also of considerable importance for the circular processes used in industry and for the relevant documentation by trade associations and institutions.

The wide range of specialist literature provides information in particular about the properties, production, processing, and recycling of metals and groups of metals. Other possible sources of information are associations and their member companies, which produce or process the relevant groups of metals or individual metals within a group. These organisations, which we used for our survey of the production sites (see Section 3.2.2), are also a source of additional material flow-specific data. Some associations provide fact sheets with information such as output data, consumption, recycling rates, annual capacities or contributions to climate protection. Further information can be found in documents such as the companies' own annual reports, sustainability reports or incident reporting material. These are some of the associations that address the recycling or recyclability of metals (see also Section 2.2.2):

- Aluminium Deutschland e. V. (AD)
- Bundesverband der Deutschen Gießerei-Industrie (BDG)
- Bundesverband Sekundärrohstoffe und Entsorgung (BVSE)
- Kupferverband e. V. (DKI)
- International Platinum Group Metals Association (IPA)
- Initiative Zink (IZ)
- Verband Deutscher Metallhändler und Recycler e. V. (VDM)
- WirtschaftsVereinigung Metalle (WVMetalle)
- Wirtschaftsvereinigung Stahl (WV Stahl)

Table 4: Classification of metals into groups of metals

Group of metals	Metals	Definition
Iron	Iron	
Alloying elements	Manganese, silicon, chromium, nickel, tungsten, molybdenum, vanadium etc.	Alloying elements are added to (alloyed with) a metal to improve its material properties in a specific way.
Steel alloying elements and ferroalloys	Chromium, manganese, molybdenum, nickel, vanadium and tungsten	Different steel alloying elements change the functionality of steel, such as making it more corrosion-resistant (stainless steel) or increasing its mechanical strength.
Base metals	Iron, aluminium, copper, tin, nickel, lead and zinc	Base metals are metals that are produced in relatively large quantities and often used as the main element in alloys.
Non-ferrous metals	Aluminium, copper, zinc, magnesium, nickel, lead and tin	Non-ferrous metals are metals other than iron or containing no iron, and alloys in which iron is not the main element (e. g. copper, zinc, bronze or brass). They include non-ferrous heavy metals and white metals.
Light metals	For instance, aluminium, magnesium or titanium	Metals and alloys with a density below 5 g/cm³ are generally referred to as light metals. In technical applications, aluminium, magnesium and titanium in particular are used, and to a lesser extent also beryllium and lithium.
Heavy metals	Antimony, arsenic, cadmium, chromium (VI), precious metals, iron, copper, lead, mercury, nickel, selenium, tellurium, thallium and tin	Metals with a density $\rho > 5$ g/cm³ are generally referred to as heavy metals. In waste legislation, heavy metals include all compounds of antimony, arsenic, cadmium, chromium (VI), copper, lead, mercury, nickel, selenium, tellurium, thallium or tin, and these substances in metallic form, provided the compound or the substance is classified as hazardous waste under Section 1.1 of the AVV Waste Catalogue Ordinance.
Transition metals	Scandium, vanadium, manganese, cobalt, copper, yt-trium, niobium, hafnium, tungsten, titanium, chromium, iron, nickel, zinc, zirconium, molybdenum, tantalum etc.	In general, the chemical elements with atomic numbers 21–30, 39–48, 57–80 and 89–112. In waste legislation, transition metals include all compounds of scandium, vanadium, manganese, cobalt, copper, yttrium, niobium, hafnium, tungsten, titanium, chromium, iron, nickel, zinc, zirconium, molybdenum or tantalum, and these substances in metallic form, provided the compound or the substance is classified as hazardous waste under Section 1.1 of the AVV Waste Catalogue Ordinance.
Non-ferrous heavy metals	For instance, copper, zinc, tin, nickel, (REE) or lead	The non-ferrous heavy metals are a subgroup of the non-ferrous metals. They include metals such as cadmium (Cd), cobalt (Co), copper (Cu), nickel (Ni), lead (Pb), tin (Sn) and zinc (Zn). Most of them are non-precious metals and either coloured themselves, or they form coloured alloys such as brass, bronze or gun metal. Their alloys are also considered non-ferrous heavy metals.

Group of metals	Metals	Definition
Precious metals	Silver, PGMs and gold	Precious metals are metals that do not react with water or aqueous acidic solutions to form hydrogen. That means they have a more positive standard electrode potential than hydrogen, which is why they often occur as native elements in nature.
Platinum group metals (PGMs)	Platinum, palladium, ruthenium, rhodium, osmium and iridium	Alongside platinum, the platinum group metals include ruthenium (Ru), rhodium (Rh), palladium (Pd), osmium (Os) and iridium (Ir), listed here in ascending order of atomic weight. The name platinum (Pt) is derived from the Spanish word for silver, plata.
Refractory metals	Titanium, zirconium, vanadium, niobium, tantalum, chromium, molybdenum and tungsten	Refractory metals (from Latin refractarius = obstinate, stubborn) are the non-precious metals with a high melting point of the fourth period (titanium, zirconium and hafnium), the fifth period (vanadium, niobium and tantalum) and the sixth period (chromium, molybdenum and tungsten).
Metals of the critical raw materials (EU definition)	For instance, REE, antimony, cobalt, gallium, germanium, magnesium, niobium and tantalum	According to the EU definition, critical raw materials are raw materials of high economic importance for the EU that have a high supply risk. The European list of critical raw materials is updated every three years.
Rare earth elements (REE)	Scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium	Collective label for the elements scandium, yttrium, lanthanum and the 14 elements following lanthanum in the periodic table – cerium, praseodymium etc. – referred to as the lanthanoids (lanthanides).

2.3.2 Types of waste

Waste is classified into different types in accordance with the Waste Catalogue Ordinance (Abfallverzeichnis-Verordnung AVV, based on the European Directive 2008/98/EC on waste). The classifications denote both the designation and the hazard level of a type of waste. Each type of waste has a 6-digit waste code and a specific designation. The 6-digit waste code consists of the 2-digit section number and the 4-digit category number. Section numbers 01 to 12 and 17 to 20 also provide for a classification of waste according to its origin. For the scope of this study, the following section numbers are of primary interest:

- 01: Wastes from the exploration, mining, quarrying and production and the physical and chemical treatment of minerals
- 06: Wastes from inorganic chemical processes
- 10: Wastes from thermal processes
  - 10 02: Wastes from the iron and steel industry

    - 10 03: Wastes from aluminium thermal metallurgy
    - 10 04: Wastes from lead thermal metallurgy
    - 10 05: Wastes from zinc thermal metallurgy
    - 10 06: Wastes from copper thermal metallurgy
    - 10 07: Wastes from silver, gold and platinum thermal metallurgy
    - 10 08: Wastes from other non-ferrous thermal metallurgy
- 11: Wastes from chemical surface treatment and coating of metals ...
- 12: Wastes from shaping and physical and mechanical surface treatment of metals and plastics
- 16: Wastes not otherwise specified in the list
- 17: Construction and demolition wastes
- 19: Wastes from waste management facilities ...
- 20: Municipal wastes

Waste metal is also mentioned separately in some subsections, such as in subsection 02 01 10 "Wastes from agriculture, horticulture, aquaculture, forestry..." or as metallic packaging in subsection 15 01 04 on waste packaging.

This list shows that waste containing metal is produced in almost all areas of application. Except for the more detailed descriptions of waste from thermal processes, which distinguish between wastes containing iron, aluminium, lead, copper or precious metals, other descriptions often mention only metals, ferrous metals or non-ferrous metals. That level of aggregation is generally not detailed enough for the scope of this study. But the AVV with its classification of types of waste forms the basis for regular official statistical surveys, which we have included in our research.

The waste balance, published annually as part of the AVV, reports on the quantities of waste disposed of two years previously (e. g., year of publication 2021, balance sheet year 2019). The balance differentiates types of waste and types of disposal in waste management facilities, distinguishing between disposal (landfill, incineration and treatment for disposal) and recovery operations (energy recovery and recycling). It also indicates a recovery rate and a recycling rate. Table 5 shows an extract from a balance that includes waste containing metal.

Table 5: Extract from a waste balance sheet

Description	Associated AVV numbers	Waste volume (t), 2018	Utilization rate (%)[1]	Recycling rate (%)[2]
Total municipal waste, of which				
Old electrical appliances	200123*, 200135*, 200136	698.000	100	100
Other (composites, metals, textiles, ...)	u. a. 150104, 200140	2.168.000	99	81
Construction and demolition waste, of which				
Other construction and demolition waste	u. a. 17 04 (Metals)	16.203.000	92	85
Other waste				
Particularly from production and trade	u. a. Chapter 02-14, 16	55.086.000	70	47

[1] Share of the input of all treatment plants classified with a recovery process in total waste generation.
[2] Share of the input of all treatment plants classified with the "Material recycling" process in the total waste volume.

The balance allows no conclusions about the share that waste containing metal accounts for in any of the categories, or how much this contributes to the recycling and recovery rates. Since several types of waste are combined into one reporting category, it is unclear what the immediate significance is for the recycling atlas. We have nevertheless included these data as background information.

In addition to the waste balance, the Federal Statistical Office of Germany publishes a **survey of waste production** every four years. This aims to provide a comprehensive overview of the quantities of waste produced in the individual sectors of industry. The survey covers around 0.5 % of enterprises and 31 % of the workforce in Germany, but no more than 20,000 enterprises. It does not include waste produced, for instance, in the construction industry, municipal waste from private households, or the wholesale trade in scrap and residues. Companies in the sector "Metal production and processing, manufacture of metal products" are selected for the survey based on an indicative value of 100 employees. Although an analysis of the survey on waste production is possible based on the waste codes (see Table 6), this cannot be extrapolated to the total quantities of waste of a specific type produced in Germany. Another aspect to be taken into account when using data from this survey is that it also groups different metals into categories (e. g. non-ferrous metals). No conclusion can be drawn, for instance, about the quantity of waste containing zinc produced annually in Germany.

Table 6: Survey of waste production (extract)

LoW	Type of waste	Companies	Quantity produced
		Number	1000 t
120101	Ferrous metal filings and turnings	2,549	1548.7
120102	Ferrous metal dust and particles	2,492	3109.9
120103	Non-ferrous metal filings and turnings	1,792	312.6
120104	Non-ferrous metal dust and particles	1,385	201.1

2.3.3 Commodity index/foreign trade statistics

The Federal Statistical Office Destatis collects data on the import and export volumes of the metals studied (data on foreign trade, exports and imports). The commodity index for the 2021 foreign trade statistics includes data on metals in sections XIV and XV:

- Section XIV: Natural or cultured pearls, precious or semiprecious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coins

- Section XV: Non-precious metals and articles thereof

The data collection is based on these definitions of the terms used:

Precious metals:
"Precious metals" refers to silver, gold and platinum.

Platinum:
"Platinum" refers to platinum, iridium, osmium, palladium, rhodium and ruthenium.

Non-precious metals:
"Non-precious metals" in the list of commodities refers to the following: iron and steel, copper, nickel, aluminium, lead, zinc, tin, tungsten, molybdenum, tantalum, magnesium, cobalt, bismuth, cadmium, titanium, zirconium, antimony, manganese, beryllium, chromium, germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium and thallium.

Waste and scrap:
"Waste and scrap" from metal produced during the production or processing of metal, and metal goods that have become unusable as such due to breakage, offcutting, wear or other reasons.

Export and import data are collected every year and can be accessed on the website of the Federal Statistical Office (www.destatis.de). The foreign trade statistics do not include data on every metal within the scope of this study and the level of detail in the data varies between metals. We have included import and export volumes in our fact sheets where no data with greater detail were available from BGR/DERA.

2.3.4 Trade names

Listing the trade names of the various secondary raw materials is important for the classification and reviewing of the metal-specific material flows that can be assigned to the individual company sites. As the classifications below show, the nomenclature used differs between industries. Germany has its own definitions for secondary raw materials, which are still often used in industry, but may not correspond to the names used internationally.

General terms of metal trading and classifications

In its publication on the terms of metal trading and classifications (last updated in 2015 (VDM2015)), the association of German metal trading and recycling companies (Verband Deutscher Metallhändler und Recycler e. V., VDM) includes the customary terms of trade as well as descriptions of metal scrap qualities for aluminium, lead, copper and copper alloys, magnesium, nickel and nickel alloys, zinc and tin. The association distinguishes 92 types of non-ferrous metal scrap.

The general terms of metal trading include both the quality levels of scrap and classifications for non-ferrous metal granulates. They are published by the cable recycling quality group within the VDM (last updated: 2000) and describe nine quality levels of copper and aluminium.

Types of scrap steel

The confederation of German steel recycling and disposal companies (Bundesvereinigung Deutscher Stahlrecycling- und Entsorgungsunternehmen e. V., BDSV) lists 32 types of scrap steel on its website (BDSV 2023b). It distinguishes between secondary raw materials, different types of scrap steel, scrap castings and foundry scrap steel.

ISRI Scrap Specifications

The latest versions of the trade names used by US-American Institute of Scrap Recycling Industries Inc. (ISRI), and also in Germany, are regularly published in the Scrap Specifications Circular (ISRI 2022).

This publication provides a comprehensive overview of scrap and waste metal specifications for iron/steel and non-ferrous metals. The trade names specified there are commonly used, particularly in the international metal industry.

HS codes

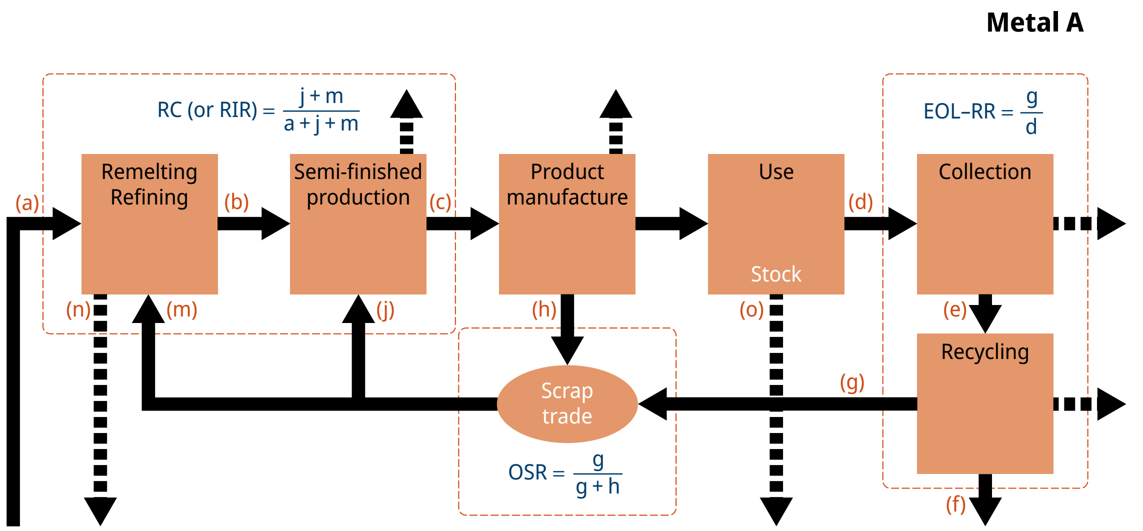
Tariff numbers (HS codes) form part of an internationally standardised system of names and codes used to classify commodities. They are developed and maintained by the World Customs Organization (WCO). This system can be used by all countries as a common basis for the classification of products for imports and exports.

Since HS codes exist for different types of metallic waste or waste containing metal, it is possible to identify the relevant material flows for secondary raw materials e. g. in the foreign trade statistics of the Federal Statistical Office (Destatis 2022).

3. Recycling terminology and definitions

The recycling indicators recycled content, end-of-life recycling rate and recycling input rate are of particular interest. Many publications consider them the main indicators for completeness of a recycling cycle. More detailed and generally systematic information on the derivation of these indicators can be found in publications under the United Nations Environment Programme (UNEP 2011), by GRAEDEL et al. 2011, and in European Union publications (TALENS PEIRO et al. 2018).

Product-specific blanket recycling rates such as those specified in the current waste legislation for end-of-life vehicles (ELV) or waste electrical and electronic equipment (WEEE) are less help-



(a)	Primary metal input	(g)	Reprocessed EOL metal (old scrap)
(b)	Refinery output	(h)	Production scrap with waste status (new scrap)
(c)	Intermediate products (e. g. alloys, semi-finished products)	(j)	Remelted scrap (new and old scrap)
(d)	Potentially available EOL products (metal content)	(m)	Scrap for remelting (new and old scrap)
(e)	EOL metal collected for reprocessing	(n)	Residues and slag
(f)	EOL metal for non-functional recycling for other material cycles	(o)	In-use dissipation; RC: recycled content; EOL-RR: end-of-life recycling rate; OSR: old scrap rate

Areas of application within the recycling cycle where key processes for the indicators take place have a dotted border. Dissipative losses from the process that leave the cycle are indicated by dotted lines. Internal cycles such as those for new scrap are not indicated separately.

Fig. 6: Reference chart for the value cycle of a specific metal A for the purpose of defining the recycling indicators, based on TALENS PEIRO et al. 2018

ful in this respect than metal-specific recycling rates (e. g. for Co, Li, Ni or Cu in the current draft of the EU Batteries Regulation).

It should be noted, however, that the literature does not give definitions for many of the values for the recycling indicators below. It is therefore not always clear on what basis the indicators were determined, nor can it always be ensured that the stated parameters are comparable in every respect. In dieser Studie wird der Begriff „Rate“ (e. g. EoL-Recycling-Rate) vordringlich verwendet, auch wenn die Begrifflichkeiten „Rate“ oder „Quote“ synonym verwendet werden könnten.

It is important to take into account both the quantitative aspect of a recycling cycle and the recycling quality. Only where it is certain that recycling actually results in a substitution of primary raw materials can recycling indicators be used as evidence.

The first area of application in Figure 6 shows that the recycling input rate at the start of the production chain concerns the interaction between primary production and the input of secondary raw materials.

Table 7: Overview and definition of relevant terms used in recycling

Old scrap (EOL metal)	Waste metal from the reprocessing/recycling of EOL products (“scrap” is used here to refer to both iron and non-ferrous metals).
Collection rate CR (abbreviated to CR) (also: capture rate)	The collection rate refers to the ratio in percent of metal content of EOL secondary raw materials actually entering the recycling cycle (e) to the total volume of EOL metal content (d) potentially available. CR = e / d [%]
End-of-life (abbreviated to EOL)	The end-of-life stage in a lifecycle starts when a product becomes waste and ends when the product re-enters the circular economy, e. g. as recycled input.
End-of-life recycling rate, (abbreviated to EOL-RR) (UNEP 2011) (Talens Peiro et al. 2018)	The end-of-life recycling rate refers to the ratio of metal generated from the recycling of EOL products (g = old scrap) to the total volume of metal (d) in percent that is potentially available for recycling at the end of its lifecycle (EOL); (d) thus denotes the volume of metal that is theoretically available at the end of the product lifecycle. This is metal that has not been collected but is contained in EOL products. Old scrap (g) then refers to the share of metal that actually enters the recycling cycle. EOL-RR provides no information about collection alone. EoL-RR = g / d [%]
Recycling process efficiency rate (abbreviated to RPER) (also recovery rate) (UNEP 2011)	The recycling process efficiency rate is equivalent to the yield of a given recycling process. RPER = g / e [%]
End-of-life recycling in-put rate (abbreviated to EOL-RIR) (Talens Peiro et al. 2018)	The EOL recycling input rate is the ratio of metals generated from the recycling of EOL products (g = old scrap) to the total of primary metals and secondary raw materials used in production (EOL or old and new scrap) (j + m) in percent. EOL-RIR thus denotes also the share of secondary raw materials in the total consumption of raw materials in production (smelting, production of semi-finished goods).

End-of-life recycling input rate (abbreviated to EOL-RIR) (Talens Peiro et al. 2018)	EOL-RIR is a good indicator of a metal's degree of circularity. It shows what share of the metals in a product re-enter the cycle at the end of the product lifecycle. EoL-RIR = g / (a + j + m) [%] = OSR x RC
Functional recycling (Graedel et al. 2011)	Functional or metal-specific recycling (where the full function of a material is retained) refers to the segment of EOL recycling in which metals or alloys from discarded products are separated to the extent where they can be used to produce new metals or alloys at the raw material production stage. It does not mean than an alloy is necessarily used to produce the same alloy again. Often, various alloys are used to produce one or several alloys, sometimes with the addition of other alloying elements. Functional recycling = m + j
Secondary raw materials	Total metal content entering the recycling process (m + j + f). This is the sum of functional and non-functional recycling.
Non-functional recycling (Graedel et al. 2011)	Non-functional or metal-unspecific recycling (where the full function of a material is not retained), on the other hand, refers to the segment of EOL recycling in which a metal is separated as old scrap but incorpo-rated in a much larger material stream as a contaminant. Although this prevents dissipation into the environment, the specific properties of the metal are lost. One example of non-functional recycling is the use of metallic zinc waste, not in the form of zinc but as an alloying element in brass. While the corrosion-related properties of zinc are lost, it is put to high-quality use in brass.
New scrap (= own scrap = production scrap = production waste)	New scrap refers to waste metal or processing losses from production (e. g. offcuts or punching waste) that can be used in recycling. The term "waste metal" is used here for both scrap metal (metallic) and produc-tion residues (slag, dross and sludges) that can be recycled.
New scrap (= own scrap = production scrap = production waste)	Depending on the declaration, new scrap is not necessarily labelled as waste. It can be processed directly in internal recycling processes without entering the waste disposal cycle, which makes it, strictly speaking, resource efficiency. Where this scrap is labelled as waste, it is counted as recycling. Internal cycles are not shown separately in the reference chart used here.
Old scrap rate (abbreviated to OSR) (UNEP 2011)	Old scrap rate refers to the ratio of metals generated from the recycling of EOL products (g = old scrap) to the total of EOL metals (g) and new scrap entering recycling (h) in percent. OSR = g / (g + h) [%]
Product-specific recycling rate	The various recycling rates listed here generally also refer to individual products, product groups or sectors. Catalytic converters are examples of an individual product, cars of a product group, and the automotive industry of a sector.

Product-specific recycling rate	The fact sheets for aluminium, for instance, show that 90 % of the aluminium from cars can be recovered when these enter recycling at the end of their lifecycle. This is no assessment of collection and the significance of this rate is only limited.
Recycled content or recycling input rate (abbreviated to RC or RIR) (TALENS PEIRO et al. 2018)	Recycled content (frame of reference: product → recycled content) and the recycling input rate (frame of reference: production → rate of recycled content used) refer to the ratio of the sum of new and old scrap (j + m) to the sum of all metal used in production, i. e. the sum of primary metals (a) and secondary raw materials (EOL or old and new scrap) (j + m) in percent. RC = RIR = (j + m) / (a + j + m) [%]
Recycling rate (definition from the waste balance)	There are different types of recycling rate (e.g. EOL-RR). In the waste balance, the recycling rate refers to the input into all treatment plants classified as using a recycling process (i. e. excluding only energy recovery) as a share of the total waste volume. But energy recovery is not relevant for metals. The reference chart does not differentiate between energy recovery and recycling and this recycling rate can therefore not be expressed in a formula.
Recycled material (Section 3 (7) (b) of the Circular Economy Act (KrWG))	Recycled materials as intended by the KrWG are secondary raw materials that are produced by recycling waste or in the disposal of waste and which are suitable for the manufacturing of goods. They are thus possible substitutes for primary raw materials as input in the manufacture of new products.
Recovery rate (definition from the waste balance)	The input into all treatment plants classified as using a recycling process as a share of the total waste volume. For metals, the recovery rate and the recycling rate are the same, since energy recovery is not relevant.

The end-of-life recycling rate, by contrast, is an indicator for the area from waste collection to recycling, while the old scrap rate concerns the area where old scrap and new scrap converge. These are, of course, only schematic processes, which can vary for the individual metals. But the aim is to illustrate the general context and the resulting definitions for the recycling indicators and terms.

Figure 6 also reveals the flaws in the value chain, with losses first of all in primary production (smelting), where slag and residues (n) with a process-related residual content of the metals considered leave the cycle. Dissipation, and thus the loss of industrial metals during their useful life, is another process that reduces the efficiency of the cycle. Dissipation can involve the metals being distributed so finely through wear alone that they are no longer available for collection and subsequent recycling (brake linings, for instance, turn into dust that is so finely distributed that the copper and iron they contain cannot be collected and recycled). But even product design can make industrial metals so inaccessible in a product that their recovery is not economically viable.

The losses resulting from a lack of collection of metals are particularly significant. There are a number of prominent examples in Germany (ELV, e-waste) of the enormous impact this lack of efficiency has on the availability of resources for recycling.

Another point to keep in mind is that losses from non-functional recycling (f) do not automatically result in real material losses in the form of an exit from the circular economy. Even in the case of non-functional recycling, metals can still be reused in parallel (high-quality) recycling cycles.

Looking at the individual processes that together make up full-scale recycling, it becomes clear (see Fig. 7) that the recycling rates are a product of the individual efficiency rates for each process. Consequently, the efficiency of the whole or the chain can only be as good as the individual efficiencies of the consecutive processes. In the example in Figure 7, the collection rate is the weakest link in the process chain, at 50 %, and thus the parameter with the largest impact on efficiency. It is also where the greatest metal losses occur. The example shows, moreover, that the process chain as a whole has to be optimised. An efficiency of 95 % in metallurgical recovery alone will not significantly improve overall efficiency. Optimal recycling will only be possible if collection, pre-treatment/reprocessing and the final recycling processes are at similarly high levels. Collection is in fact a major weakness for many of the secondary raw materials considered in this study: often there is a lack of suitable measures to boost the effective collection of different products at the end of their lifecycle (Hagelüken et al. 2023).

High-quality recycling therefore requires the economically viable recovery of many relevant constituents, high yields, a marketable quality and compliance with high environmental and social standards that also take into account energy efficiency and CO_2 balances (Hagelüken et al. 2023).

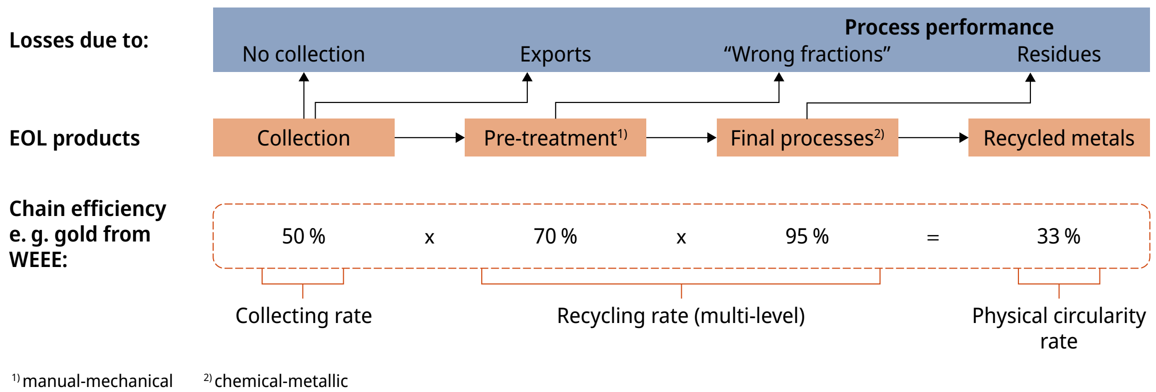


Fig. 7: Basic recycling chain for (complex) products incl. the example of gold from WEEE (based on Hagelüken, C. und Goldmann, D., 2022)

4. Findings

The findings from this study are summarised in the fact sheets for each raw material and the map of recycling company sites on the BGR geoportal. The map is based on a table that lists the key indicators for each company in combination with site-specific data. Both the fact sheets and the map of sites are publicly accessible via the DERA website or the geoportal. They are updated at regular intervals.

With this data compilation and analysis, it is possible to assess the level of intensity at which recovery of the elements currently takes place in Germany. The data also reveal information about the technical processes used in recycling and the shortcomings.

4.1 Fact sheets

The fact sheets are intended as a complement to the site-specific company data. They provide general and element-specific information that is relevant to the production and recycling context. The aim is to present both recycling-related data and the basic structures of the industries involved.

A first data overview lists the basic metal properties and information on the following:

Production
- Type of production
- Output volume
- Processing volume

Application
- Area of application
- Formats/semi-finished products
- Import/export particularly of secondary raw materials of different types

Recycling rates
- Recycling input rates (RIR)
- End-of-life recycling rates (EOL-RR)
- Product-specific recycling rate
- Recycling rates according to the United Nations Environment Programme UNEP (RC, EOL-RR, OSR)
- Recycling rates compiled according to the EU's RMIS Raw Materials Information System (EOL-RIR)

In particular the various recycling rates in this list are useful indicators for assessing the efficiency of the recycling sector. One difficulty in the investigation has been poor data availability, even for major industrial metals and particularly for Germany; another, the range of definitions used in the relevant literature, which permit only limited comparability. Nonetheless, the figures provide a significant basis for assessing the current state of recycling efforts for each element, at least in qualitative terms.

4.1.1 Aluminium

Aluminium is a key base and industrial metal, for which primary and secondary processing facilities exist in Germany on a large scale. In 2022, Germany produced around 341,213 t of primary raw aluminium and 2,963,300 t of recycled aluminium (AD 2023). Most of the latter originated from the remelting of new or production scrap, and only 472,800 t from refinery output. Secondary raw materials thus account for 58 % of refinery input (RIR), which is slightly more than the 53 % given by the Wirtschaftsvereinigung Metalle for 2021 (WVM 2021). This is not due to an increase in recycling output, but because of the ratio: while recycling output fell (2021: 564,481 t), primary output in Germany (2021: 509,193 t) declined even more because of energy prices.

Product-specific recycling rates in Germany, of 90 % in the automotive and construction industries and around 95 % in packaging, are evidence of a well-developed recycling infrastructure (BDE 2020). Despite the lack of German data on the end-of-life recycling rate (EOL-RR), the European figure of 69 % (EuRIC 2020) also paints a generally positive picture of the recycling situation. The EU's Raw Materials Information System (RMIS) by contrast reports a recycling input rate for EOL scrap (EOL-RIR) of only 20 %. Again, the problem is that the search for recycling indicators and original literature sources often results in outdated material flow data and different definitions of the recycling rates. This is the case with Passarini et al. (2018), the original source of EuRIC 2020, who use three different EOL-RR definitions for aluminium and cite two different results for 2013, 51 % and 69 %.

The trade in secondary raw materials is considerable, too, with 2022 imports of waste and scrap of 1.039m t and exports of 1.113m t (Destatis 2022). Germany imports large quantities of scrap, but exports even more. The slight export surplus for these materials found in the figures from Destatis or the WVM could indicate that there are at present insufficient recycling capacities for aluminium in Germany. This would fit in with the results of a material flow analysis by the German Environment Agency based on 2015 data for aluminium (UBA 2019).

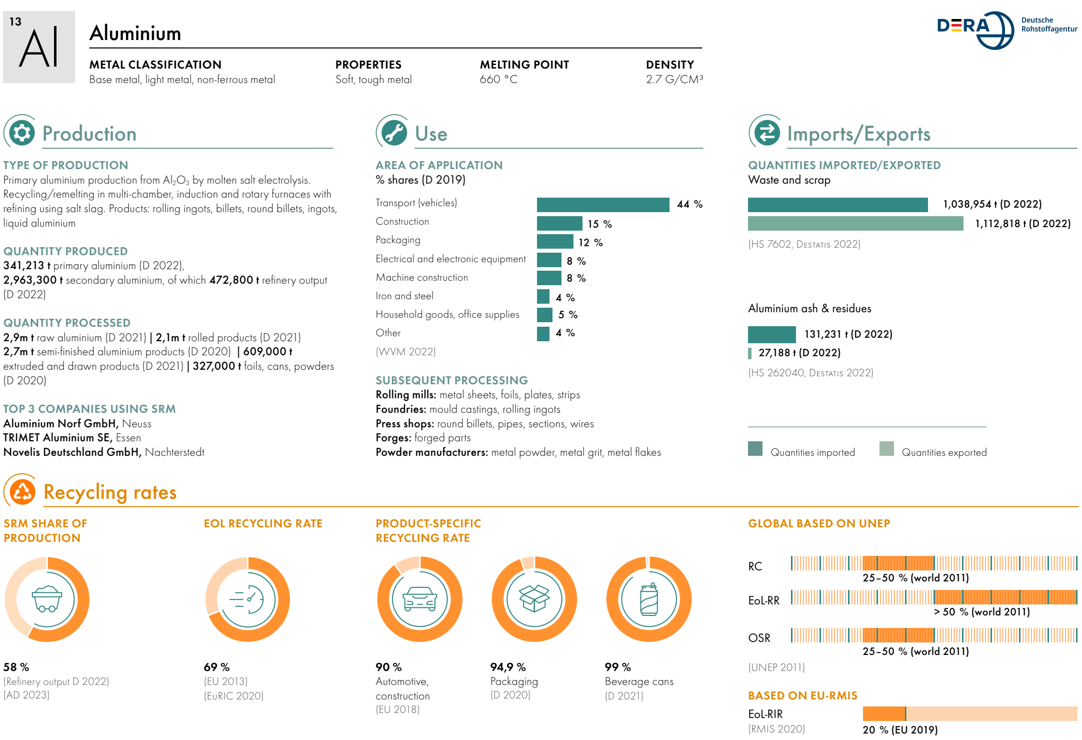


Fig. 8: Cover page of the fact sheet for aluminium with key element-specific recycling facts

4.1.2 Cobalt

Cobalt, a non-ferrous heavy metal, has only come into the focus of the recycling industry with the start of the transition in the transport sector and the rapid rise in the use of lithium-ion batteries (LIBs). Primary production is therefore generally expected to increase considerably worldwide, due to the high demand for use in electric vehicles. The battery industry accounts for a share of 57 % of the total use of cobalt. Particularly the many projects planned in Germany for a national LIB recycling network will lead to a strong increase in recycling rates. At present, however, there are hardly any output or recycling data for Germany. According to a recent study (Matos et al. 2020) based on 2016 data, EOL recycling rates for the European Union amount to 32 % and recycling input rates to 22 %. That is consistent with the EOL-RIR of 22 % in the EU's RMIS figures. Overall, the low rates show that there is a large recycling potential. With the many lithium-ion battery projects, a strong increase in recycling activities and rates can be expected in the short to medium term.

German trade in secondary raw materials containing cobalt is still very limited, with imports and exports of waste and scrap containing cobalt amounting to 602 t and 404 t respectively in 2022. But particularly in the context of e-mobility and the recycling of LIBs containing cobalt, growth markets in Europe can be expected in the foreseeable future. In Germany alone, the LIB recycling capacity will almost double by 2023, with growth rates of 100,000 t/a (Kresse et al. 2022). Strong growth can therefore be expected in Europe, at least in the trade flows related to LIB recycling.

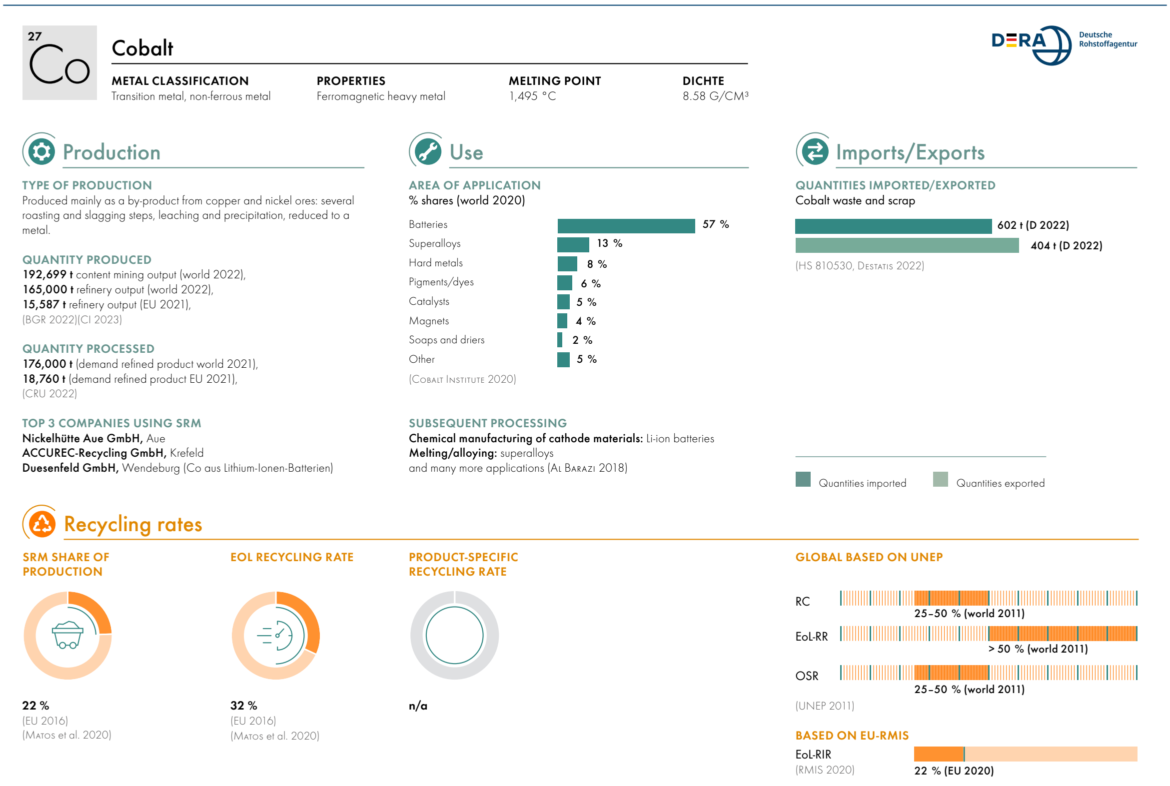


Fig. 9: Cover page of the fact sheet for cobalt with key element-specific recycling facts

4.1.3 Chromium

Chromium is mostly used as an alloying element, particularly in the steel industry. Its use in stainless steel accounts for 72 % of total use, and in carbon alloy steel for 24 % (RMIS 2020). Only a small percentage is used in chromium chemicals, e. g. for surface coatings, and thus the direct application of chromium.

Almost all chromium recycling is therefore recycling of chromium alloy steel. As a result, EOL recycling rates are high, although no separate figures are available for Germany. The global EOL-RR is 90 % (OECD 2019), but mainly because the product-specific recycling rate for stainless steel exceeds 90 %. In Europe, however, the EOL recycling input rate is only at 21 % (RMIS 2020). Overall, however, good capture and recovery of Cr units can be assumed, since the state of the art allows stainless steel recycling at a high level.

In 2022, German imports of waste and scrap containing chromium amounted to 6,346 t, far more than the 340 t of exports in the same period. A comparison with the figures for primary production (e. g. 11.3m t of ferrochromium globally in 2020 (BGR 2020)), however, would suggest that only very small volumes were traded across German borders.

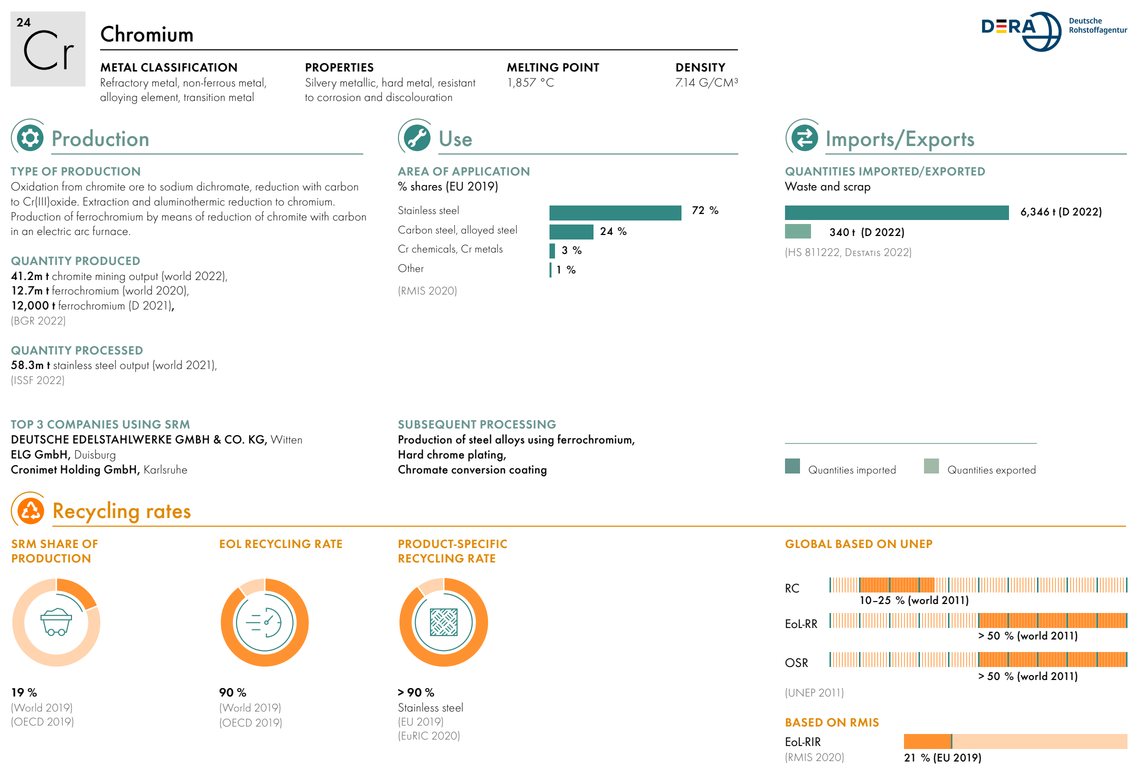


Fig. 10: Cover page of the fact sheet for chromium with key element-specific recycling facts

4.1.4 Copper

Copper is a very versatile metal. It is used as a base metal in many alloys and is crucial in many applications because of its outstanding thermal and electrical properties, particularly in pure form. The German copper industry has therefore long focused on efficiency in production and processing, with companies that are vertically integrated across the value chain including highly efficient closing-the-loop processes. At present, Germany is the world's fourth largest importer of copper as a primary raw material. This is partly due to the fact that key buyer markets, also for recycling services, are located in Germany and its neighbouring countries.

Copper is also a key base and industrial metal with better data availability for German recycling activities than most of the other metals considered here. The reason for this is the strong presence of German companies engaged in the primary production and recycling of copper, and of downstream enterprises, which are organised in powerful trade associations.

Based on the data for refinery output in 2022 of 609,000 t in total, of which 245,000 t are secondary (BGR 2023), a recycling input rate of around 40 % can be calculated for Germany. If the direct use of scrap in remelting is included, which amounted to as much as 234,000 t in 2021 (BGR 2023), the recycling input rate is far higher. According to 2022 figures from the German copper institute, a recycling input rate as high as 45 % can even be assumed for Germany. Looking at the European recycling input rate only in the context of end-of-life materials, the EOL-RIR was 33 % in 2019, and thus quite low by comparison (RMIS 2020).

Germany's end-of-life recycling rate is 80 % according to the German copper institute (DKI 2022) and thus even higher than the 70 % for Europe (EuRIC 2020).

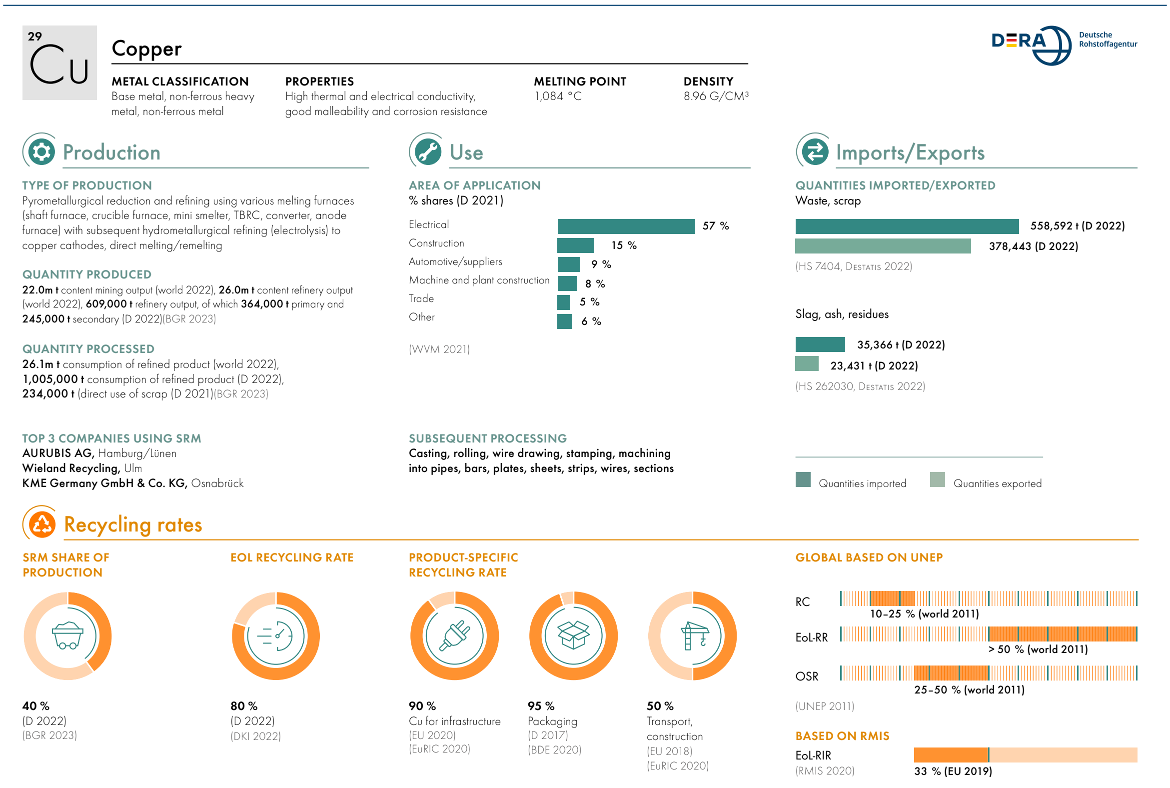


Fig. 11: Cover page of the fact sheet for copper with key element-specific recycling facts

The product-specific recycling rates for copper are also very high, at 95 % in the German construction industry (DKI 2022) and 90 % in the European infrastructure sector (EuRIC 2020). The current copper recycling rate of 50 % for WEEE scrap leaves room for improvement, largely in collection.

German trade in copper scrap and waste is also quite high compared to output figures, with 558,592 t of imports and 378,443 t of exports (Destatis 2022). This trade situation would suggest that the collection rate is high and the recycling routes for the metal are well-established.

4.1.5 Iron/steel

As a basic industry, steelmaking is of particular importance for the German value chains. The many innovations in this sector and its close links with other industries have contributed to the success of, for instance, the automotive and mechanical engineering sectors. More than 80,000 people work directly in the German steel industry. With an annual output of around 37m tonnes of crude steel (2022), Germany is the eighth largest steel producer worldwide, and the largest in the European Union (EU27) (despite a drop in output of about 8 % compared to 2021, due to a price decline and high energy costs). Germany is also one of the ten largest steel producers worldwide (WVStahl 2022).

Of the 36.85m t of crude steel output in Germany in 2022, 25.85m t were produced in blast furnaces and 11.0m t in electric arc furnaces (EAF). In a blast furnace, a rate of about 30 % secondary raw materials can be used, in an EAF even 100 % scrap. With the availability of these technical capabilities, Germany achieved recycling input rates of 45.8 % in crude steel production in 2022 (BDSV 2023a). On a European scale, this indicator was even 56 % (EuRIC 2020), and 60 % in German stainless steel production (BDSV 2023a). For German iron foundries, recycling input rates as high as 90 % were found in 2020. Overall, there is a lack of data on EOL recycling rates specifically for Germany. But it can be assumed that they will not be below the 75 % determined for Europe (2015, Passarini et al. 2018) or the global rate of 70 % in 2019 (OECD 2019). This assumption is based on the high product-specific recycling rates of > 90 % for stainless steels and alloyed steel scrap. For new alloyed steel scrap, the collection and reuse rates are almost 100 % (Hiebel & Nühlen 2016). And the EOL recycling input rate in the EU still amounts to an impressive 31 % according to RMIS (2020).

Trade in iron-based secondary raw materials is also at a high level. In 2022, Destatis (Destatis 2022) recorded an export volume of 7,766,038 t and thus almost double the import level of

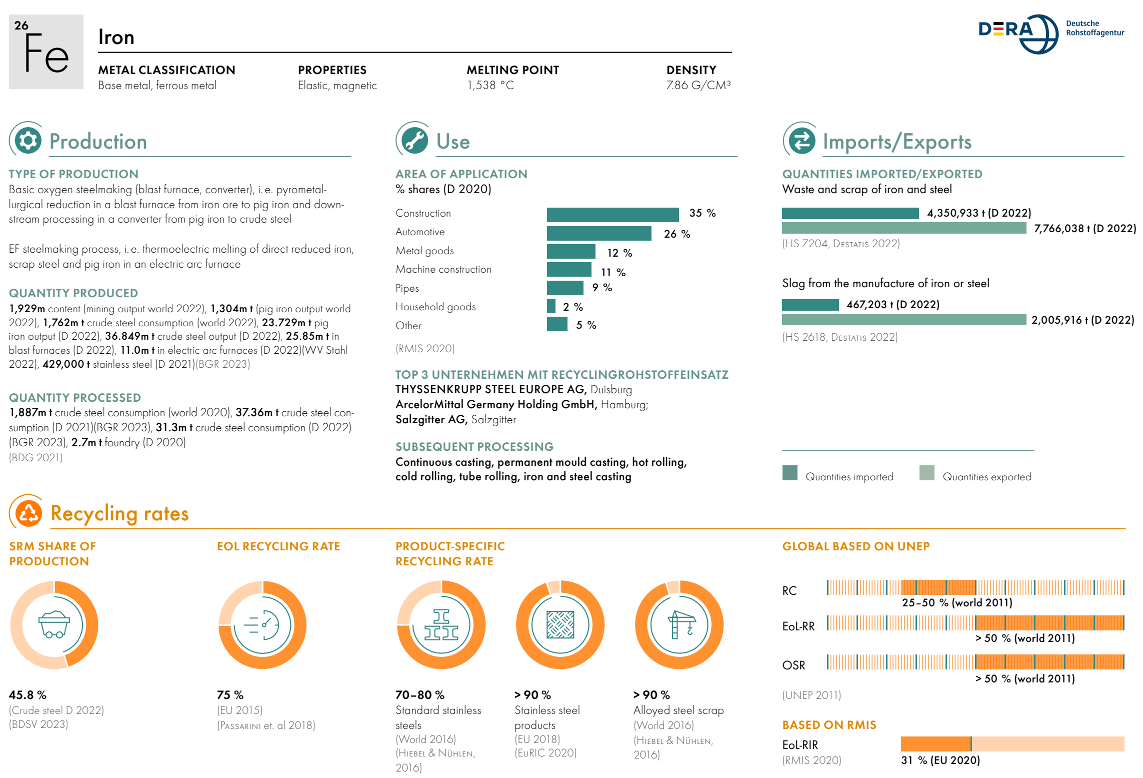


Fig. 12: Cover page of the fact sheet for iron/steel with key element-specific recycling facts

4,350,933 t. The reason for this export surplus is Germany's limited capacity for the reprocessing of scrap steel, which is why around 59 % of scrap steel is exported to other EU countries (WVStahl 2022). They also have efficient collection and recycling networks, which are limited only in range by the economically justifiable transport of scrap.

4.1.6 Gallium

Gallium is a non-ferrous metal. Its main application is in the production of semiconductors (such as LEDs), in the form of gallium arsenide or gallium nitride. It is also required for extending the 5G network, which is why the EU has classed gallium as a strategic or critical raw material (EU 2023). Moreover, although Germany has (some) primary and secondary productive capacities (30 t and 12 t, BGR 2018), it produces no primary gallium at all. At 550 t (BGR 2023), total global annual output is low. Very little and often outdated information is available on gallium, which can be obtained as a primary raw material as a by-product of bauxite production, and as a secondary raw material from GaAs wafer production waste. Gallium has an EOL recycling rate of 0 % (Mrotzek-Blöss et al. 2015), which means that no recyclables enter the circular economy in Germany after use. EOL recycling input rates for 2020 recorded by the European Union, also at 0 %, show that recycling is non-existent (RMIS 2020).

The recovery of gallium from the production waste of the wafer industry, on the other hand, is state of the art and, in 2010 at least, resulted in recycling input rates of up to 50 % (Sander et al. 2016). The fact that Germany processes at least 30–40 t of gallium (BGR 2018) would indicate that some quantities of production scrap at least should be available for processing.

Regarding the trade in gallium waste, there are no usable data for either imports or exports. The Destatis records include only one figure for an aggregate group of waste and scrap from niobium, rhenium, gallium, indium, vanadium and germanium, with total imports of 24 t for 2022 (Destatis 2022). It is not certain, however, whether gallium was traded at all.

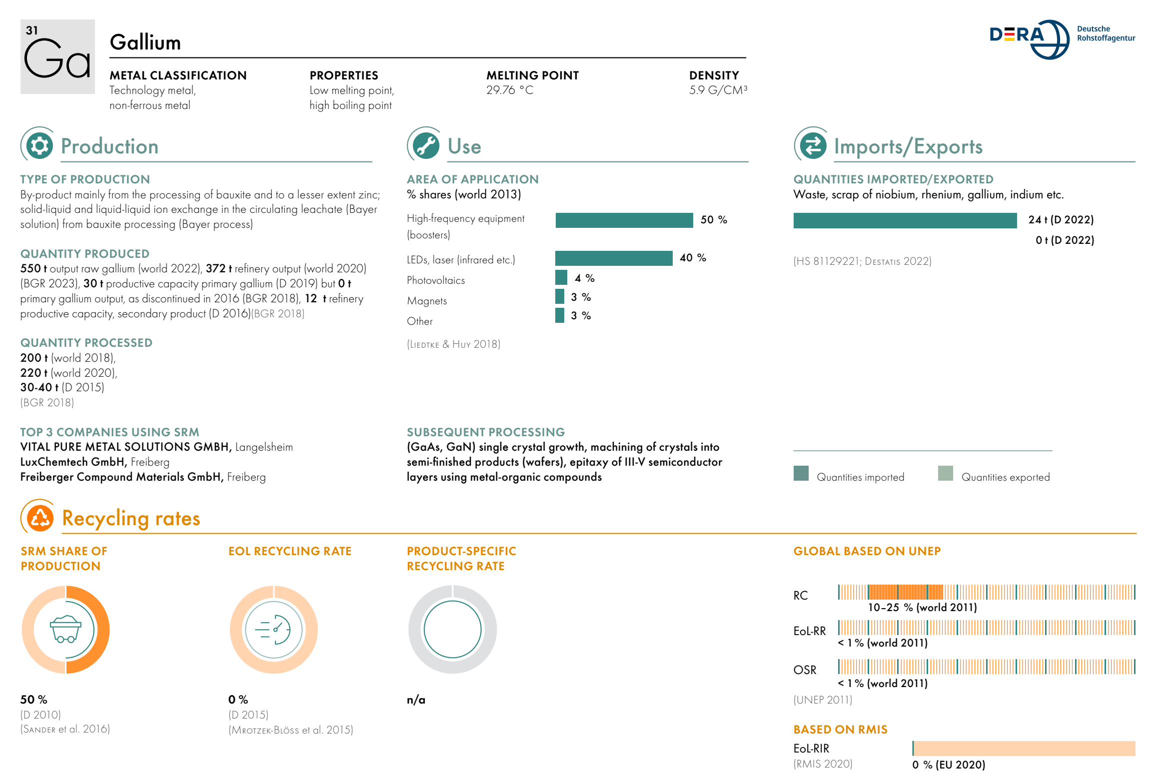


Fig. 13: Cover page of the fact sheet for gallium with key element-specific recycling facts

4.1.7 Indium

Indium is used mainly in the compound indium tin oxide (ITO), which is needed in the production of LCD displays. It is generally processed using sputtering techniques to produce transparent conductive coatings. Indium is also used in lead-free solders and in LEDs.

The annual global output of indium is very low, at 897 t (BGR 2023), and it is produced only as a by-product of zinc and lead production. As with gallium, only little and often outdated information is available, particularly on indium recycling. While the share of secondary raw materials in production is small, e. g. 11 % in China (China 2000–2019/Lin et al. 2021), the recycling from production scrap such as sputtering targets is widespread. Product-specific recycling rates in this area can be up to 70 % (Mrotzek-Blöss et al. 2015). Recycling from EOL scrap is non-existent, with EOL recycling rates of 0 % for Germany and Europe (Licht et al. 2015; RMIS 2020). This is because the application of indium in end products such as LEDs or ITOs is extremely dissipative, and recovery from EOL products therefore not likely to be viable, at least economically. Some studies indicate that, because of the dissipative distribution in secondary raw materials, the recovery of indium involves more energy and GHG emissions than primary production (Schmidt et al. 2020).

Regarding the trade in indium waste, there are no usable data for either imports or exports. The Destatis records include only one figure for an aggregate group of waste and scrap from niobium, rhenium, gallium, indium, vanadium and germanium, with total imports of 24 t for 2022 (Destatis 2022). It is not certain, however, whether indium was traded at all.

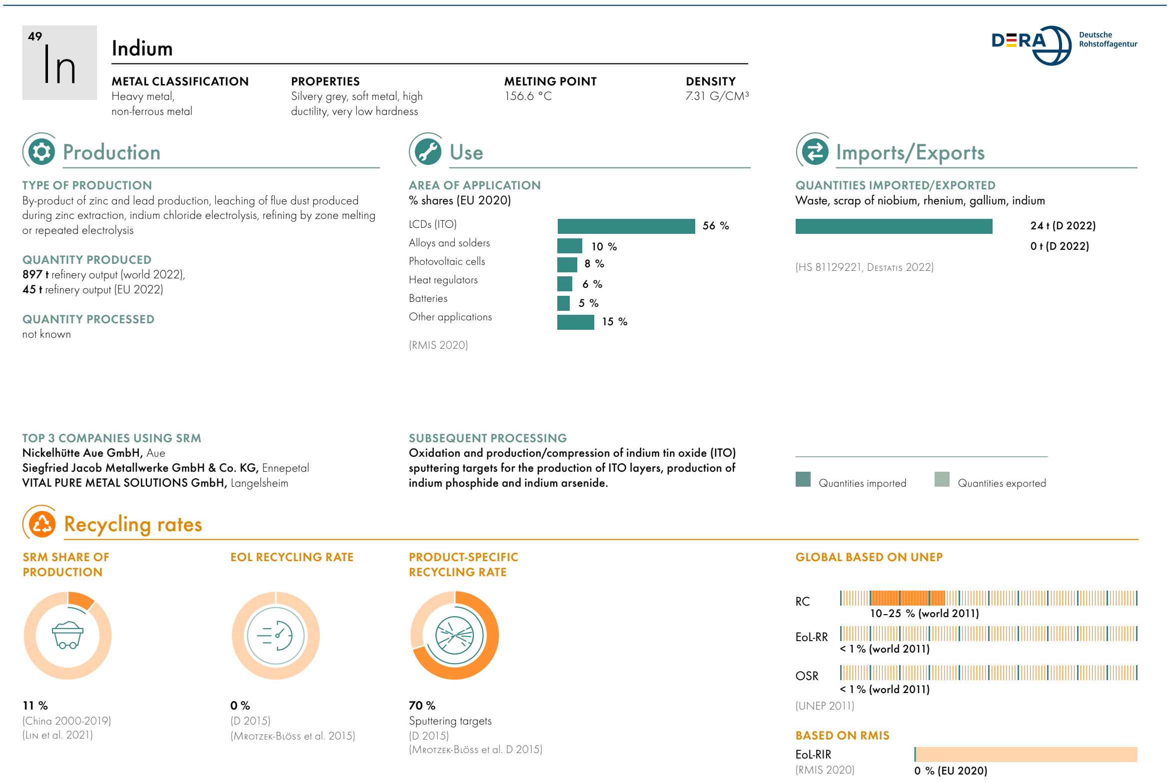


Fig. 14: Cover page of the fact sheet for indium with key element-specific recycling facts

4.1.8 Magnesium

Magnesium is a light metal and a major constituent of aluminium alloys (AlSiMg, AlMg). Because of its low density, it is also used in lightweight construction, especially in the aircraft and automotive industries. Magnesium is another strategically important and even critical raw material. This is because around 84 % of primary production is concentrated in China (2016, Schmitz 2019), resulting in a massive dependence of the German and European processing industries. Magnesium is used in Mg and Al alloys and in metallurgy, which is why magnesium recycling, with its around 15,000–20,000 t/a is playing an increasingly important role in Germany, where total demand amounts to 55,000–60,000 t (Schmitz 2019). Despite this importance, only few and partly conflicting data are available on recycling. There is no information at all for Germany. According to the OECD, secondary raw materials had a share of 33 % in global output in 2019 (OECD 2019), whereas the International Magnesium Association puts this figure at only 7 % based on 2012 data (IMA 2017). The EOL recycling input rate for Europe is given as merely 7 % (RMIS 2020), while older figures from the same source put it at 13 % for 2018, for instance. Depending on the source, the EOL recycling rate varies significantly. According to the OECD, the global rate is 39 % (OECD 2019), while other sources report only 14 % (Schmitz 2019, IMA 2017).

In trade, imports of magnesium waste and scrap exceed exports, with 2,910 t of imports and 2,602 t of exports in 2022. The reason for significantly less trade than in 2021 (imports 17,938 t, exports 7,677 t) was probably the 2022 magnesium crisis (Destatis 2022).

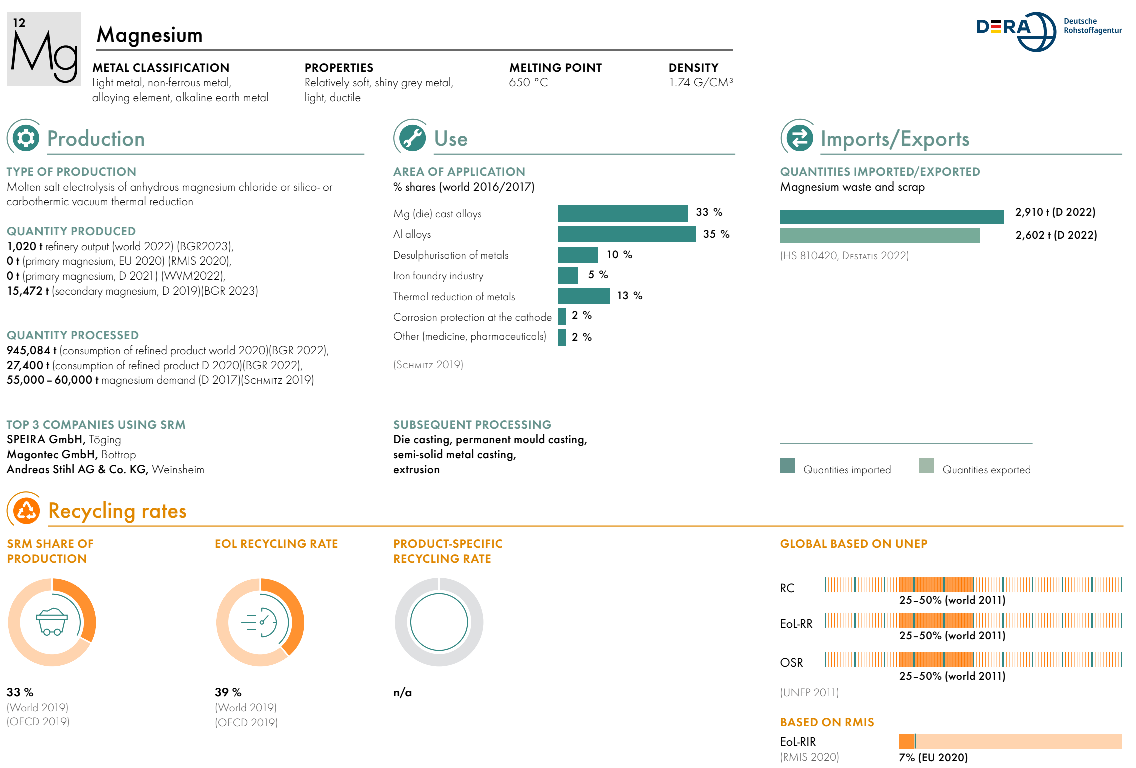


Fig. 15: Cover page of the fact sheet for magnesium with key element-specific recycling facts

4.1.9 Manganese

Manganese is a non-ferrous metal that is used predominantly in steel and stainless steel metallurgy and also in non-ferrous metallurgy. Worldwide demand for ferro- and ferrosilicomanganese amounts to 23.3m t, of which about 399,000 t are used in Germany (CRU 2022). Unfortunately, only EU and global recycling data are available, but none that are specific to Germany. Some of these figures also vary greatly, depending on the source and reference scope. According to the European Union, the EOL-RIR for Europe is 9 % (RMIS 2020), while the OECD puts the global EOL-RIR at 37 %. The OECD has also published a global EOL recycling rate of 53 % (OECD 2019). This is not really consistent with EU reports of a far lower EOL-RR of 40 % based on 2016 figures (MATOS et al. 2020).

Figures for trade in manganese waste and scrap are very low compared to consumption in Germany, with 781 t of imports and 392 t of exports in 2022 (DESTATIS 2022). However, this waste and scrap probably comprises only pure manganese or manganese compounds, but no alloys containing manganese.

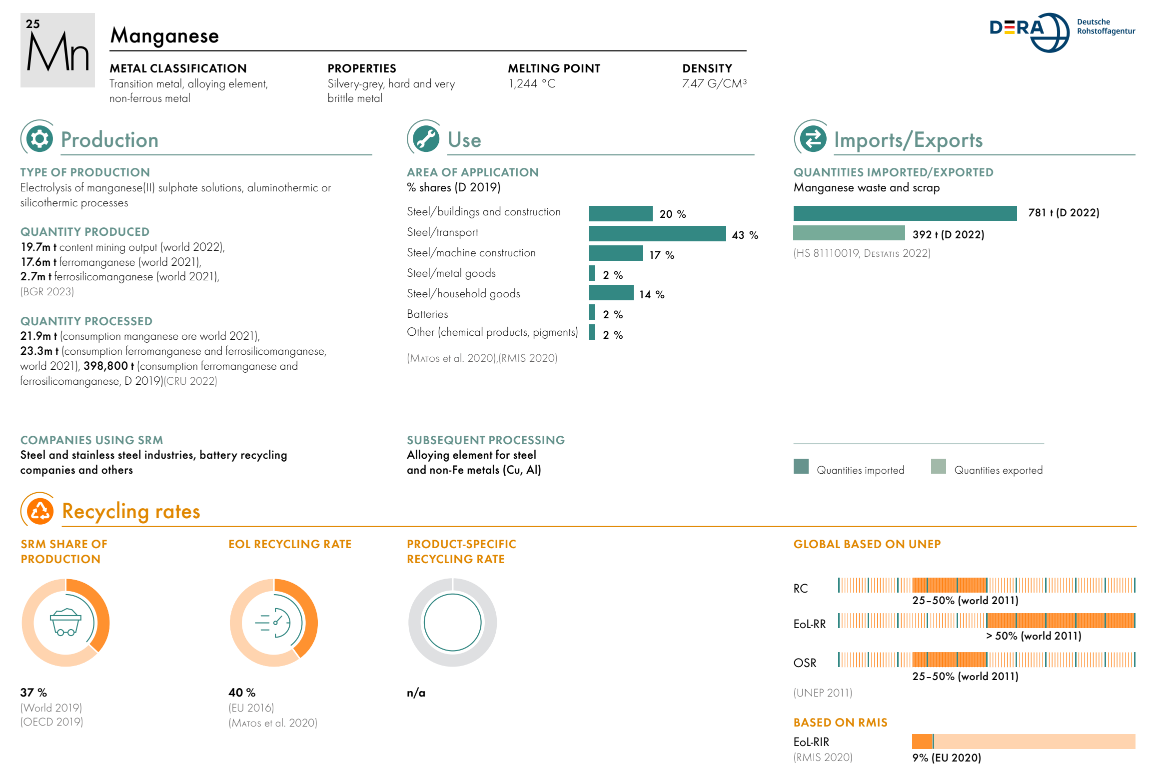


Fig. 16: Cover page of the fact sheet for manganese with key element-specific recycling facts

4.1.10 Molybdenum

Molybdenum, too, is mainly used as a major alloying element in steel and stainless steel metallurgy. Of the 296,600 t produced globally in 2021 (BGR 2023), 278,640 t were processed (IMOA 2022), and the market was therefore in surplus that year in relative terms. Only rather old global recycling data are available, unfortunately, and the European Union has not published any relevant recycling information either (RMIS 2020). The global share of secondary raw materials in production (RIR) amounted to 33 % (based on 2011 data, OECD 2019), with an EOL recycling rate of 26 % (2013, IMOA 2022). TALENS PEIRO et al. (2018) give at least an estimate of the EOL-RIR, putting it at around 30 %. Slightly more recent information is available only on product-specific recycling rates, which were 39 % for stainless steel and 50 % for tool steels/HSS in 2013 (IMOA 2022).

Trade in molybdenum waste and scrap was also rather low, at 1,904 t of imports and 477 t of exports in 2022 (DESTATIS 2022). Again, given the low figures, it is relatively certain that these are not steels containing Mo but alloys with a high Mo content or waste from these alloys.

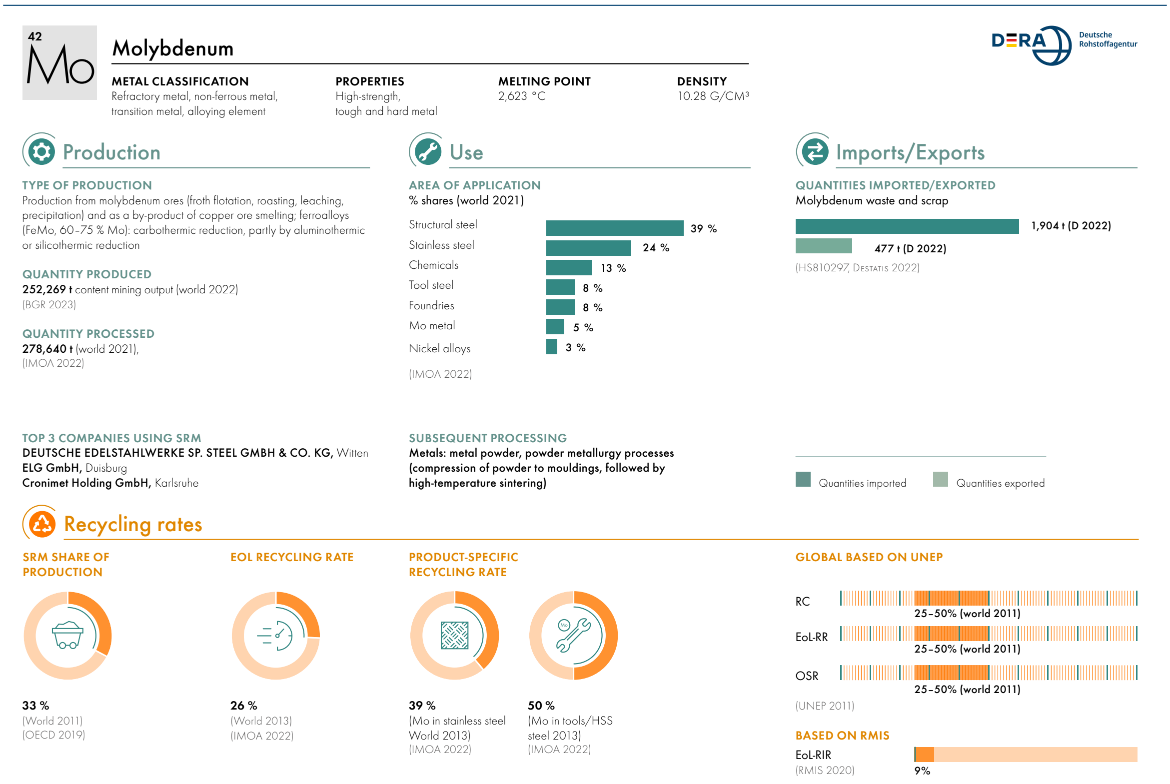


Fig. 17: Cover page of the fact sheet for molybdenum with key element-specific recycling facts

4.1.11 Nickel

Nickel is a non-ferrous metal that has to date been used as an alloy constituent in a wide range of Cr-Ni steels and as a matrix metal in superalloys. Another area of strong growth is the use of nickel chemicals in batteries, mainly lithium-ion batteries for e-mobility applications.

In 2022, global refinery output of nickel (i. e. concentrated metallic nickel > 99.8 %) (BGR 2023) amounted to 3.05m t, around 1m t of which was estimated to be recycled nickel (VDM 2022). It is not known how much of this refined nickel from recycling was produced from EOL scrap and how much from production scrap. Overall, the ratio would indicate a global recycling input rate of around 40 %. The last global recycling input rate of 35 % was published in 2019 (OECD 2019), but this was based on 2011 source data, which included production scrap. The EOL-RIR for Europe and the reference year 2016 is only 16 % (Matos et al. 2020). The EOL recycling rate (EOL-RR) reported in 2022 for waste in Germany is 70 %, while the product-specific recycling rate for stainless steel is 50 % (GDB 2022). Based on 2019 data, the EOL-RR is 60 %. This shows that efficient and effective recycling routes ensure the reuse of nickel, both in Germany and worldwide. Given the large number of battery recycling projects across the globe, it can be assumed that battery-grade nickel will in future also be collected and properly recycled on a large scale.

German trade in nickel waste (waste and scrap) in 2022 amounted to 13,055 t of imports and 8,783 t of exports (Destatis 2022). The import surplus for slag, ash and residues was also considerable (3,619 t of imports compared to 28 t of exports), since several companies in Germany are engaged particularly in nickel recycling.

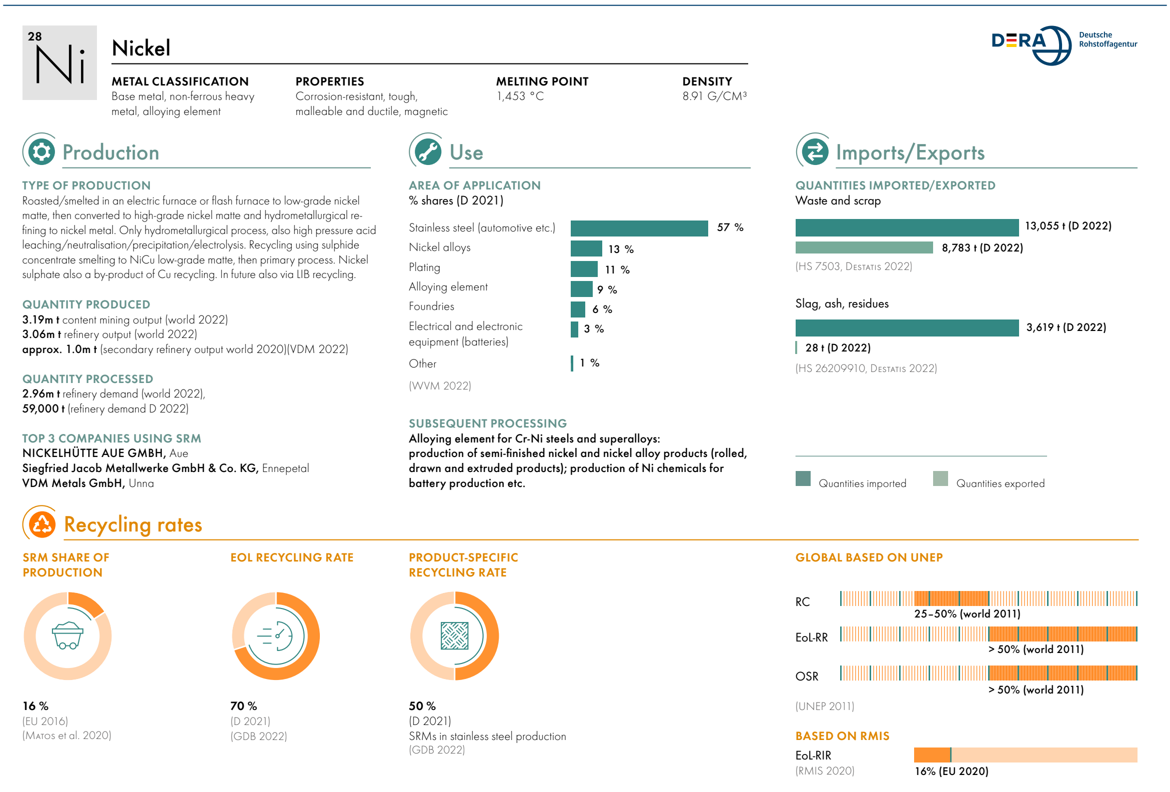


Fig. 18: Cover page of the fact sheet for nickel with key element-specific recycling facts

4.1.12 Lead

Lead is used mainly in lead-acid batteries and there have long been effective recycling schemes both within and outside Germany. This is evident from fact that the refined lead output from recycling in 2022 amounted to 192,200 t and thus more than five times the primary output (35,000 t). Consumption in 2021 was even 341,825 t, also exceeding domestic output. By comparison, global output in 2022 amounted to 12.3m t (BGR 2023). Recycling input rates of about 85 % for Germany and 78 % for Europe can be calculated from these figures (WVM 2021). At 95 %, German EOL recycling rates are even higher and evidence of the collection and recycling schemes aimed specifically at lead waste, particularly the reprocessing of lead-acid batteries (VDM 2022). Their product-specific recycling rates amount to 97.3 % at EU level, which is almost ideal (ACEA 2020). EOL recycling input rates in Europe are 75 % and therefore also far higher than for other metals (RMIS 2020)

Imports and exports of scrap and waste in 2022 amounted to 16,514 t and just 12,194 t respectively (DESTATIS 2022), while far more slag, ash and residues were imported (48,546 t) than exported (6.379 t).

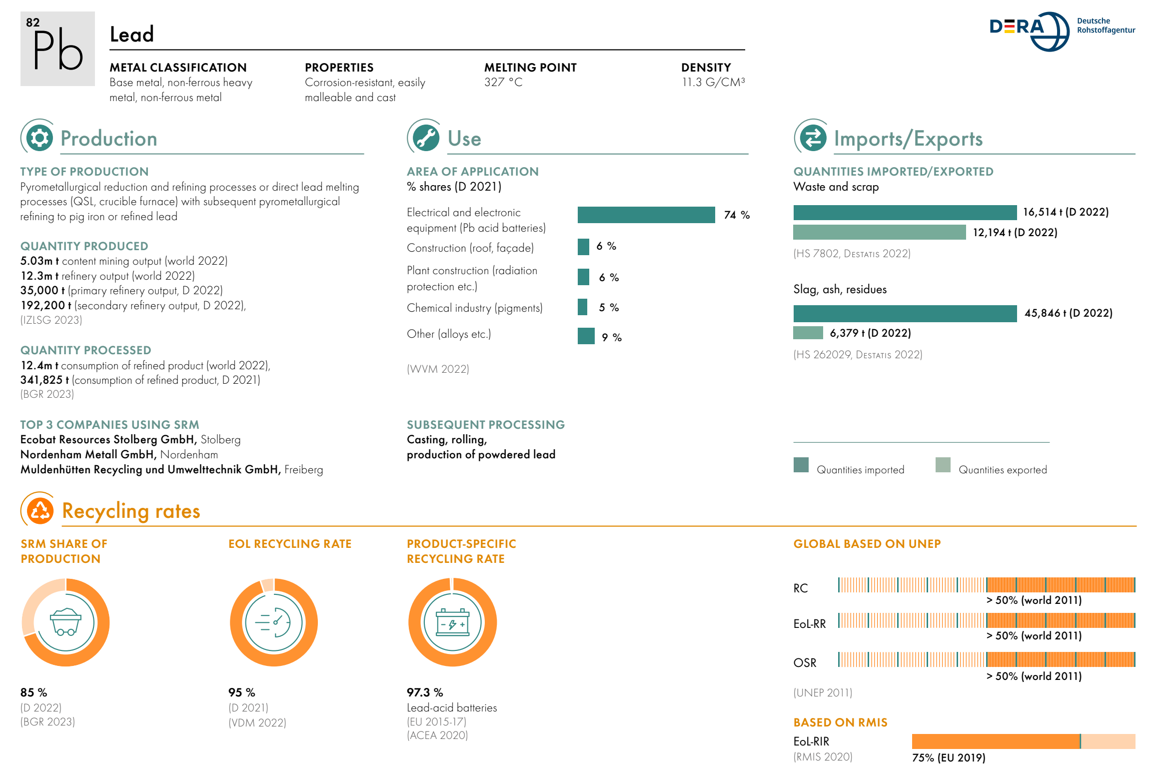


Fig. 19: Cover page of the fact sheet for lead with key element-specific recycling facts

4.1.13 Tin

Tin is used mainly in solder for electrical and electronic applications, for tin chemicals, and in the production of tinplate. There has been no primary production (i. e. production from imported concentrates) in Germany for a long time. Secondary tin production, on the other hand, is well-established in Germany and takes different routes. One is the production of tin from alloys (such as gun metal), often as a by-product of secondary copper production in the form of a lead-tin-alloy. Old and new scrap from solder production is also recovered on a large scale and made available for new products in the circular economy. There are also industrial-scale processes for detinning scrap tinplate.

In 2020, the share of secondary raw materials in global production was 33.1 % (ITA 2021) and exceeded 50 % for end-of-life scrap (BGR 2020). This is also the figure determined by UNEP for 2011 (UNEP 2011).

A reevaluation of the UNEP figures by the OECD in 2019 even showed a global EOL-RR of 75 % (OECD 2019). And the product-specific recycling rates for solder dross and paste were at 70 % some years ago (DERA 2014). The European RMIS database gives the end-of-life recycling input rate as 26 % (RMIS 2020), and Talens Peiro et al. (2018) provide an additional estimate of the EOL-RIR of 32 %.

In 2022, both German imports and exports of tin waste were low, at 663 t and 899 t respectively (Destatis 2022). One reason is that tin is exported in the form of lead-tin mixed alloys, to be processed into refined tin. The export figure of 1,837 t for ash and residues is higher than that for metallic waste.

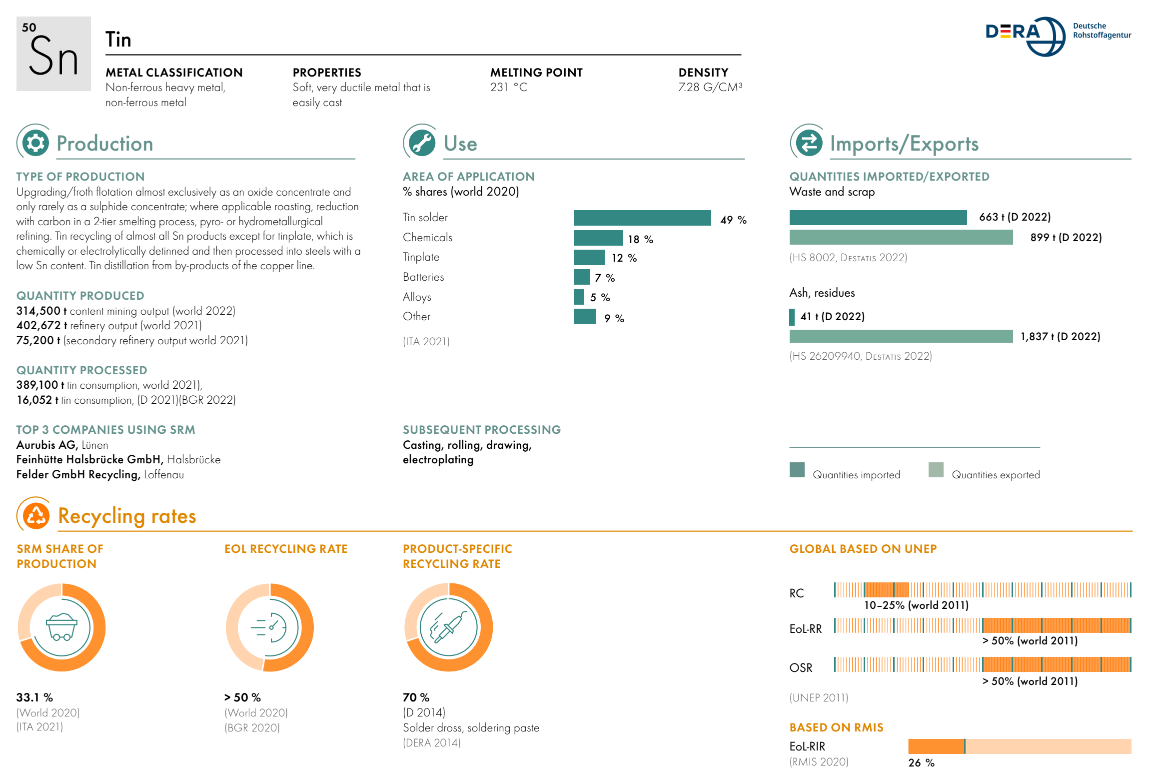


Fig. 20: Cover page of the fact sheet for tin with key element-specific recycling facts

4.1.14 Zinc

Zinc is a non-ferrous metal that is currently produced in Germany both from imported concentrate and in recycling.

In 2022, global refinery output amounted to 13.3m t, of which 1.7m t were produced by recycling within the refinery process and about 6m t by remelting (IZA 2023). The quantities in Germany are 110,900 t for primary and 24,000 t for secondary refinery output (2022). Added to these is the recycling of 47,800 t (2020) of direct-melt (remelted) scrap (BGR 2022).

Based on BGR figures, the recycling input rate (RIR) for Germany is 18 %, or 53 % if high-quality direct-melt scrap is included. The German Resource Research Institute found a much lower total RIR of 27 % based on 2019 figures (GERRI 2021). With EOL recycling rates exceeding 60 % in Europe (GDB 2021), however, the collection and recycling rates for zinc are relatively high compared with other metals. This is partly due to the high product-specific recycling rates exceeding 95 % for zinc sheet, titanium construction zinc and steelworks dust from the recycling of hot-dip galvanised steel (IZA 2022).

The end-of-life recycling input rate given in the European RMIS database is 14 % (RMIS 2020), while Talens Peiro et al. (2018) put it at 31 %.

Trade data for waste and scrap containing zinc show a clear export surplus for 2022, with exports of 39,953 t and imports of 6,070 t.

The situation is similar for slag, ash and residues containing zinc (22,733 t of imports and 99,346 t of exports) (Destatis 2022).

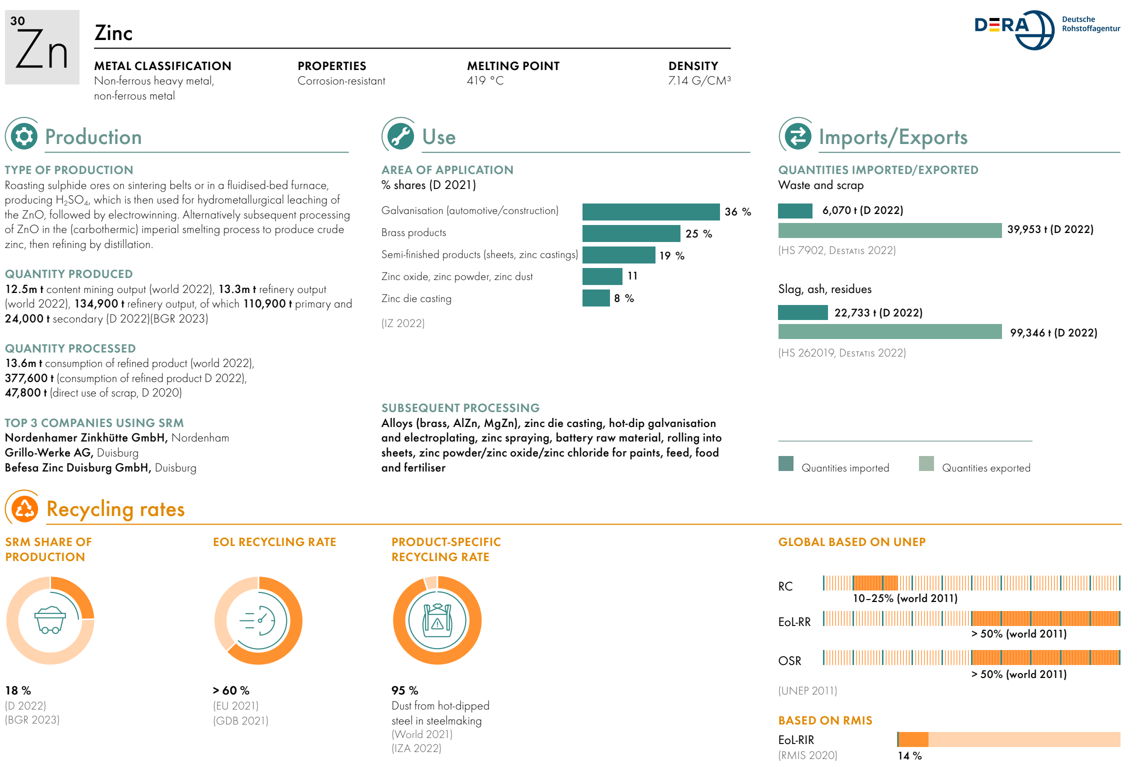


Fig. 21: Cover page of the fact sheet for zinc with key element-specific recycling facts

4.2 Summary information from the fact sheets

The data presented here are intended to permit conclusions on the status of recycling in Germany for each of the metals concerned. One major difficulty, however, is data inconsistency, such as the different output volumes or recycling rates given. It is often not clear what geographical area or time frame the recycling rates apply to, or which recycling rate they refer to (EOL, RIR etc.). With several elements, for instance, no data specific to Germany could be analysed, since the source studies had a European or even global reference area. Even though this analysis included the most recent data in each case, the time references in the source studies vary. Moreover, although the terms used for the data are the same, definitions sometimes differ, and in some cases no definition is provided.

The only recycling rates that are consistent in time and location were found in the RMIS Raw Materials Information System: its end-of-life recycling input rates use the same definition, the same local reference and similar reference time periods. Figure 22 shows a comparison of the EOL-RIR for the elements considered here. Particularly for the base metals iron/steel, copper and lead, collection and processing of end-of-life products are good to very good at the European level.

Looking at the base metals for which data for Germany are available, the recycling input rates that refer to the share of metals from recycling in total output are also good in comparison to international data. The 85 % figure for lead largely results from the effective collection and large-scale recycling of automotive batteries and is thus an example of the potential level that can be achieved for the other metals. Reasons for the large-scale collection of secondary lead are the easy removal and dismantling of lead-acid batteries in motor vehicles, and legal requirements in the EU and Germany (Batt-VO).

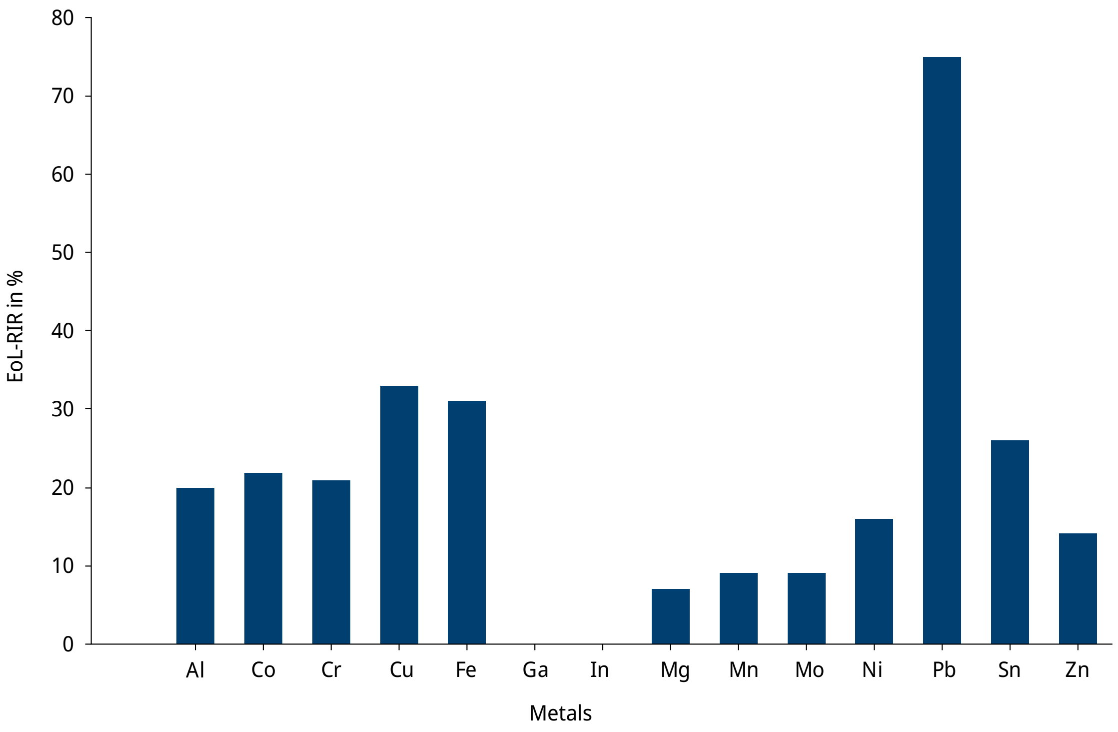


Fig. 22: Overview of end-of-life recycling input rates in Europe in percent based on the European Raw Materials Information System (RMIS 2020)

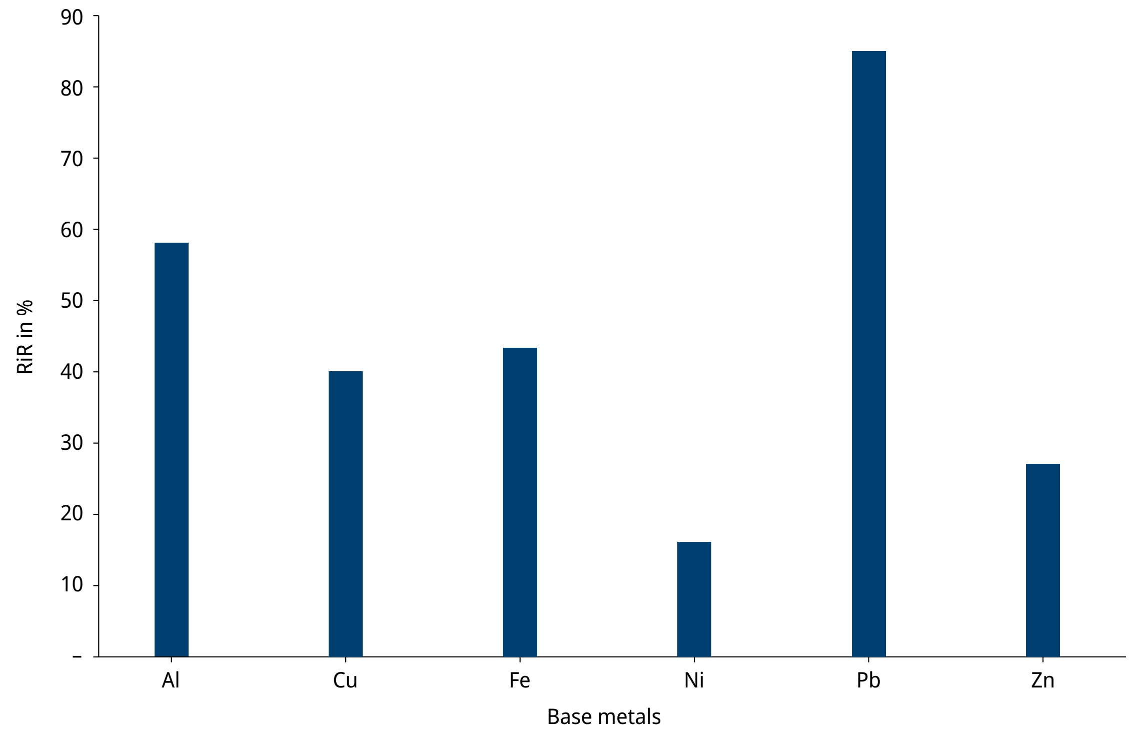


Fig. 23: Overview of recycling input rates for base metals in Germany in percent (sources in the individual fact sheets)

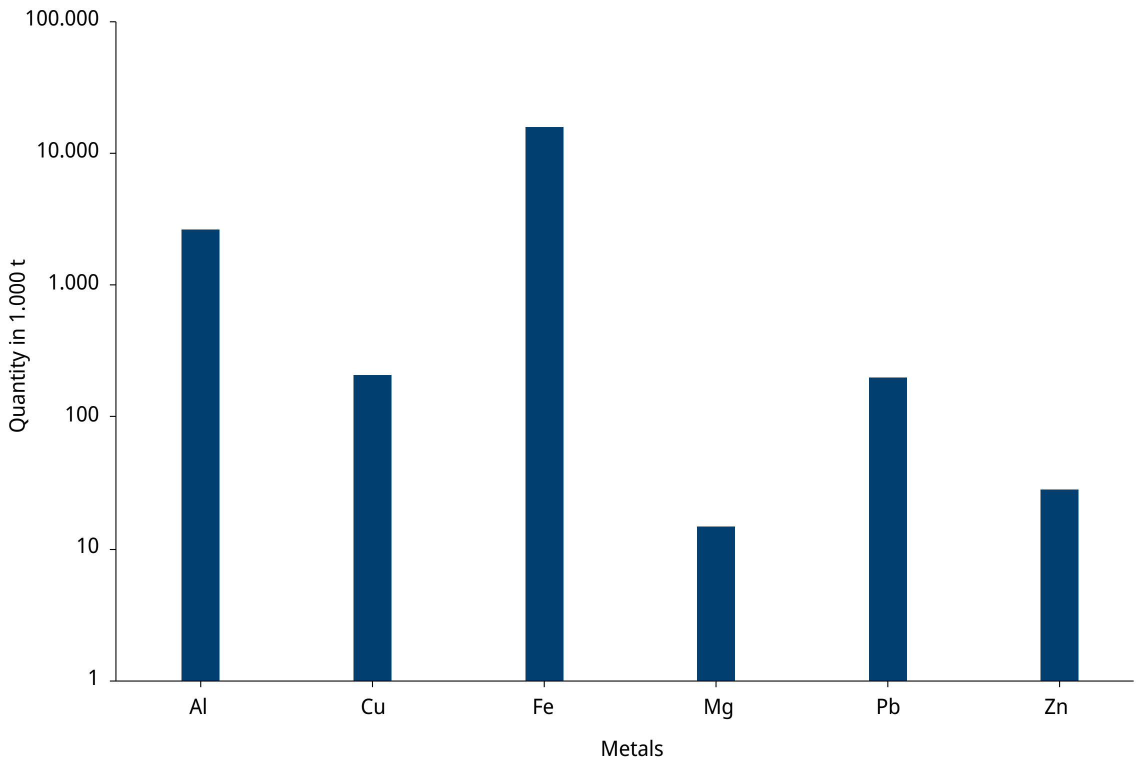


Fig. 24: Overview of the quantities of base metals recycled in Germany in 2022 (sources in the individual fact sheets)

Particularly the figure for aluminium illustrates the weakness in the definitions of some recycling indicators, since the calculation in fact excludes the large volumes from direct melting mainly of production scrap and new scrap. These effects are usually attributed to improved efficiency of production processes and not to recycling, although they do represent local recovery cycles. At almost 3 m t in 2022, the quantity of aluminium produced in Germany from recycled refinery output and remelted aluminium was far higher than primary output (341,213 t). Recycling capacities are thus much higher than the recycling indicators suggest.

The product-specific recycling rates listed for individual end-of-life metal products are also remarkable. They show that if the collection and reprocessing of EOL products are legally regulated – such as in the End-of-life Vehicle Ordinance, the Packaging Act or the Battery Directive – high recycling rates result. For aluminium, for instance, the collection and recycling rates are very nearly ideal, with a 90 % EOL recycling rate in the automotive industry, 95 % for packaging and 99 % for beverage cans. The same applies to the recycling rate for copper in the infrastructure and packaging industries (95 %), and for lead from lead-acid batteries, as mentioned earlier.

The value of the recoverable metals is, of course, also a factor in this development. In the iron/steel sector, collection and recycling rates for the more valuable stainless steels are significantly higher (90 %) than for "normal" types of steel (75 %).

A simple comparison of the quantities of most base metals for which data were available for Germany shows that, as expected, iron was the most recycled metal in 2021, followed by aluminium and copper, for which there are also well-established large-scale collection and processing processes. The same applies to the next metals, lead and zinc, and partly also to magnesium, although this is mostly recycled as an element in aluminium alloys and only rarely in pure form.

4.3 Overview of sites in the recycling atlas

The overview of sites is another key result of this study. It essentially consists of a table of sites and a map of sites on the BGR geoportal. Both the table and map are organised by metals and groups of metals. For reasons of simplicity and data availability, multi-metal processors have also been grouped by group of metals or application of the original products.

The map includes site information for companies recycling the following:

- Aluminium
- Lead
- Iron/steel
- Copper
- Magnesium
- Multi-metal
- Multi-metal batteries
- Nickel
- Zinc
- Tin

We were unable to find relevant element-specific site information for chromium, gallium, indium and molybdenum, the steel alloying elements chromium and molybdenum in particular being part of the material flow for iron. The recycling data for these elements are nevertheless included in their fact sheets.

4.3.1 Table of sites

The data about the company sites are organised as shown in Table 8.

Companies are sorted by the capacity indicated. Some companies publish only data for the whole group and often not concerning all relevant metals.

Table 9 shows that we surveyed and analysed 278 companies in total (296 companies, 18 of them listed more than once for different metals). More than half of them belong to the iron/steel sector, because Germany has many iron

Table 8: Table of sites – structure

Column heading	Description
Company	Full company name
Production or processing	Classification of the company's main activity as metal production or processing
Process	Brief description of the relevant production processes
Product	Main metal products the company makes
Use of SRMs	Does the company currently use secondary raw materials
SRMs used	Main secondary raw materials used (these are not standard names but the terms used in the company)
Annual capacity or out-put (t)	Total volumes produced by the company, in some cases also the quantities of recycled material used
Details of capacity/output	Additional details of the capacity/output data
RC (%)	Recycled content as a percentage of total output
Other metals	Details of other metals as main products or by-products
No. employees	Current number of employees (in some cases not per site but for the whole company/group)
Location	Place name of the company site
State	German state
Postcode	Postcode of the company site
Address	Street address and number of the company site
IED	Industrial Emissions Directive category
Link	Link to the company website
Comments	Additional details of the data

Table 9: Overview of the number of companies, employees and capacity by category of metal

Element (group)	No. of companies	No. of employees[1)]	Total capacity[2)] [t/a]
Aluminium	29	14348	3,536,412
Lead	19	10044	504,800
Iron/steel	161	143525	40,150,082
Copper	19	12680	2,614,000
Magnesium	6	5962	26,992
Multi-metal	15	4900	955,010
Multi-metal batteries	15	9349	129,650
Nickel	7	9081	208,600
Zinc	11	2619	1,162,900
Tin	14	2056	5,430
Total[3)]	**296**	**214,564**	**49,293,876**

[1] Number of employees per company site; does not refer to recycling work only.
[2] Total capacity across the sites for primary and secondary production or use of raw materials
[3] Total number of companies incl. multiple listings in different metal categories

foundries that use significant quantities of recycled content, particularly in processing. The total number of companies would be far higher if our analysis focused not only on functional recycling and thus on companies whose products re-enter the circular economy. A considerable number of reprocessing and treatment companies, many of which sort and partly concentrate secondary raw materials on a large scale, are therefore not included in this list. Despite this limitation, it can be assumed that we included at least 90 % of companies engaged in the functional recycling of the metals or groups of metals considered.

It is generally not possible to aggregate the capacities or output data from these companies, since many of them publish data only for their group and several countries, but not for individual sites. In many cases, only productive capacities are specified, and only rarely the quantities of secondary raw materials used.

The same inaccuracy applies to the number of employees: it is hard to quantify how many employees across a company or its individual sites are in fact working in recycling and not in primary production or processing. Overall, the list includes companies with a total of 215,000 employees in Germany.

The complete table with the site-specific data can be found on page 70 in the Appendix.

4.3.2 Map of sites

The site data from the table of sites described in Section 4.3.1 have been compiled into a map of the metal recycling sector in Germany, which can be found on the BGR geoportal. In the Geoviewer application, the display of the industrial sector for each metal can be scaled using a wide range of features (see also "Map of metal recycling sites in Germany on the BGR geoportal – user guide" in the Appendix). In addition to a simple overview of company sites for each metal or group of metals, sites can be sorted by additional company-specific data (capacity, recycled content, number of employees etc.). This option is available only for companies that have agreed to the publication of these data. Using zoom functions, it is also possible to identify regions where individual metals or groups of metals are concentrated.

Fig. 25: Screenshot of the recycling atlas on the BGR geoportal

The individual map views can be accessed via the “Special Topics” tab, by selecting “Metals Recycling Locations in Germany” in the “Resources” category. In the categories for the individual metals on the “My Maps” tab, the user can select one or several elements and view the company information. In addition to the map views for individual metals, the companies are listed in an attribute table that can be sorted by individual data sets or properties. The map also uses layer filters.

Where capacity/output data are available and permission for publication has been given, companies are shown as circles on the map, scaled by these data (companies without capacity data are shown as simple squares). When zooming out, companies are combined into clusters at scales above 1 : 10 million to reduce clutter. On zooming in, the clusters are broken down to company level. This makes information about the regional concentration of the recycling industry quickly accessible.

By clicking on a company symbol, the company and location names (city/state) can be viewed, along with details of employee numbers, capacity in t/a, and recycled content in percent. This option is available only for companies that have agreed to the publication of these data.

A more detailed user guide can be found in the Appendix (“Map of metal recycling sites in Germany on the BGR geoportal – user guide”).

4.4 Possible courses of action/obstacles

During our survey, company representatives named some obstacles for Germany as a recycling location. We have summarised and anonymised these statements and topics below, but in no particular order.

4.4.1 Availability of raw materials

The (current) lack of availability of raw materials was addressed in several discussions, for instance:

- Production waste: Some specialised suppliers to the automotive industry mentioned shortages of production waste from the automotive industry, which is needed as a secondary raw material in foundries. The reasons are lower productive capacities in the automotive industry due to problems in the supply chain, and also the transition to electric vehicles (The switch of the production programme to electric vehicles affects both the quantity and composition of the waste. An example: when there is no ICE, fewer castings are needed, and these parts will then not become available as production or EOL scrap.).

- Alloying elements: Rising costs and a lack of availability, particularly of nickel, were mentioned. They are due to the shortage of raw materials resulting from Russia’s war in Ukraine.

- Exports in combination with transparency requirements: One possible obstacle could in future be the transparency requirements of the (German) Supply Chain Act. Concerns were voiced that scrap merchants would be more likely to export their scrap rather than provide details of its origins, which would risk disclosure of trade relationships and could thus be counterproductive for the business model.

- Post-consumer products: Because the collection rate e. g. for e-waste is not high enough (the required rate is 65 %, Germany’s current rate around 45 %), there are insufficient quantities of metallic preconcentrates and secondary raw materials. Improved collection and recovery could boost the existing potential.

4.4.2 Quality of raw materials

The availability of raw materials is partly linked to raw material quality.

Although metals can in principle be recycled, some metal products are not recycled further because of economic, energy or legal reasons. This is the case, for instance, with the increasingly fine distribution of metals in e-waste because of miniaturisation. It also applies to metal-plastic compounds, which are becoming ever more complex because of the innovative joining techniques and are responsible for high organic loads in the scrap concerned.

Where production requires larger shares of alloying elements or primary raw materials, and secondary raw materials are not available in the required quantities or of a suitable quality, their share in production can fall. An example: when higher-grade aluminium scrap is exported because remelting capacities are limited, smaller quantities may be remelted, resulting in a rise in demand for primary aluminium. Another example is the substitution of alloying elements (such as nickel in stainless steel) with secondary raw materials (e. g. from battery recycling). This is currently considered not economically possible or viable, because nickel compounds for use in batteries are of a much higher quality and cost far more than nickel as an alloying element.

4.4.3 Energy

Recycling processes require energy, although less than primary processes in most cases. Higher energy costs cannot be passed on at all or only in part to downstream links of the supply chain (e. g. for products that compete on international markets or in cases of rarely used metals and few market participants). Over the past two years, several smelting plants in Germany have slowed or discontinued production, such as in the primary aluminium and zinc sectors. As a result, the use of secondary raw materials linked to primary production has declined.

In addition to higher energy costs, the type of energy source is another possible obstacle. Examples mentioned were the loss of coking coal as an energy source and insufficiencies in the electricity infrastructure. The costs of the necessary conversion to a new electricity infrastructure or a planned hydrogen infrastructure would make the switch to electricity- or hydrogen-powered melting units very expensive. This is the case, for instance, in the required transition of the steel industry from fossil fuels at present to a hydrogen-fuelled direct induction process. Costs are only one aspect here, availability another: the hydrogen infrastructure, market and supply in Germany are not yet sufficiently established and specific iron ore qualities are required for the direct induction process in some cases.

While the steel industry is already receiving support from the federal and state governments for the necessary conversion under a number of development schemes, this will take time.

4.4.4 Contribution to climate protection

Climate protection is not generally seen as an obstacle for the recycling sector. But it was said that the contribution to climate protection today resulting from the considerable use of secondary raw materials is not widely known or sufficiently recognised. One approach is the production and marketing of metal products manufactured in special low-carbon processes, for which there is increasing demand, also in processing.

A general problem is that no standard calculation of carbon costs exists and it is therefore not possible to express the benefits of recycling as cost benefits.

4.4.5 Regulatory requirements

Some of the obstacles mentioned refer to regulatory requirements.

- Labelling of scrap as waste: This was said to make certification more complex, e.g. because of the need to be certified as a waste management company, or in cross-border transport. It was suggested that a "separate" product category would be desirable. However, in some of the companies there was little awareness of tools that reassign a product status to waste.

- Definitions in waste legislation do not always address metal recycling requirements. Metal recycling has a long tradition, in many respects longer than laws on waste or products, and was well-established before the advent of waste legislation. Requirements that might be useful for other material flows (such as plastic or organic waste) to increase the use of secondary raw materials (e. g. the duty to use an authorised facility for the disposal of certain types of waste) can lead to less use of SRMs in metals.

- The lack of rules for recycling-friendly product design also makes recycling less effective. Product specifications are generally geared to production processes and only rarely to recycling processes.

- Long permit delays for new recycling facilities represent an obstacle to investment opportunities and prevent the location of innovative recycling processes in Germany.

- Many companies mentioned the lack of skilled staff and trainees as an obstacle to an expansion of the recycling sector in Germany.

4.4.6 Recommendations from the platform for dialogue on secondary raw materials

As part of Germany's 2020 Raw Materials Strategy, DERA was commissioned to set up a "platform for dialogue on secondary raw materials", with the aim of developing measures that would strengthen the contribution of secondary raw materials to ensuring the security of metal and industrial mineral supply. In dialogue with representatives from industry, science, the public administration and civil society, we developed specific courses of action in eight material flow-specific sub-working groups over a period of two years. The findings from this study were incorporated in that dialogue. In October 2023, the findings of the platform for dialogue will be presented and published. They will be publicly available on the DERA website (www.recyclingrohstoffe-dialog.de). The findings present obstacles and possible courses of action in the recycling industry in far greater detail.

5. Conclusions

This study addressed two key issues:

- What is the status of the German metal recycling industry today?
- What actions are necessary to develop metal recycling in Germany into a comprehensive circular economy?

In order to provide fact-based answers to these questions, a comprehensive database of German recycling sites and a metric in the form of consistent sets of data is desirable. As the study has shown, the main difficulty is a lack of consistency in the available data, which are, unfortunately, not complete. Moreover, the relevant data are distributed across a large number of sources, which makes it hard to bring them together in a single context. The metal and recycling industries as the source of these data have also stated that full disclosure of their recycling capacities, recycled content or supplier relationships etc., i. e. their market situation, would limit the competitiveness of companies in the German and international markets.

Despite these constraints in data availability, the study has produced an overview of metal recycling sites in Germany, which permits some major conclusions regarding the German recycling industry.

The findings of this study show that there is already an efficient recycling sector based on well-established business models, particularly for the base metals. To date, the main driving force behind the development into established circular models was the proven economic efficiency of recycling processes. Now an additional driver is the focus on aspects of sustainability, which, in combination with economic factors, has made the expansion of recycling structures a topic of social relevance. Because of current developments (Russia's war in Ukraine and the energy crisis), there is the need for greater diversification of Germany's supply of raw materials. And there is the call from political stakeholders to satisfy raw material demand from domestic sources. All these factors together are drivers of potential growth in the German recycling sector. Regarding the use of domestic sources, the growing demand for raw materials for the industrial transition that is already underway is going to result in new recycling potential, such as for battery raw materials (Li, Co, Ni). As numerous technologies of the future are becoming established, the demand for base metals (Cu, Al) will rise significantly, too, resulting in an increase in Germany's future recycling potential (Marscheider-Weidemann et al. 2021). This also applies to the traditional industrial metals sector, which, in terms of value, forms one of the largest parts of the German circular economy. According to estimates in this study, the main metals produced from secondary raw materials (Al, Cu, Fe, Mg, Ni, Pb, Sn, Zn, Ag, Au, Pt) had a financial value of around €34bn in 2022.[1]

In the recycling of battery raw materials (Co, Ni, Li), sustainable growth resulting from the requirements of the e-mobility transition is particularly evident. New recycling projects with considerable capacities are regularly and frequently announced in this area, and commissioned. This is an indication that recycling and circular processes can be quickly and purposefully expanded if they are economically viable, despite the obstacles mentioned in Section 4.4.

Regarding the question what actions from politics, industry and society can boost German recycling efforts, this study shows primarily the need to update legislation to provide incentives for recycling processes. This concerns not only

[1] For this rough estimate, we multiplied the secondary outputs calculated for the fact sheets (incl. direct-melt scrap wherever possible) with the average prices for new metals (refinery output) for 2022 (largely LME-based).

provisions for product design, but generally the need to coordinate waste, material and product legislation, and the long approval processes. Moreover, the recycling industry, too, is restricted by the general industrial environment, with companies suffering at present under high energy prices and the lack of skilled staff.

The recycling industry itself is also facing a radical transformation, particularly because many traditional metallurgical processes rely on fossil fuels and reducing agents. These are today either viewed critically because of their impact on the climate, or they will no longer be economically viable simply because of future price rises. It is evident that the recycling sector analysed here is also taking first steps towards a switch to hydrogen technologies and other renewable energy sources. Whether or not these approaches are economically viable will partly determine the future of the production sites listed here. Growth and expansion of the secondary processing industry in Germany is thus not the only possible development. First setbacks can be seen in the energy-intensive zinc and aluminium industries, where capacity reductions and closures of primary production sites have resulted in fewer recycling capacities for these metals.

This is generally a sign that it is very important to keep an eye on the changing situation of recycling sites and to continue to develop this recycling atlas in different directions. In a further stage, we will, from 2024, include more elements in the atlas (bringing the total to up to 35 elements), in order to highlight the situation of metals that to date are rarely recycled. As part of this broader focus, we are also planning to expand the map to include non-functional recycling in the form of an intermediate reprocessing of metals (collection, sorting and treatment).

DERA will continue to track the development of the German metal recycling sector as part of its commodity monitoring work, and in future also address its unused potential. Our aim is to provide comprehensive advice on secondary raw materials to German industry, to permit better use of these resources and tap new potential.

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Appendix

Tables of sites

Aluminium

Company	Production or processing	Process	Product	Use of SRMs	SRMs used	Annual capacity or output (t/a)
Aluminium Norf GmbH	Production and processing	Hot rolling, cold rolling, melting, aluminium rolling mill and foundry	Aluminium ingots, hot and cold rolled aluminium strips, beverage cans	Yes	Scrap aluminium	1,500,000
TRIMET Aluminium SE Essen	Production and processing	Molten salt electrolysis, melters/mixer furnaces, casting furnaces, continuous casting, homogenisation	Aluminium casting products, aluminium alloys, extrusion billets, rolling ingots and primary cast alloys	Yes	Post- and pre-consumer scrap, dross	285,000
Novelis Deutschland GmbH	Processing	Cold rolling technology, continuous annealing and finishing lines, aluminium casting, aluminium melting	Aluminium rolled products	Yes	Beverage cans, scrap aluminium	400,000
OETINGER Aluminium GmbH Werk Neu-Ulm	Production	Melting and refining processes	Ingots, liquid aluminium	Yes	Scrap aluminium, aluminium residues and scrap, e. g. dross, swarf, scrap sheets, shredded aluminium, sections or packaging materials	180,000
OETINGER Aluminium GmbH Werk Weißenhorn	Production	Melting and refining processes	Ingots, liquid aluminium	Yes	Scrap aluminium, aluminium residues and scrap, e. g. dross, swarf, scrap sheets, shredded aluminium, sections or packaging materials	180,000
Befesa Salzschlacke GmbH Lünen	Processing	Aluminium salt slag recycling services	Aluminium alloys, secondary aluminium (source: Aluminium Deutschland e. V.)	Yes	Salt slag, SPLs (spent pot lining)	170,000
Speira GmbH	Processing	Recycling of wrought and cast alloys	Liquid metal, RSIs, deoxidisers	Yes	Scrap aluminium	134,200
Befesa Salzschlacke GmbH Hannover	Processing	Aluminium salt slag recycling services	Aluminium alloys, secondary aluminium (source: Aluminium Deutschland e. V.)	Yes	Salt slag, SPLs (spent pot lining)	130,000
Trimet Aluminium SE Gelsenkirchen	Processing	Rotary furnaces, melting furnaces	Liquid metal, sows, foundry ingots	Yes	Post- and pre-consumer scrap, dross	114,000
TRIMET Aluminium SE Harzgerode	Processing	Melting and recycling plant: rotary furnaces, converters, vertical shaft furnaces, crucible furnaces, die casting	Liquid metal, sows, foundry ingots	Yes	Post- and pre-consumer scrap, dross	114,000

Details of capacity/ output	Recy-cled con-tent	Recycled content – comments	Other metals	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
Rolled aluminium				> 2,200	North Rhine-Westphalia	Neuss	41468	Koblenzer Str. 120	2.5(b)	www.alunorf.de
Foundry capacity (165,000 t electrolysis capacity)	35 %	approx. 100,000 t/a SRMs		780	North Rhine-Westphalia	Essen	45356	Aluminium-allee 1	2.5(a), 2.5(b)	www.trimet.eu
From recycled material	100 %			> 1,200	Saxony-Anhalt	Nachterstedt	06469	Gaterslebe-ner Straße 1	2.5(b)	www.de.novelis.com
(total capacity incl. Weißenhorn site)	90 %			300 (Neu-Ulm and Weißen-horn)	Bavaria	Neu-Ulm	89231	Max-Eyth-Straße 40		www.oetinger.net
(total capacity incl. Neu-Ulm site)	90 %			300 (Neu-Ulm und Weißen-horn)	Bavaria	Weißenhorn	89264	Robert-Bosch-Straße 16 + 18		www.oetinger.net
170,000 t salt slag	100 %			1,540 globally, of which 406 in DE	North Rhine-Westphalia	Lünen	44536	Brunnen-straße 138		www.befesa.com
2020 output	> 90 %	Recycling content is at least 90 %.		1,850	North Rhine-Westphalia	Grevenbroich	41515	Aluminium-str. 3		www.speira.com
Salt slag	100 %			1,540 globally, of which 406 in DE	North Rhine-Westphalia	Hanover	30179	Am Brinker Hafen 6		www.befesa.com
Capacity recycling div. (2 plants) from annual report:	< 95 %			92	North Rhine-Westphalia	Gelsen-kirchen	45881	Am Stadt-hafen 51–65	2.5(b)	www.trimet.eu
Capacity recycling div. (2 plants) from annual report:	< 95 %			70	Saxony-Anhalt	Harzgerode	06493	Aluminium-allee 1	2.5(b)	www.trimet.eu

Company	Production or processing	Process	Product	Use of SRMs	SRMs used	Annual capacity or output (t/a)
Hydro Aluminium Gießerei Rackwitz GmbH	Production and processing	Remelting/casting, shape casting, melting furnaces 1 and 2	Round billets	Yes	Secondary aluminium	100,000
BAGR Berliner Aluminium-werk GmbH	Production and processing	Melting plant and foundry	Aluminium sheet ingots, rolling ingots from secondary aluminium	Yes	Secondary aluminium, scrap	90,000
AGN Aluminium GmbH Nachrodt	Processing	Foundry for non-Fe metals, Wagstaff	Extrusion billets, secondary aluminium (source: Aluminium Deutschland e. V.)	Yes	Post-consumer scrap and trade scrap	84,000
Speira GmbH	Processing	Melting plant for aluminium and magnesium	Liquid metal, RSIs, sheet ingots	Yes	Scrap aluminium	78,038
Befesa Aluminium Germany GmbH	Processing	Aluminium secondary melting plant	Aluminium alloys, secondary aluminium (source: Aluminium Deutschland e. V.)	Yes	Secondary aluminium	75,000
Speira GmbH	Production	Molten salt electrolysis, melters/mixer furnaces, casting furnaces, continuous casting, homogenisation	Aluminium casting products, aluminium alloys, extrusion billets, rolling ingots and primary cast alloys	Yes	Scrap aluminium	70,000
Stockach Aluminium GmbH	Processing	Hearth-type melting furnaces, rotary furnaces, tilting rotary furnaces; oxide works for salt slag treatment, melting plant, remelting of scrap, melting of non-ferrous metals >= 4 t/d (Pb/Cd) or >= 20 t/d	Secondary aluminium, wrought alloys, rolling ingots	Yes	Scrap aluminium	70,000
THÖNI Deutschland GmbH	Processing	Aluminium melting plant	Aluminium billets	Yes	Scrap aluminium	60,000
AWW Aluminium-werke Wutöschingen AG & Co. KG	Production and processing	Foundry, range of forming and processing processes, surface finishing	Lightweight construction solutions, using in particular aluminium sections, mechanically worked extruded products for cold and hot forming processes	Yes	Production waste: Aluminium section waste, waste from pure aluminium sheets and wires, forging waste (all bare scrap free from oil, PVC, iron and other additions or adhesives.)	50,000
Speira GmbH	Processing	Recycling, trade, melting of non-ferrous metals >= 4 t/d (Pb/Cd) or >= 20 t/d	Liquid metal, RSIs	Yes	Scrap aluminium	46,174
Hydro Aluminium Recycling Deutschland	Processing	Recycling	Aluminium, e. g. for façade sections	Yes	Used aluminium components, scrap aluminium	36,000

Details of capacity/ output	Recy-cled con-tent	Recycled content – comments	Other metals	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
Round billets from extrusion				90	Saxony	Rackwitz	04519	August-Horch-Straße 2	2.5(b)	www.hydro.com
		Only small qties primary aluminium		69	Berlin	Berlin	13407	Kopenhage-ner Straße 59		www.bagr.gmbh
Extrusion billets	70–80 %	Recycling content be-tween 70 % and 80 %.		115	North Rhine-Westphalia	Nachrodt-Wi-blingwerde	58769	Hagener Str. 145–149	2.5(b)	www.alu-met.com
2020 output	> 90 %	Recycling content is at least 90 %.	Magnesium	500 (group division Recycling)	Bavaria	Töging a. Inn	84513	Aluminium-str. 8	2.5(b)	www.speira.com
Secondary aluminium				1,540 globally, of which 406 in D	Saxony-Anhalt	Bernburg	06406	Claude-Breda-Straße 6	2.5(b)	www.befesa.com
Remaining electrolysis capacity (currently suspended)				300	North Rhine-Westphalia	Neuss	41468	Koblenzer Strasse 122		www.speira.com
Rolling ingots and sows	94 %			120 (com-bined total of Stockach site and neigh-bouring business AS Oxid-werke)	Bavaria	Stockach	78333	Nenzinger Str. 17	2.5(b)	www.stockachalu.com
Aluminium billets	80 %			850	Bavaria	Kempten (Allgäu)	87437	Daimlerstr. 21	2.5(b)	www.thoeni.com
> 40,000 t/a extruded products, annual capacity extruder 50,000 t/a	75 %			750	Baden-Württem-berg	Wutöschin-gen	79793	Werkstr. 4	2.5(b)	www.aww.de
2020 output	> 90 %	Recycling content is at least 90 %.		500 (group division Recy-cling)	Baden-Württem-berg	Deizisau	73779	Am Rheinkai 34–36		www.speira.com
Scrap aluminium	75 %			30	North Rhine-Westphalia	Dormagen	41542	Edison-straße 5		www.hydro.com

Company	Production or processing	Process	Product	Use of SRMs	SRMs used	Annual capacity or output (t/a)
Alunova Recycling GmbH	Processing	Pyrolysis	Aluminium granulate and grit	Yes	Aluminium waste from the DSD recycling scheme, aluminium packaging materials (production waste)	30,000
Siegfried Jacob Metallwerke GmbH & Co. KG	Production	Hydro- and pyrometallurgical processes	Electrode copper, copper alloys, copper master alloys	Yes	Scrap, swarf, residues, slurry and solutions, industrial residues and production waste containing non-Fe metal	25,000
Aluminium Giesserei Hannover GmbH	Processing	Foundry, melting, continuous casting, homogenisation; channel-type induction furnaces	High-strength aluminium alloys, aluminium wrought alloys, ingots	Yes	Secondary aluminium (reprocessed scrap), mixed scrap, own milling “waste“, sawdust and other process “scrap“	20,500
Franken Guss	Processing	Foundry	Castings	(Yes)	Secondary/recycled aluminium	4,500
HMT Höfer Metall Technik GmbH & Co. KG	Processing	Remelting plant for scrap aluminium	Aluminium sections	Yes	Scrap aluminium	3,000
Druckguss Westfalen	Processing	(Vacuum) die casting	Precision Al casting	Yes	Secondary aluminium	
Otto Fuchs KG	Processing	Forging, extrusion	Al components	Yes	Secondary aluminium	
Superior Industries Production Germany GmbH	Processing	Foundry for non-Fe metals (Al)	Wheels	Yes	Production waste (at least within the group)	

	Details of capacity/ output	Recy-cled con-tent	Recycled content – comments	Other metals	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
	Aluminium waste, of which 11,500 t coarse and fine Al granules	100 %			50	Baden-Württem-berg	Bad Säckingen	79713	Rotfluh-straße 18		www.alunova-recycling.de
	Secondary raw materials	100 %		Titanium, hafnium, tantalum, tungsten, nickel, cobalt, niobium, vanadium, chromium, aluminium, copper, zinc, tin, lead, gallium, germanium, indium, manga-nese, tellurium, silicon, REE, bismuth	300; 1,000 (group)	North Rhine-Westphalia	Ennepetal	58256	Jacobstraße 41–45		www.jacob-metall.de
	2019 output	75 %		Copper, chromium, nickel, titanium, beryllium, zirco-nium, manga-nese, zinc, tin, magnesium, silicon, lead, iron	29	Lower Saxony	Hanover	30453	Göttinger Chaussee 12–14		www.leicht-metall.eu/
	Secondary aluminium			Iron	484	Bavaria	Kitzingen	97318	An der Jung-fernmühle 1	2.4	www.fran-kenguss.de
	45 t/d aluminium billets				>350 at 3 sites (Urmitz, Hettstedt and Dillingen)	Saxony-Anhalt	Hettstedt	06333	Gewerbe-ring 32	2.5(b)	www.hoefer-hmt.de
					> 250	North Rhine-Westphalia	Geseke	59590	Schneidweg 37		www.dw-alu.de
					2,663	North Rhine-Westphalia	Meinerz-hagen	5840	Derschlager Str. 26		www.otto-fuchs.com
					approx. 500	North Rhine-Westphalia	Werdohl	58791	In der Lacke 9	2.5(b)	www.supind.com

Lead

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Nyrstar Stolberg GmbH	Production	QSL process	Primary lead, refined lead, lead alloys	Yes	Lead-acid batteries	155,000
Nordenham Metall GmbH	Production	Lead smelter, lead refinery, bath furnace, reduction furnace	Primary lead, soft lead, hard lead, lead ingots	Yes	Secondary raw materials containing lead (lead-acid batteries);	92,000
Muldenhütten Recycling und Umwelttechnik GmbH/Ecobat Resources Freiberg GmbH	Production	Production of non-Fe crude metal	Soft lead, hard lead, lead alloys	Yes	Battery scrap	75,000
IVH GmbH – Industriepark und Verwer-tungszentrum Harz GmbH	Processing	Neutralisation, shredding, regeneration of electrolytes	Secondary raw materials for lead industry	Yes	Lead-acid batteries e. g. starter batteries, EV batter-ies, stationary lead batteries and other intermediate products containing lead	60,000
Clarios Recycling GmbH	Production	Shaft furnace	Soft lead, hard lead, lead alloys, lead oxide, car batteries	Yes	Lead-acid batteries, residues from battery production, lead waste	40,000
BSB Recycling GmbH/Ecobat Resources Braubach GmbH	Production	Tilting furnace process	Soft lead, hard lead, lead alloys	Yes	Batteries, secondary raw materials, waste	40,000
Aurubis AG – Standort Hamburg	Production	Secondary smelting/ lead refining	Lead ingots, lead-bismuth alloy, lead-antimony litharge	Yes	Lead materials, lead sludge	13,000
Feinhütte Halsbrücke GmbH	Production and proces-sing	Tin and lead smelting	Semi-finished products (bars, ingots, anodes, wire rod)	Yes	Industrial waste and resi-dues: Swarf, dross, slurry, dust, tableware, scrap, metals and scrap containing tin, lead and antimony	15,000
F. W. Hempel Legierungs-metall GmbH & Co. KG	Production	Remelting	Alloy blocks	Yes	(Production waste)	12,000

Details of capacity/ output	Recy-cled con-tent	Recycled content – comments	Publication	Other metals	No. em-ploy-ees	German state	Location	Post-code	Street address and number	IED	URL
Lead capacity			Annual capacity from website	Antimony, copper, silver, precious metals, bismuth	280	North Rhine-Westpha-lia	Stolberg	52224	Binsfeld-hammer 14	2.5(a)	www.ecobat.com
Lead capacity	70 %	Recycling content between 70 % and 80 %.	All infor-mation published on website	Zinc	330	Lower Saxony	Norden-ham	26954	Johanna-str. 2	2.5(a), 2.5(b)	www.norden-ham-metall.de
Battery scrap, 55,000 t/a lead/lead alloys			Annual capacity from website	Antimony	110	Saxony	Freiberg	09599	Mulden-hütten 25		www.ecobat.com
50,000 t/a output lead-acid batteries	98 %		Data from current and former websites		437 (group)	Lower Saxony	Goslar	38644	Land-straße 93		www.i-v-h.de
Hard lead alloys and soft lead 21,000 t/a lead oxides			Annual capacity from UFO-PLAN project FKZ 3713 33 333	Antimony	135	Rhine-land-Palatinate	Buchholz	53567	Kraut-scheider Str. 22	2.5(a)	www.clarios.com
Crude lead	60 %	Recycled content between 60% and 80 %.	Recycled content use provided by company; annual capacity from PIUS Check	Silver	89	Rhine-land-Palatinate	Braubach	56338	Emser Str. 11	2.5(a)	www.ecobat.com
Pb as a sales product (across the group)	45 %	Group average	Data are from pub-lished reports and not site-spe-cific	Copper, tin, lead, gold, silver, nickel, zinc, PGM, bismuth, antimony	2,600	Hamburg	Hamburg	20539	Hove-strasse 50		www.aurubis.com
Annual output	100 %		Mr Patzig has not given precise figures, but they can be found in the brochure (p. 12)	Tin, antimony	90	Saxony	Hals-brücke	09633	Krummen-henners-dorfer Straße 2	2.5(a), 2.5(b)	www.feinhuette.de
Battery recycling	> 90 %	Recycling content is at least 90 %.	Yes		33	North Rhine-Westpha-lia	Ober-hausen	46149	Erlen-straße 71		www.legie-rungsme-tall.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)	
Aurubis AG – Standort Lünen	Production	Remelting: Secondary copper smelter	Tin composite (lead-tin alloy)	Yes	E-waste, scrap copper, alloy scrap, PCBs, industrial residues, lead slurry, filter dust	2,800	
Anton Schneider Söhne GmbH u. Co. KG	Processing	Smelting plant, production of rolled lead	Roof building materials, products for industrial batteries, materials for sound insulation and radiation protection				
Clarios VARTA Hannover GmbH	Processing	Lead smelting plant, lead foundry					
Clarios Zwickau GmbH & Co. KG	Processing	Lead melting, lead casting	Car batteries				
Eppstein FOILS GmbH & Co. KG	Processing	Casting, rolling	Lead and lead alloys, tin foil	Yes	Secondary lead		
JL Goslar GmbH & Co. KG	Processing	Lead works, scrap lead melting, foundry for non-Fe metals, (homogenised) lead lining	Lead wool, lead granulates	Yes	Anode recycling programme		
Metallhütte Hoppecke GmbH & Co. KG	Production and processing	Battery production incl. metal works	Lead-acid batteries, NiCd industrial batteries, soft lead, hard lead, lead alloys, lead oxide	Yes	Lead-acid batteries, nickel, NiCd industrial batteries		
Metallhütten-gesellschaft Schumacher GmbH & Co. KG	Processing	Non-Fe metal melting plant (lead/tin alloys) 30 t/d	Lead keels and weights, soft lead types and all hard lead alloys.				
Mommer Metall-und Kunststoff-technik GmbH	Processing	Melting plant for non-Fe metals (lead), lead powder produc-tion	Lead wire, seals, moulded parts, balls				
NKT GmbH & Co. KG	Processing	Non-Fe melting plant (lead, cable jackets)	Cable jackets				

Details of capacity/ output	Recycled content	Recycled content – comments	Publication	Other metals	No. employees	German state	Location	Postcode	Street address and number	IED	URL
Lead content in tin composite	45 %	Group average	Data are from published reports and not site-specific	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth	660	Lünen		44532	Kupferstrasse 23	2.5(a)	www.aurubis.com
			No		20	North Rhine-Westphalia	Mönchengladbach	41236	Unterheydener Straße 30	2.5(b)	www.schneider-ass.de
					1300	Lower Saxony	Hanover	30419	Am Leineufer 51	2.5(b)	www.clarios.com
					400	Saxony	Zwickau	08056	Reichenbacher Straße 89	2.5(b)	www.clarios.com
	97 %		Figure from website	Tin	100	Hessen	Eppstein	65817	Burgstraße 81–83		www.eppstein-foils.de
	99 %		Information from website	Tin	> 200	Lower Saxony	Goslar	38640	Im Schleeke 108	2.5(b)	www.jlgoslar.de
			No	Antimony, tin	2,080 (group)	North Rhine-Westphalia	Brilon	59929	Bontkirchener Straße 1	2.5(a)	www.hoppecke.com
					520	North Rhine-Westphalia	Rommerskirchen	41569	Venloer Straße 8–10	2.5(b)	www.schu-metall.de/
					80	North Rhine-Westphalia	Stolberg	52224	Hamicher Weg 18–22	2.5(b)	www.mommer-gmbh.de
					580	North Rhine-Westphalia	Leverkusen	51368	Gebäude C 512, CHEMPARK	2.5(b)	www.nkt.de

Iron/Steel

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
thyssenkrupp Steel Europe AG	Production	Basic oxygen steelmaking	Slabs, flat steel slabs	Yes	Scrap iron; circulating scrap: residues containing iron and/or carbon	11,000,000
Hüttenwerke Krupp Mannesmann GmbH	Production	Basic oxygen steelmaking	Slabs, round steel slabs	Yes	Scrap	5,200,000
ArcelorMittal Bremen GmbH	Production and processing	Basic oxygen steelmaking	Hot-rolled strips, pickled hot-rolled strips, cold-rolled strips, hot- and cold-dipped galvanised steel strips, blast-furnace slag, steelmaking slag	Yes	Scrap	3,600,000
Salzgitter Flachstahl GmbH	Production	Basic oxygen steelmaking	Crude steel	Yes	Scrap	3,500,000
ArcelorMittal Eisenhüttenstadt GmbH	Production and processing	Basic oxygen steelmaking	High-strength steel, zinc-iron coating, cold-rolled flat products, hot-rolled flat products, rough slabs: continuous casting	Yes	Scrap	2,400,000
Saarstahl AG – Werk Völklingen	Production	Basic oxygen steelmaking	Steel	Yes	Scrap	2,700,000
Badische Stahlwerke GmbH	Production	EF steelmaking process	Rebar, wire rod, reinforcement products	Yes	Scrap	2,000,000
AG der Dillinger Hüttenwerke	Production	Basic oxygen steelmaking	Continuous cast slabs, heavy-plate products	Yes	Scrap	1,800,000
B.E.S. Brandenburger Elektrostahlwerke GmbH	Production	EF steelmaking process	Billets, wire rod, steel rebar mesh, rebar	Yes	Scrap	1,600,000
Lech Stahlwerke GmbH	Production	EF steelmaking process	Structural steel, rebar, high-grade steel	Yes	Scrap	1,100,000
ArcelorMittal Hamburg GmbH	Production and processing	EF steelmaking process	Billets, wire rod, various steel products: Steel cord, prestressing steel, wire rope, spring wire, chain steels, unalloyed carbon steel for industrial applications, steels for cold forming (Al-free), mild and extramild drawing qualities, wire rod for flat rolling, unalloyed welding consumables, medium-alloyed welding consumables, mesh and rebar	Yes	Scrap steel	1,100,000
Peiner Träger GmbH	Production	EF steelmaking process	Steel beams, steel sections	Yes	Scrap	1,000,000

Details of capacity/output	Recycled content	No. employees	German state	Location	Postcode	Street address and number	IED	URL
Crude steel		> 26,000 (group)	North Rhine-Westphalia	Duisburg	47166	Kaiser-Wilhelm-Str. 100	2.2	www.thyssen-krupp-steel.com
Pig iron		3,000	North Rhine-Westphalia	Duisburg	47259	Ehinger Str. 200	2.1, 2.2	www.hkm.de
Pig iron/year 3.7m t/a steel 4.5m t/a hot rolling mill 2m t/a cold hot rolling mill 1.1m t/a hot-dip galvanisation		3,200	Bremen	Bremen	28237	Carl-Benz-Straße 30	2.1, 2.2	www.bremen.arcelormittal.com
Flat steel slabs	20 %	5,480	Lower Saxony	Salzgitter	38239	Eisenhütten-str. 99	2.1, 2.2	www.salzgitter-ag.com
Foundry 5,000 t/24h melting capacity blast furnace 230 t/batch of pig iron + 80 t/batch scrap converter		2,500	Brandenburg	Eisenhütten-stadt	15890	Werkstraße 1	2.1, 2.2	www.eisenhuettenstadt.arcelormittal.com
Steel 2.4m t ore 241,942 t recycled materials 248,002 t scrap	12 %	5,214	Saarland	Völklingen	66333	Torhaus 1 + 10	2.2	www.saarstahl.de
Steel/year		> 1,300	Baden-Würtemberg	Kehl am Rhein	77694	Graudenzerstr. 45	2.2	www.bsw-kehl.de
Crude steel (2020) 1m heavy-plate products (2020) 2.3m t ore 231,246 t recycled materials 382,767 t scrap	15 %	4,445	Saarland	Dillingen/Saar	66763	Werkstraße 1–6	2.2	www.dillinger.de
Steel		800	Brandenburg	Branden-burg an der Havel	14770	Woltersdorfer Str. 40	2.2	www.rivastahl.com
Steel	> 95 %	800	Bavaria	Meitingen	86405	Industriestr. 1	2.2	www.lech-stahl-werke.de
Steel		523	Hamburg	Hamburg	21129	Dradenaustraße 33	2.2	www.hamburg.arcelormittal.com
Crude steel	100 %	786	Lower Saxony	Peine	31226	Gerhard-Lucas-Meyer-Str. 10	2.2	www.peiner-traeger.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Stahlwerk Thüringen GmbH	Production	EF steelmaking process	Steel girders, I-beams and wide flange beams, U and UPE sections, steel sleepers and special sections	Yes	Scrap steel	1,000,000
H.E.S. Hennigsdorfer Elektrostahlwerke GmbH	Production	EF steelmaking process	Billets, rebar, bright steel	Yes	Scrap	900,000
ESF Elbe-Stahlwerke Feralpi GmbH	Production	EF steelmaking process		Yes	Scrap	900,000
Saarstahl AG – Werk Neunkirchen	Processing	Bar steel line, wire rod line	Wire rod			900,000
ArcelorMittal Duisburg GmbH	Production and processing	Basic oxygen steelmaking	Free-cutting steel, BSM qualities, carbon steel, carbon steel with boron, stainless steel solder, iron wire, spring steel, hardness grades, chain steel, wire rod for welding, other stainless steel, other non-stainless steel, steel cord, roller bearing steel, tool steel			870,000
Georgsmarienhütte GmbH	Production	EF steelmaking process	Cast ingots, blooms and billets, steel bars (rolled), bright steel	Yes	Scrap	800,000
Benteler Steel/ Tube GmbH	Production	EF steelmaking process	Billets	Yes	Scrap	650,000
DK Recycling und Roheisen GmbH	Production	DK process (sintering plant), furnace	Pig iron, zinc concentrate	Yes	Oxidic residues from the iron and steel industry: BOF or oxygen dust, gas sludge and different types of mill scale and used foundry sand	580,000
Deutsche Edelstahlwerke Specialty Steel GmbH & Co. KG Werk Witten	Production	EF steelmaking process	Crude steel, stainless steel	Yes	Scrap	500,000
Fritz Winter Eisengießerei GmbH & Co. KG	Processing	Iron foundry	Cast iron	Yes	Scrap steel	406,000
Fritz Winter Eisengießerei GmbH & Co. KG	Processing	Iron foundry	Cast iron	Yes	Scrap steel	406,000
Deutsche Edelstahlwerke Specialty Steel GmbH & Co. KG Werk Siegen	Production	EF steelmaking process	Crude steel, stainless steel	Yes	Scrap	400,000
Stahlwerk Bous GmbH	Production	EF steelmaking process	Cast ingots, blooms and billets	Yes	Scrap	300,000
Buderus Guss GmbH	Processing	Iron foundry	Cast iron: car brake discs	Yes	Scrap	260,000

Details of capacity/output	Recycled content	No. employees	German state	Location	Post-code	Street address and number	IED	URL
Crude steel	100 %	700	Thuringia	Unterwellenborn	07333	Kronacher Str. 6	2.2	www.stahlwerk-thueringen.de
Crude steel		670	Brandenburg	Hennigsdorf	16761	Wolfgang-Küntscher-Straße 18	2.2	www.rivastahl.com
Crude steel		425	Saxony	Riesa	01591	Gröbaer Straße 3	2.2	www.feralpigroup.com
Steel, 2 wire rod lines with 600,000 t/a each		800	Saarland	Neunkirchen	66538	Zum Eisenwerk 1		www.saarstahl.de
Crude steel (2020)		767	North Rhine-Westphalia	Duisburg	47137	Vohwinkelstrasse 107		www.duisburg.arcelormittal.com
Steel	87 %	1,275	Lower Saxony	Georgsmarienhütte	49124	Neue Hüttenstraße 1	2.2	www.gmh-gruppe.de
Steel	100 %	260	Lower Saxony	Lingen	49811	Niederdarmer Straße 5	2.2	www.benteler-steeltube.com
Residues from the iron and steel industry	> 98 %	300	North Rhine-Westphalia	Duisburg	47053	Werthauser Str. 182	2.1, 2.2	www.dk-duisburg.de
500,000 t		1,700	North Rhine-Westphalia	Witten	58452	Auestr. 4	2.2	www.dew-stahl.com
Castings (4 sites)	100 %	2,800	Hesse	Stadtallendorf	35260	Albert-Schweitzer Straße 15	2.4	www.fritzwinter.de
Castings (4 sites)	100 %	165	Hesse	Laubach	35321	Bürgelweg 1		www.fritzwinter.de
Steel (2019)		1,200	North Rhine-Westphalia	Siegen	57078	Obere Kaiserstraße	2.2	www.dew-stahl.com
Steel		330	Saarland	Bous	66359	Saarstr. 5	2.2	www.gmh-gruppe.de
Melting capacity		610	Hesse	Breidenbach	35236	Buderusstraße 26		www.buderus-guss.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Buderus Edelstahl GmbH	Production	EF steelmaking process	Tool steel, hot- and cold-dipped galvanised steel strips, engineering steel, open die forgings, rolled semi-finished products	Yes	Scrap steel	257,000
BBS Bayerische Bewehrungs-stahl GmbH	Processing	Forming	Structural steel, structural steel mesh, reinforcing steel	Yes	Scrap steel	220,000
BGH Edelstahl Siegen GmbH (Stahlwerk Eintracht)	Production	EF steelmaking process	Stainless steel: steel bars	Yes	Scrap	200,000
BGH Edelstahl Freital GmbH	Production	EF steelmaking process	Stainless steel: cast ingots, wire rod, steel bars, high-speed steel, nickel-based alloys	Yes	Scrap steel	200,000
Eisenwerk Brühl GmbH	Processing	Iron foundry	Cast iron, production of cast-iron engine blocks and cylinder heads	Yes		197,000
Gienanth GmbH	Processing	Iron foundry	Cast iron	Yes	Scrap steel, scrap castings, circulating scrap	197,000
FONDIUM Singen GmbH	Processing	Iron foundry	Ductile iron	Yes	Secondary raw materials	190,000
Fondium Mettmann GmbH ehemals GF Casting (Georg Fischer)	Processing	Iron foundry	Ductile iron	Yes	Secondary raw materials	180,000
Daimler AG Mercedes Benz Werk Mannheim Eisengießer	Processing	Iron foundry	Commercial vehicle castings	Yes	Industrial stampings, cupola furnace scrap (steel beams, iron sections), own circulating scrap	172,000
SLR Gießerei GmbH	Processing	Iron, malleable, steel casting	Ductile iron	Yes	Scrap steel and iron	130,000
SLR Elsterheide	Processing	Iron foundry	Ductile iron	Yes	Scrap steel and iron	130,000
Schmiedewerke Gröditz GmbH	Production	Production	Cast ingots, steel bars (forged), seamless rolled rings, tool steels, open die forgings	Yes		125,000
M. Busch GmbH & Co. KG	Processing	Iron foundry	Cast iron: e. g. brake drums, brake discs, flywheels, housings	Yes	Scrap steel, swarf from processing, sprues from casting	116,000
M. Busch GmbH & Co. KG	Processing	Iron foundry	Cast iron: e. g. brake drums, brake discs, flywheels, housings	Yes	Scrap steel, swarf from processing, sprues from casting	116,000
Giesserei HEUNISCH GmbH	Processing	Iron foundry	Cast iron			100,000
Gießerei HEUNISCH, Steinach GmbH	Processing	Iron foundry	Cast iron			100,000
Robert Bosch Lollar Guss GmbH	Processing	Iron foundry	Castings			100,000

Details of capacity/output	Recycled content	No. employees	German state	Location	Postcode	Street address and number	IED	URL
Crude steel		> 400	Hesse	Wetzlar	35576	Dillfeld 40	2.2	www.buderus-steel.com
Rebar products		47	Bavaria	Dinkelscherben	86424	Siefenwanger Strasse 35		www.bayerische-bewehrungs-stahl.de
Steel		650	North Rhine-Westphalia	Siegen	57072	Stumme-Loch-Weg 1	2.2	www.bgh.de
Steel		1,711	Saxony	Freital	01705	Am Stahlwerk 1	2.2	www.bgh.de
Sale of Fe castings		1,520	North Rhine-Westphalia	Brühl	50321	Kölnstr. 262–266	2.4	www.eb-bruehl.com
Liquid iron		590	Rhineland-Palatinate	Eisenberg	67304	Ramsener Str. 1		www.gienanth.com
Fe castings		1,000	Baden-Würtemberg	Singen	78224	Julius-Bührer-Straße 12		www.fondium.eu
Fe castings		1,000	North Rhine-Westphalia	Mettmann	40822	Flurstr. 15–17	2.4	www.fondium.eu
Fe castings		5,130	Baden-Würtemberg	Mannheim	68305	Hanns-Martin-Schleyer-Str. 21–57	2.4	www.mercedes-benz-trucks.com
Scrap steel and iron		700 (group)	Baden-Würtemberg	St. Leon-Rot	68789	Am Bahnhof 16	2.4	www.slr-gruppe.de
Castings (group of companies)		700 (group)	Saxony	Elsterheide	02979	An der Siebanlage 3	2.4	www.slr-gruppe.de
Technical capacity; 85,000 t sales (2015)		700	Saxony	Gröditz	01609	Riesaer Straße 1	2.2	www.gmh-gruppe.de
2021 (Bestwig+Meschede):	< 96 %	500 (group)	North Rhine-Westphalia	Bestwig	59909	Ruhrstraße 1	2.4	www.mbusch.de
2021 (Bestwig+Meschede):	< 96 %	500 (group)	North Rhine-Westphalia	Meschede	59872	Wehrstapeler Straße 12		www.mbusch.de
Castings (group)	95 %	1,200 (group)	Bavaria	Bad Windsheim	91438	Hofmannstr. 25a	2.4	www.heunisch-guss.com
Castings (group)	95 %	1,200 (group)	Thuringia	Steinach	96523	Lauschaer Str. 70		www.heunisch-guss.com
Melting capacity		260	Hesse	Lollar	35457	Justus-Kilian-Str 1	2.4	www.bosch-kundenguss.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Franken Guss GmbH & Co. KG	Processing	Iron foundry	Cast iron	Yes	Stampings	80,000
ACO Eurobar GmbH/ACO Guss GmbH	Processing	Iron foundry	Cast iron	Yes	Scrap	75,000
Sachsen Guss GmbH	Processing	Iron foundry	Cast iron			75,000
MAT Foundries Europe GmbH	Processing	Iron foundry	Ductile iron	Yes		65,000
MAT Foundries Europe GmbH	Processing	Iron foundry	Ductile iron	Yes		65,000
Bergmann Automotive GmbH	Processing	Iron foundry	Cast iron			
Metalltechnik Schmidt GmbH & Co. KG Ferrosad	Processing	Iron, malleable, steel casting	Blasting agents	Yes	New steel scrap	60,000
GF Casting Solutions Leipzig GmbH	Processing	Iron foundry	Castings			60,000
Luitpoldhütte GmbH	Processing	Iron foundry	Castings			60,000
Procast Guss GmbH Nortorfer Gusswerk	Processing	Iron foundry	Grey iron, ductile iron			52,000
Procast Guss GmbH Christopherus-hütte	Processing	Iron foundry	Grey iron, ductile iron			52,000
Procast Guss GmbH	Processing	Iron foundry	Grey iron, ductile iron			52,000
Gienanth Chemnitz Guss	Processing	Iron foundry	Cast iron	Yes	Scrap steel, scrap castings, circulating scrap	50,000
HGZ Gießerei GmbH & Co. KG	Processing	Iron foundry	Grey iron, ductile iron	Yes	Old scrap (reprocessed), new scrap (stampings from sheet metal forming, briquettes from metal swarf	50,000
SHW Auto-motive GmbH	Processing	Iron foundry	Brake discs	Yes	Scrap steel	50,000
Silbitz Group Torgelow GmbH	Processing	Foundry	Castings for off-shore wind power	Yes	Waste metal	50,000
Bosch Rexroth AG Gießerei	Processing	Iron foundry	Cast iron			25,000–50,000 t/a
Düker GmbH & Co. KGaA	Processing	Iron foundry	Cast iron			25,000–50,000
Düker GmbH & Co. KGaA	Processing	Iron foundry	Cast iron			25,000–50,000
Linde Hydraulics GmbH & Co. KG	Processing	Iron foundry	Cast iron			25,000–50,000

Details of capacity/output	Recycled content	No. employees	German state	Location	Postcode	Street address and number	IED	URL
Fe castings		650	Bavaria	Kitzingen	97318	An der Jungfernmühle 1	2.4	www.frankenguss.de
Melting capacity		300	Rhineland-Palatinate	Kaisers-lautern	67663	Am Gusswerk 8	2.2, 2.4	www.aco-eurobar.de
Fe castings		694	Saxony	Chemnitz	09228	Obere Haupt-straße 228–230	2.4	www.sachsenguss.de
Foundry capacity (group)		319	Saarland	Neunkirchen	66539	Am Ochsenwald 2	2.2, 2.4	www.matfoun-drygroup.com
Foundry capacity (group)		700	Mecklenburg-Western Pomerania	Uecker-münde	17373	Eggesiner Straße 11	2.4	www.matfoun-drygroup.com
		220	Lower Saxony	Barsing-hausen	30890	Gießereiweg 17	2.4	www.bergmann-auto.de
Blasting agents		69	Baden-Würtemberg	Filderstadt	70794	Schulstr. 41	2.4	www.ferrosad.com
Productive capacity		255	Saxony	Leipzig	04249	Georg-Fischer-Str. 2	2.4	www.gfcs.com
Fe castings		380	Bavaria	Amberg	92224	Sulzbacher Str. 121	2.4	www.luitpoldhuette.de
Castings (group)		360 (group)	Schleswig-Holstein	Nortorf	24589	Gießereiweg 17	2.4	www.proca.st
Castings (group)		360 (group)	North Rhine-Westphalia	Gütersloh	33330	Brockhäger Str. 217	2.4	www.proca.st
Castings (group)		360 (group)	Baden-Würtemberg	Saulgau	88348	Josef-Bautz-Str. 6	2.4	www.proca.st
Liquid iron		392	Saxony	Chemnitz	09113	Schönherr-straße 8		www.gienanth.com
Fe castings	approx. 96 %	500	Lower Saxony	Zorge	37449	Walkenrieder Str. 32	2.4	www.gmh-gruppe.de
Scrap steel		450	Baden-Würtemberg	Tuttlingen	78532	Ludwigstal	2.4	www.shw.de
Productive capacity		300	Mecklenburg-Western Pomerania	Torgelow	17358	Borkenstraße 15a	2.4	www.silbitz-group.com
Productive capacity		460	Bavaria	Lohr am Main	97816	Zum Eisen-gießer 1	2.4	www.boschrexroth.de
Productive capacity		200	Bavaria	Karlstadt	97753	Würzburger Str. 10	2.4	www.dueker.de
Productive capacity		300	Bavaria	Laufach	63846	Hauptstr. 39–41	2.4	www.dueker.de
Productive capacity		1,400 (4 plants)	Bavaria	Aschaffen-burg	63741	Wailandtstraße 13		www.linde-hydraulics.com

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Ortrander Eisenhütte GmbH	Processing	Iron foundry	Cast iron			25,000–50,000
Walzengießerei Coswig GmbH (DIHAG)	Processing	Iron and steel foundry	Cast iron, cast steel			40,000
VDM Metals GmbH	Production	EF steelmaking process	Nickel materials, special stainless steels, blocks, slabs			40,000
MEUSELWITZ GUSS Eisen-gießerei GmbH (DIHAG)	Processing	Iron, malleable, steel casting	Cast iron			35,000
WESO-Aurorahütte GmbH	Processing	Iron foundry	Cast iron	Yes	Scrap metal	33,000
Neckar Drahtwerke GmbH	Processing	Forming	PE-coated wire netting, heavy galvanised wire netting, grilles, standard galvanised steel wire, heavy galvanised steel wire, annealed steel wire, barbed wire, PE wire, multi wire, types supplied: wires, screed mesh, radiator grills, spiral gabion mesh	Yes	Scrap steel	30,000
Eisengiesserei Baumgarte GmbH	Processing	Iron foundry	Cast iron			30,000
Miele & Cie. KG	Processing	Iron foundry	Cast iron	Yes	Crude iron waste, stampings, foundry waste	30,000
Gontermann-Peipers GmbH Werk Hain	Processing	Iron and steel foundry	Castings			
Römheld & Moelle Eisengießerei GmbH	Processing	Iron foundry	Cast iron	Yes	Rails, swarf from machining or stampings	29,000
Gontermann-Peipers GmbH Werk Kaan-Marienborn	Processing	Iron and steel foundry	Rolled products			
Silbitz Guss GmbH	Processing	Iron and steel foundry	Cast steel, cast stainless steel and cast iron applications	Yes		25,000
ZGG – Zeitzer Guss GmbH	Processing	Iron foundry	Castings for off-shore wind power	Yes	Waste metal	25,000
Isselburg Guss und Bearbei-tung GmbH	Processing	Iron foundry	Cast iron			25,000
Josef Brechmann GmbH & Co. KG	Processing	Iron foundry	Cast iron	Yes	Waste iron moulds	10,001–25,000
Vulcast Germany GmbH	Processing	Iron foundry	Cast iron			10,001–25,000

Details of capacity/output	Recycled content	No. employees	German state	Location	Postcode	Street address and number	IED	URL
Productive capacity		> 250	Brandenburg	Ortrand	01990	Königsbrücker Straße 10–12	2.4	www.ortrander.de
Castings capacity		260	Saxony	Coswig	01640	Grenzstraße 1	2.4	www.walze-coswig.de
Supply volume		1,838 (group)	North Rhine-Westphalia	Unna	59425	Formerstraße 17	2.2	www.vdm-metals.com
Productive capacity		320	Thuringia	Meuselwitz	04610	Luckaer Landstraße	2.4	www.meuselwitz-guss.de
Good castings (2021)		> 400	Hesse	Gladenbach	35075	Aurorahütte 1	2.4	www.weso.de
Steel products		138	Baden-Würtemberg	Eberbach	64412	Friedrichsdorfer Landstraße 54–58		www.neckardraht.de
Max. capacity		202	North Rhine-Westphalia	Bielefeld	33647	Duisburger Str. 35	2.4	www.eisengiesserei-baumgarte.de
Fe castings	99 %	6,800	North Rhine-Westphalia	Gütersloh	33332	Carl-Miele-Str. 29	2.4	www.miele.de
		547 (group)	North Rhine-Westphalia	Siegen	57074	Marienborner Straße 49		www.gontermann-peipers.de
Fe castings	90 %	140	Rhineland-Palatinate	Mainz	55120	Rheinallee 92	2.4	www.roemheld-moelle.de
		547 (group)	North Rhine-Westphalia	Siegen	57074	Hauptstraße 20	2.4	www.gontermann-peipers.de
Fe castings		430	Thuringia	Silbitz	07613	Dr.-Maruschky-str. 2	2.2, 2.4	www.silbitz-group.com
Fe castings		165	Saxony-Anhalt	Zeitz	06712	Naumburger Straße 52		www.silbitz-group.com
Level of production		250	North Rhine-Westphalia	Isselburg	46419	Minervastr. 1	2.4	www.ihi.de
Productive capacity		200	North Rhine-Westphalia	Schloß Holte-Stukenbrock	33758	Hauptstr. 37–39	2.4	www.brechmann-guss.de
Productive capacity		200	Rhineland-Palatinate	Jünkerath	54584	Gewerkschafts-straße 1	2.4	www.vulcast.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Jürgens Gießerei GmbH & Co. KG	Processing	Iron foundry	Cast iron	Yes		10,001–25,000
MAN Truck & Bus AG	Processing	Iron foundry	Cast iron	Yes	Swarf and scrap	10,001–25,000
Schmiede-berger Gießerei GmbH (DIHAG)	Processing	Iron foundry	Cast iron			10,001–25,000
Duktil Guss Fürstenwalde GmbH	Processing	Iron foundry	Cast iron			10,001–25,000
Georg Röth Eisengießerei GmbH & Co. KG	Processing	Iron, malleable, steel casting	Cast iron			10,001–25,000
Keulahütte GmbH	Processing	Iron foundry	Cast iron			10,001–25,000
Koenig & Bauer Gießerei GmbH	Processing	Iron foundry	Cast iron			10,001–25,000
M. Jürgensen GmbH & Co. KG	Processing	Iron foundry	Cast iron			10,001–25,000
MAN Energy Solutions SE	Processing	Iron foundry	Cast iron			10,001–25,000
Lintorfer Eisen-gießerei GmbH (DIHAG)	Processing	Iron foundry	Cast iron			24,000
EMG Casting AG	Processing	Iron foundry	Grey iron, ductile iron	Yes	Stampings	20,000
Fronberg Guss GmbH	Processing	Iron foundry	Cast iron	Yes	Scrap steel, scrap castings, circulating scrap	18,500
Kemptener Eisengiesserei Adam Hönig AG	Processing	Iron foundry	Cast iron	Yes	Stamping and own circulating scrap (e. g. waste from runner system)	15,000
Dossmann GmbH Eisen-gießerei und Modellbau	Processing	Iron, malleable, steel casting	Iron, malleable, steel casting	Yes	Scrap castings, scrap metal	15,000
Eickhoff Gießerei GmbH	Processing	Iron and steel foundry	Cast iron, cast steel			15,000
Gießerei Lößnitz GmbH	Processing	Iron foundry	Grey iron, ductile iron			14,000
Stahl- und Hartgußwerk Bösdorf GmbH (DIHAG)	Processing	Iron and steel foundry	Cast steel			14,000
Reinhard Tweer GmbH Gießerei	Processing	Iron foundry	Cast steel, ductile iron			13,800
Stahlwerke Bochum GmbH	Processing	Steel foundry	Castings e. g. for shredder hammers	Yes	Scrap iron and steel	13,500

Details of capacity/output	Recycled content	No. employees	German state	Location	Postcode	Street address and number	IED	URL
Productive capacity	97 %	–	North Rhine-Westphalia	Emsdetten	48282	Lönsstraße 15	2.4	www.juergens.net
Productive capacity		3,789	Bavaria	Nürnberg	90441	Vogelweiherstr. 33	2.2, 2.4	www.man-truckandbus.com
Productive capacity		270	Saxony	Dippoldis-walde	01744	Altenberger Str. 59a	2.4	www.schmie-guss.de
Productive capacity		300	Brandenburg	Fürsten-walde	15517	Saarower Chaussee 34		www.duktil-guss.de
Productive capacity		128	Baden-Würtemberg	Mosbach	74821	Bahnhofstr. 6	2.4	www.roeth-guss.de
Productive capacity		272	Saxony	Krauschwitz	02957	Geschwister-Scholl-Str. 15	2.4	www.keula.world
Productive capacity		130	Bavaria	Würzburg	97080	Friedrich-Koenig-Str. 4	2.4	www.giesserei.koenig-bauer.com
Productive capacity		280	Schleswig-Holstein	Sörup	24966	Markschell 3	2.4	www.m-juergensen.de
Productive capacity		4,000	Bavaria	Augsburg (Deutsch-land/Germany)	86153	Stadtbachstr. 1	2.4	www.man-dieselturbo.com
Fe castings		76	North Rhine-Westphalia	Ratingen	40885	Rehhecke 83–87	2.4	www.lintorfereg.de
Fe castings	25–30 %	133	Bavaria	Wald-kraiburg	84478	Teplitzer Str. 22	2.4	www.emg-casting.de
Liquid iron		160	Bavaria	Schwandorf	92421	Maximilian-straße 13		www.gienanth.com
Liquid iron	50–75 %	170	Bavaria	Kempten	87435	Adam-Hönig-Straße 1	2.4	www.ke-ag.de
Fe castings	90 %	175	Baden-Würtemberg	Walldürn-Rippberg	74731	Amorbacher 43	2.4	www.dossmann.de
Fe castings		200	North Rhine-Westphalia	Bochum	44789	Am Eickhoff-park 1	2.4	www.eickhoff-bochum.de
Good castings		85	Saxony	Lößnitz	08294	Rudolf-Weber-Straße 89	2.4	www.giesserei-loessnitz.de
Cast steel parts		200	Saxony	Leipzig	04249	Werkstraße 7	2.4	www.shb-guss.de
Good castings		264	North Rhine-Westphalia	Bielefeld	33689	Krackser Str. 191	2.4	www.tweer.de
Cast steel	75–90 %	135	North Rhine-Westphalia	Bochum	44791	Castroper Str. 228	2.4	www.stahlwerke-bochum.com

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Ferrotec GmbH	Processing	Iron foundry	Grey iron	(Yes)	Circulating scrap	13,000
Josef Schonlau Maschinen-fabrik u. Eisengießerei GmbH & Co. KG	Processing	Iron foundry	Cast iron	Yes	High-quality scrap, swarf, sprues	12,500
Gießerei Elsterberg GmbH	Processing	Iron foundry	Castings			12,000
Bartz-Werke GmbH	Processing	Iron foundry	Cast iron			12,000
Eisengiesserei Dhonau GmbH & Co. KG	Processing	Iron foundry	Ductile iron	Yes	Scrap steel and copper granulate (shredded copper wire)	11,000
Siegfried Jacob Metallwerke GmbH & Co. KG	Production	Hydro- and pyrometallurgical processes		Yes	Scrap, swarf, residues, slurry and solutions, industrial residues and production waste containing non-Fe metal	10,000
FOCAST Lüneburg GmbH	Processing	Iron foundry	Cast iron, small batches			9,000
MEIKO Eisengießerei GmbH	Processing	Iron foundry	Ductile iron	Yes	70 % secondary raw materials, 30 % circulating scrap	7,200
VS GmbH & Co. KG	Processing	Iron foundry	Malleable iron, grey iron	Yes	Stampings	7,200
Friedr. Lohmann GmbH Edel-stahlgießerei Annen	Processing	Iron foundry	Castings from own manual moulding facility, moulding machines, automatic moulding facility and shell-moulding facility	Yes	Scrap, sorted scrap and sheet metal waste, shredded scrap	4,500
Otto Junker GmbH	Processing	Stainless steel foundry	Cast steel materials, cobalt-based alloys			3,500
Sande Stahl-guss GmbH	Processing	Steel foundry	Cast steel parts	Yes	Circulating scrap from casting and metal processing	3,500
NRU GmbH	Processing	Casting	Cobalt alloys, steel, nick-el-based alloys, cast iron, aluminium-based alloys, titanium, Titanium-based alloys, zinc, zinc-based alloys, copper, copper-based alloys			1,501–3,500
Esterer Gießerei GmbH	Processing	Iron foundry	Grey iron, ductile iron	Yes	Circulating scrap	3,000
Edelstahlwerke Schmees GmbH	Processing	Stainless steel foundry	Stainless steel	Yes	Scrap, trimmings and stampings	3,000
BFG Feinguss Niederrhein GmbH	Processing	Casting	Superalloys (e. g. Ni-based)			1,500
Gießerei Wurzen GmbH	Processing	Iron foundry	Grey iron, ductile iron	Yes	Secondary raw material	1,300

Details of capacity/output	Recycled content	No. employees	German state	Location	Post-code	Street address and number	IED	URL
Liquid iron		43	Lower Saxony	Gifhorn	38518	Eyßelheideweg 12	2.2, 2.4	www.ferrotec-gifhorn.de
Fe castings	90 %	170	North Rhine-Westphalia	Geseke	59590	Ernst-von-Bayern-Str. 22	2.4	www.schonlau-werke.de
Fe castings		92	Saxony	Elsterberg	07985	Greizer Straße 14–16	2.4	www.giesserei-elsterberg.de
Fe castings		215	Saarland	Dillingen	66763	Franz-Meguin-Straße 14–16	2.2, 2.4	www.bartz-werke.de
Fe castings	10–25 %	60	Baden-Württemberg	Triberg im Schwarzwald	78098	Schonachbach 7	2.4	www.dhonau.de
Annual capacity	100 %	300; 1,000 (group)	North Rhine-Westphalia	Ennepetal	58256	Jacobstraße 41–45		www.jacob-metall.de
Finished goods		130	Lower Saxony	Lüneburg	21337	Gebrüder-Heyn-Str. 1	2.4	www.focastluneburg.com
Fe castings 600 t/month	70 % secondary iron, 30 % from own cycle	60	Baden-Württemberg	Ettenheim	77955	Mühlenweg 31	2.4	www.meiko-guss.de
Of which 5,800 t/a recycled scrap steel	75–90 %	160	North Rhine-Westphalia	Solingen	42719	Parallelstr. 17	2.4	www.vsguss.de
Stainless steel		350 (2 plants)	North Rhine-Westphalia	Witten-Annen	58454	Brauckstr. 37		www.lohmann-stahl.de
Fe castings		450	North Rhine-Westphalia	Simmerath	52152	Jägerhausstraße 22	2.4	www.otto-junker.com
Cast steel		200	Lower Saxony	Sande	26452	Gießereistr. 32	2.4	www.sande-stahlguss.de
Cast steel		30	Saxony	Neukirchen	09221	Südstraße 3		www.nru-gmbh.de
Productive capacity		75	Bavaria	Altötting	84503	Estererstraße 12		www.esterer-giesserei.de
Fe castings		> 180	Saxony	Pirna	01796	Basteistraße 60	2.4	www.schmees.com
Fe castings		190	North Rhine-Westphalia	Moers	47441	Am Schürmannshütt 11		www.bfg-feinguss.de
Fe castings		26	Saxony	Wurzen	04808	Dresdener Straße 40		www.giesserei-wurzen.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
SCHMEES cast Langenfeld GmbH	Processing	Stainless steel foundry	Stainless steel	Yes	Scrap stainless steel and steel, procurement of master alloys from scrape merchants	1,200
Nippes & Schmidt GmbH & Co. KG	Processing	Stainless steel foundry	Stainless steel castings, cobalt-based alloys, nickel-based alloys	Yes	Circulating scrap, purchased scrap stainless steel grades	570
AB-GUSStech GmbH	Processing	Iron foundry	Castings for core-intensive hydraulics components, drive and valve technology			
ALBERT HOFFMANN GMBH	Processing	Steel foundry	Pattern shop, moulding shop, smelting operation, grinding shop, heat treatment, machining shop, quality inspection			
Bischoff Stahl- und Edelstahlguss GmbH	Processing	Stainless steel and steel foundry				
Böhmer Gusstechnik GmbH & Co. KG	Processing	Stainless steel and steel foundry	Cast steel, cast stainless steel	Yes	Scrap, circulating scrap	
Carolinenhütte GmbH	Processing	Iron foundry				
Daimler AG Untertürkheim Werkteil Mettingen	Processing	Foundry	Drive axle production			
Dörrenberg Edelstahl GmbH	Production	EF steelmaking process	Forging and rolling ingots	Yes	Scrap	
Eisen- und Stahlguss Dessau GmbH	Processing	Iron and steel foundry	Grey iron, ductile iron and cast steel			
Eisengießerei Dinklage GmbH	Processing	Iron, malleable, steel casting	Counterweights for forklifts, construction machinery and cranes			
Eisengiesserei Theodor Schultz GmbH & Co.	Processing	Iron foundry	Grey iron, ductile iron			
Eisenwerk Arnstadt GmbH (DIHAG)	Processing	Iron foundry	Grey iron, ductile iron	Yes	Ferrous materials	
Eisenwerk Erla GmbH	Processing	Iron foundry	Cast iron			
Eisenwerk Hasenclever & Sohn GmbH	Processing	Iron and steel foundry	Cast steel, cast iron			
Eisenwerk Martinlamitz GmbH	Processing	Iron foundry	Grey iron, ductile iron			
Friedr. Lohmann GmbH Stammwerk, Stahlwerk Herbede	Production	Induction melting furnace, VD/VOD plant, rolling mill	Cast ingots for plate mill, steel bars	Yes	Presorted scrap	

	Details of capacity/output	Recycled content	No. employees	German state	Location	Postcode	Street address and number	IED	URL
	Fe castings	~ 90 %	> 100	North Rhine-Westphalia	Langenfeld	40764	Rudolf-Diesel-Weg 6–8		www.schmees.com
	Melting capacity, 300 t sold castings	75–90 %	23	North Rhine-Westphalia	Solingen	42719	Itterstraße 17		www.nippes-schmidt.de
			149	Bavaria	Aschaffenburg	63743	Schweinheimer Straße 34	2.4	www.ab-gusstech.com
			230	North Rhine-Westphalia	Eschweiler	52249	Bergrather Straße 66–70	2.4	www.albert-hoffmann.de
			50	North Rhine-Westphalia	Lüdinghausen	59348	Seppenrader Str. 23–25	2.4	www.bischoff-guss.com
			353	North Rhine-Westphalia	Witten	58453	Annenstr. 79	2.4	www.boehmer-guss.de
			70	Bavaria	Kallmünz	93183	Carolinenhütte 1	2.4	www.carolinen-huette.de
			18,500 (whole plant)	Baden-Württemberg	Esslingen am Neckar	73733	Emil-Kessler-Str. 1–32	2.4	www.group.mercedes-benz.com
			>500 (group)	North Rhine-Westphalia	Engelskirchen	51766	Hammerweg 7	2.4	www.doerrenberg.de
			37	Saxony-Anhalt	Dessau	06842	Thomas-Müntzer-Straße 42	2.4	www.sg-dessau.de
			132	Lower Saxony	Dinklage	49413	In der Bahler Heide 5	2.4	www.eisen-giesserei-dinklage.de
			45	North Rhine-Westphalia	Warendorf	48231	Daimlerstraße 3	2.4	www.eisen-giesserei-schultz.de
			100	Thuringia	Arnstadt	99310	Bierweg 4	2.4	www.ewa-guss.de
			400	Saxony	Schwarzenberg/Erzgeb.	08340	Gießereistraße 1	2.4	www.eisenwerk-erla.de
			650	Hesse	Battenberg (Eder)	35088	Auhammer 1	2.4	www.hasenclever.com
			298	Bavaria	Schwarzenbach a. d. Saale	95126	Eisenwerk 2	2.4	www.ewm-martinlamitz.de
			350 (2 plants)	North Rhine-Westphalia	Witten	58456	Ruhrtal 2	2.2	www.lohmann-stahl.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Friedrich Wilhelms-Hütte Eisen-guss GmbH	Processing	Iron and steel foundry	Cast steel			
Giesserei Schmidt GmbH & Co. KG	Processing	Iron foundry	Grey iron, ductile iron			
GZO Guss-Zentrum-Ost-friesland GmbH	Processing	Iron foundry	Cast-iron parts for wind energy plants			
Harzer Werke Motorentechnik GmbH	Processing	Iron foundry	Centrifugal castings, cylinder liners, anti-polish rings			
Heger Ferrit GmbH	Processing	Iron foundry	Mould castings			
Heger Guss	Processing	Iron foundry	Mould castings			
Heinrich Meier Eisengießerei GmbH & Co. KG	Processing	Iron foundry	Castings, e.g. for drainage technology			
Hundhausen Casting GmbH	Processing	Iron foundry	Iron castings			
Hüttenwerke Königsbronn GmbH	Processing	Iron foundry	Rollers			
innoCast GmbH	Processing	Iron foundry	Grey iron, ductile iron			
Ischebeck GmbH, Friedr.	Processing	Iron foundry	Cast iron			
Karl Buch Walzengießerei GmbH & Co. KG	Processing	Roll casthouse	Rollers			
Kind & Co Edelstahlwerk GmbH & Co. KG Standort Wiehl	Production	Melting plant (steel remelting), vacuum induction treatment, ladle treatment, crucible induction furnace, substi-tute induction furnace, Vacuum induction degas-sing (VID) plant	Tool steels			
Klaus Kuhn Edelstahl-gießerei GmbH	Processing	Stainless steel foundry	Stainless steel casting, centrifugal casting, bi-metal casting			
Ludwig Frischhut GmbH & Co. KG	Processing	Iron foundry	Cast iron			
Olsberg GmbH	Processing	Iron foundry	Castings			
Olsberg Königshütte GmbH & Co. KG	Processing	Iron foundry	Castings, heating systems industry			

Details of capacity/output	Recycled content	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
		205	North Rhine-Westphalia	Mülheim	45473	Friedrich-Ebert-Str. 125	2.4	www.fwh.de
		50	Lower Saxony	Cuxhaven	27472	Neue Industrie-strasse 4		www.giesserei-schmidt.de
		190	Lower Saxony	Südbrook-merland	26624	Gewerbestraße 56	2.4	www.enercon.de
		45	Saxony-Anhalt	Blanken-burg (Harz)	38889	Michaelsteiner Straße 29	2.2, 2.4	www. harzerwerke.de
		270 (4 plants)	Rhineland-Palatinate	Sembach	67681	Junkerstr. 4	2.4	www. heger-gruppe.de
		270 (4 plants)	Rhineland-Palatinate	Enkenbach	67677	Donnersberg-straße 48		www. heger-gruppe.de
		350 (3 plants)	North Rhine-Westphalia	Rahden	32369	Auf der Welle 5–7	2.4	www. meierguss.de
		380	North Rhine-Westphalia	Schwerte	58239	Ostendamm 23	2.4	www.beinbauer-group.de
		90	Baden-Württemberg	Königs-bronn	89551	Heidenheimer Str. 1	2.4	www. hwk1365.de
		44	North Rhine-Westphalia	Langenfeld	40764	Haus-Gravener-Straße 191–193		www.innocast.de
		170 (D)	North Rhine-Westphalia	Ennepetal	58256	Loher Str. 31–79	2.4	www. ischebeck.de
		103	North Rhine-Westphalia	Siegen	57076	Auf den Hütten 7	2.4	www.karlbuch.de
		510	North Rhine-Westphalia	Wiehl	51674	Bielsteiner Str. 128	2.2, 2.4	www.kind-co.de
		170	North Rhine-Westphalia	Radevorm-wald	42477	Otto-Hahn-Str. 12–14	2.2	www.kuhn-edelstahl.de
		150	Bavaria	Neumarkt-Sankt Veit	84494	Ludwig-Ganghofer-Str. 7	2.4	www. frischhut.de
		260 (3 plants)	North Rhine-Westphalia	Olsberg	59939	Hüttenstraße 38		www. olsberg.com
		260 (3 plants)	Saxony-Anhalt	Oberharz am Brocken	38875	Schulstr. 1	2.2, 2.4	www. olsberg.com

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Pleissner Guss GmbH	Processing	Iron and steel foundry	Cast steel			
Hermann Reckers GmbH + Co. KG	Processing	Iron foundry	Castings			
Saint-Gobain PAM Deutsch-land GmbH	Processing	Iron foundry	Pipes	Yes	Secondary raw material	
Schmidt + Clemens GmbH + Co. KG	Processing	Stainless steel foundry	Stainless steel casting, centrifugal casting, mould casting, precision casting	Yes	e. g. take-back of stainless steel components	
Schmolz + Bickenbach Guss GmbH Werk Krefeld	Processing	Stainless steel foundry	Stainless steel			
TechnoGuss GmbH	Processing	Iron foundry	Cast iron			
Tenneco Federal-Mogul Burscheid GmbH vormals Goetze GmbH	Processing	Foundry	Kolbenringe			
Gebr. Tigges GmbH & Co. KG	Processing	Iron foundry	Grey iron, ductile iron			
Vulkan Inox GmbH	Processing	Steel foundry	Blasting agents	Yes	Secondary raw materials	
Walzen Irle GmbH	Processing	Iron and steel foundry	Rollers, castings			
Walzengießerei & Hartgußwerk Quedlinburg GmbH	Processing	Iron foundry	Rolling mills for metallurgy, roller rings, roller shells, pistons			
Wilh. Stolle GmbH	Processing	Iron foundry	Castings			

Details of capacity/output	Recycled content	No. employees	German state	Location	Post-code	Street address and number	IED	URL
		300	Lower Saxony	Herzberg	37412	Duderstädter Str. 17	2.4	www.gmh-gruppe.de
		300	North Rhine-Westphalia	Rheine	48432	Dille 9	2.4	www.reckers.eu
		100	Saarland	Saarbrücken	66130	Saarbrücker-straße 51	2.2, 2.4	www.pamline.de
		619	North Rhine-Westphalia	Lindlar	51789	Kaiserau 2	2.2	www.schmidt-clemens.de
		171	North Rhine-Westphalia	Krefeld	47803	Hülser Str. 810	2.4	www.sbguss.de
		140	Saxony-Anhalt	Tangerhütte	39517	Rudi-Arndt-Straße 15	2.2, 2.4	www.technoguss.de
		1,800	North Rhine-Westphalia	Burscheid	51399	Montanusstr. 13	2.4	www.tenneco.com
		90	North Rhine-Westphalia	Oelde	59302	Oelder Str. 6	2.4	www.tigges.com
		64	North Rhine-Westphalia	Hattingen	45525	Gottwaldstr. 21	2.4	www.vulkan-inox.de
		263	North Rhine-Westphalia	Netphen	57250	Waldstraße 52	2.4	www.walzenirle.com
		125	Saxony-Anhalt	Quedlinburg	06484	Klopstockweg 33	2.2, 2.4	www.walzengiesserei-quedlinburg.de
		109	North Rhine-Westphalia	Bonn	53227	Broichstr. 78–90	2.4	www.stolle.net

Copper

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Wieland-Werke AG	Processing	Casting, rolling	Semi-finished copper products (rolled products, pipes, bars)	Yes	Millberry copper, granulates, scrap alloys	714,000
Aurubis AG – Standort Hamburg	Production	Remelting: Primary smelter East and North plants, copper electrolysis	Cathodes, wire rod, continuous casting formats, precious metals	Yes	E-waste, waste copper	480,000
KME Germany GmbH	Processing	Copper melting plant with refinery and foundry	Sheet metal, discs, strips made from copper, brass, bronze, copper-nickel and other alloys and conductive materials	Yes	Scrap metal	385,000
KME Mansfeld GmbH (Alt: Mansfelder Kupfer und Messing GmbH)	Processing	Production site	Sheet metal, discs, strips, pipes made from copper, brass, bronze, copper-nickel and other alloys and conductive materials	Yes	Scrap metal	385,000
Diehl Metall/ Diehl Metall Stiftung & Co. KG	Processing	Remelting plant	Semi-finished brass products	Yes	Scrap copper, brass, zinc, granulates, swarf from machining, Sn scrap	
Aurubis AG – Standort Lünen	Production	Remelting: Secondary copper smelter	Anodes, cathodes, iron silicate sand and by-products	Yes	E-waste, scrap copper, alloy scrap, PCBs, industrial residues, lead slurry, filter dust	220,000
Schwermetall Halbzeugwerk GmbH & Co. KG	Processing	Melting and casting furnaces, continuous casting plants, milling, rolling and cutting plants	Pre-rolled copper and copper alloy strips	Yes	Millberry copper	200,000
Nickelhütte Aue GmbH	Production	Melting plant, production of non-ferrous crude metals, pyro- and hydrometallurgy	Concentrates (Cu, Zn, Co, V, Mb, Ni, W); Ingot alloys (Al, Cu), metals and metal alloys (Al, Cu, Pb, Zn, Sn, Ni, Co, W, Ti), precious metals, chemicals	Yes	Catalysts (recycling scheme with manufacturers of catalysts), sludge, filter cake, dust, ash, salt, acids and solutions from surface engineering and metal processing, nickel plating sludge and residues from metal processing, and batteries and used catalysts, e. g. from the food, petrochemical and chemical industries	3,000
Siegfried Jacob Metallwerke GmbH & Co. KG	Production	Hydro- and pyrometallurgical processes	Electrode copper, copper alloys, copper master alloys	Yes	Scrap, swarf, residues, slurry and solutions, industrial residues and production waste containing non-Fe metal	80,000

	Details of capacity/ output	Recycled content	Other metals	No. em- ployees	German state	Location	Post- code	Street address and number	IED	URL
	Sale of copper products	76 %		1,200	Baden-Württem-berg	Ulm	89079	Graf-Arco-Str. 36		www. wieland.com
	Copper output	45 % group average	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth, antimony	2,600	Hamburg	Hamburg	20539	Hovestraße 50	2.5(a)	www. aurubis.com
	Copper products (group)	56 %		1,000, 3,959 (group)	Lower Saxony	Osnabrück	49074	Klosterstraße 29	2.5(b)	www.kme.com
	Copper products (group)	56 %		1,700, 3,959 (group)	Saxony-Anhalt	Hettstedt	06333	Lichtlöcherberg 40		www.kme.com
			Copper, tin	2,821	Bavaria	Röthen-bach a. d. Pegnitz	90552	Heinrich-Diehl-Straße 9		www.diehl.com
	Copper cathode production Lünen	85 %	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth	660	North Rhine-West-phalia	Lünen	44532	Kupferstrasse 23	2.5(a)	www. aurubis.com
	Output of copper products	35 %		300	North Rhine-West-phalia	Stolberg	52223	Breiniger Berg 165		www. schwermetall. de
	Copper content in 12,000 t scrap	> 95 %	Titanium, hafnium, tantalum, tungsten, nickel, cobalt, molybdenum, niobium, vanadium, chromium, alumin-ium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE	> 400	Saxony	Aue-Bad Schlema	08280	Rudolf-Breit-scheid-Straße 65–75	2.5(a)	www.nickel-huette-aue.de
	Annual capacity	100 %	Titanium, hafnium, tantalum, tungsten, nickel, cobalt, niobium, vanadium, chromium, aluminium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE, bismuth	300; 1,000 (group)	North Rhine-West-phalia	Ennepetal	58256	Jacobstraße 41–45		www. jacob-metall.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Wieland Recycling/ Metall-schmelzwerk Ulm GmbH	Production and processing	Rotary furnaces, continuous casting, melting of non-ferrous metals >= 4 t/d (Pb/Cd) or >= 20 t/d	Cast copper alloys, continuous aluminium bronze castings, Ecocast (lead-free)	Yes	Copper scrap and residues, small quantities of secondary tin from waste gunmetal	13,000
Otto Fuchs Dülken GmbH & Co. KG	Processing	Forging, extrusion, ring rolling, additive manufacturing	Bars, sections, pipes made from copper, brass, bronze, other copper alloys	Yes	Own circulating scrap, granulates	
Berkenhoff GmbH Werk Kinzenbach	Processing	Casting, rolling, drawing, annealing and galvanising	Wire rod from copper, brass, bronze, nickel silver, copper-nickel, copper alloys, conductive material	Yes	Take-back system for wire rod materials planned	11,000
Berkenhoff GmbH Werk Merkenbach	Processing	Casting, rolling, drawing, annealing and galvanising	Wire rod from copper, brass, bronze, nickel silver, copper-nickel, copper alloys, conductive material	Yes	Take-back system for wire rod materials planned	11,000
F. W. Hempel Legierungs-metall GmbH & Co. KG	Production	Remelting	Alloy blocks	Yes	(Production waste)	12,000
Franz Hillebrand KG	Production	Metal smelting, crucible induction furnace	Copper-zinc base alloys: Fine-grained brass, low-lead and lead-free brass, dezincification resistant brass, special brass alloys, aluminium bronzes	Yes	Circulating scrap and residues from customers' production process, foundry dross, metal buying	8,000
ECKA Granules Germany GmbH/ Kymera	Processing	Melt spinning	Non-Fe metal powder from copper and copper alloys, aluminium and aluminium alloys and zinc	Yes	Copper granulates	3,500
Heinrich Schneider NE-Metall-urgie GmbH	Production	Crucible induction furnace	Copper alloys, copper master alloys	Yes	Customers' production waste (scrap, dross, swarf), secondary raw materials from metal trade	
HME Brass Germany GmbH	Processing	Copper melting plant with refinery and foundry	Brass products	Yes	Scrap metal/ Granulate	
Sundwiger Messingwerk GmbH	Processing	Strip casting, rolling mills	Wire rod, sheets, strips etc. made from copper, brass, bronze, nickel silver and other copper alloys	Yes	Production waste, stampings	

	Details of capacity/output	Recycled content	Other metals	No. employees	German state	Location	Postcode	Street address and number	IED	URL
	Sale of copper products	100 %	Tin	49	Baden-Württemberg	Ulm	89079	Daimlerstraße 20	2.5(b)	www.wieland.com
				500	North Rhine-Westphalia	Viersen	41751	Heiligenstraße 70		www.otto-fuchs-duelken.de
	Productive capacity (together with Merkenbach)			385 (2 plants)	Hesse	Heuchelheim	35452	Berkenhoffstr. 14		www.bedra.com
	Productive capacity (together with Kinzenbach)			385 (2 plants)	Hesse	Herborn	35745	Rehmühle 1		www.bedra.com
	Alloys	> 90 %		33	North Rhine-Westphalia	Oberhausen	46149	Erlenstraße 71		www.legierungs-metall.de
	Ingot metal	90–93 %		20	North Rhine-Westphalia	Wilnsdorf	57234	Essener Straße 4		www.franz-hillebrand.com
	Annual use of metal	75–90 %		80	Bavaria	Velden	91235	Eckastr. 1	2.5(b)	www.kymera-international.com
				40	North Rhine-Westphalia	Olpe	57489	Im Öhlchen 20		www.schneider-ne-metallurgie.de
				292	Berlin	Berlin	13509	Miraustr. 10–14		www.hmemetal.com
		90 %		300 (2 plants)	North Rhine-Westphalia	Hemer	58675	Hönnetalstraße 110		www.sundwiger-mw.com

Magnesium

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Magontec GmbH	Production and processing	Magnesium melting and casting	Mg special alloys	Yes	Standard and special alloys	18,000
Andreas Stihl AG & Co. KG Magnesium Druckguss	Production and processing	Melting and casting	Magnesium ingots from foundry	Yes	End-of-life magnesium parts, circulating scrap	4,500
Speira GmbH	Production and processing	Melting plant for magnesium	Liquid metal, RSIs, cast ingots	Yes	Scrap magnesium	2,992
Magnesium Solutions Europe GmbH	Production	Reprocessing of metal swarf	Briquettes	Yes	Metal swarf	
Magrec Recycling GmbH	Trade	Deoiling and briquetting	Assembled waste	Yes	Magnesium swarf	
Speira GmbH	Production and processing	Melting and rolling		Yes	Scrap magnesium	

Details of capacity/ output	Recycled content	Other metals	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
Productive capacity magnesium	40–70 %		83	North Rhine-West-phalia	Bottrop	46240	Industriestr. 61	2.5(b)	www. magontec. com
Capacity of melting plant	25–50 %		900	Rhineland-Palatinate	Weinsheim	54595	Andreas-Stihl-Straße 3		www. magnesium. stihl.de
Magnesium products	> 90 %	Aluminium	2,992	Bavaria	Töging a. Inn	84513	Aluminiumstr. 8	2.5(b)	www.speira. com
		Aluminium, iron		Thuringia	Sonders-hausen	99706	Am Förderturm 1		www.mse-recycling.de
			4	Thuringia	Föritztal	96524	Steinräum 3		www. magrec.de
		Aluminium	1,850	North Rhine-West-phalia	Grevenboich	41515	Aluminiumstr. 1		www. speira.com

Multi-metal

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Aurubis AG – Standort Hamburg	Production	Remelting: Primary smelter East and North plants, copper electrolysis	Cathodes, wire rod, continuous casting formats, precious metals	Yes	E-waste, waste copper	500,000
Aurubis AG – Standort Lünen	Production	Remelting: Secondary copper smelter	Anodes, cathodes, iron silicate sand and by-products	Yes	E-waste, scrap copper, alloy scrap, PCBs, industrial residues, lead slurry, filter dust	230,000
Siegfried Jacob Metall-werke GmbH & Co. KG	Production	Hydro- and pyrometallurgical processes	Different metals and metal alloys	Yes	Industrial residues and production waste	130,000
Nickelhütte Aue GmbH	Production	Pyro- and hydrometallurgical processes	Concentrates (Cu, Zn, Co, V, Mb, Ni, W); Ingot alloys (Al, Cu), metals and metal alloys (Al, Cu, Pb, Zn, Sn, Ni, Co, W, Ti), precious metals, chemicals	Yes	Catalysts (recycling scheme with manufactur-ers of catalysts), sludge, filter cake, dust, ash, salt, acids and solutions from surface engineering and metal processing, nickel plating sludge and residues from metal processing, and batteries and used catalysts, e. g. from the food, petrochemical and chemical industries	95,000
SOLAR MATERIALS GmbH	Processing	Physical and chemical recycling	Secondary metal resources for reprocessing (Si, Al, Ag, Cu)	Yes	Solar panels	9,200
VITAL PURE METAL SOLUTIONS GmbH	Production and processing	Hydro- and pyrometallurgical processes	Pure metals and metal compounds (Ge, Ga, In, Te, Bi, Se, Co, Cu, Cd, Sb, As, Sn, Pb)	Yes	Filter cake, sludge, waste water flows, filters slag, ash, swarf	10–12 t
Buss & Buss Spezialmetalle GmbH	Production and processing	Metal recycling (mechanical, thermal and chemical)	Metals (round blanks, ingots, chunks, pellets, powder...)	Yes	New and contaminated scrap, powders, dewatered sludge, swarf, encrustations, furnace condensate, slag	
First Solar Recycling GmbH	Production	Recycling	Cd/Te resources for further recovery	Yes	Solar panels	

Details of capacity/output	Recycled content	Publication	Other metals	No. employees	German state	Location	Post-code	Street address and number	IED	URL
Copper products (main product)	45 % group average	Data are from published reports and not site-specific	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth, antimony	2,600	Hamburg	Hamburg	20539	Hovestraße 50	2.5(a)	www.aurubis.com
Copper cathode production Lünen (main product)	0,85	Data are from published reports and not site-specific	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth	660	North Rhine-Westphalia	Lünen	44532	Kupferstrasse 23	2.5(a)	www.aurubis.com
Secondary raw materials	1	Annual capacity from website	Titanium, hafnium, tantalum, tungsten, nickel, cobalt, niobium, vanadium, chromium, aluminium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE, bismuth	300, 1,000 (group)	North Rhine-Westphalia	Ennepetal	58256	Jacobstraße 41–45		www.jacob-metall.de
Secondary raw materials	> 95 %	Annual capacity from website, recycled content from Mr Sommer; release for publication of recycled content requested	Titanium, hafnium, tantalum, tungsten, nickel, cobalt, molybdenum, niobium, vanadium, chromium, aluminium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE	> 400	Saxony	Aue-Bad Schlema	08280	Rudolf-Breitscheid-Straße 65–75	2.5(a)	www.nickelhuette-aue.de
2 plants, each with a capacity of 4,600 t solar panels	1	Release for publication requested	Aluminium, copper, silicon, silver	3 (Start-up)	Saxony-Anhalt	Magdeburg	39114	Paul-Ecke-Straße 4		www.solar-materials.com
Gallium capacity			Gallium, cobalt, copper, tin, lead, germanium, indium, tellurium, bismuth, antimony, selenium, cadmium	26	Lower Saxony	Langelsheim	38685	Am Bahnhof 1		www.vital-pms.de
			Zirconium, hafnium, tantalum, niobium, rhenium, gallium, germanium	23	Mecklenburg-Western Pomerania	Sagard	18551	Sassnitzer Straße 10		www.buss-spezial-metalle.de
			Cadmium, tellurium	16	Brandenburg	Frankfurt (Oder)	15236	Marie-Curie-Straße 3		www.firstsolar.com

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Freiberger Compound Materials	Processing	Synthesis, crystal growth, machining, final cleaning	Semi-insulating and semiconducting gallium arsenide substrates (wafers)	Yes		
GfE Metalle und Materialien GmbH	Processing	Melting, casting	Titanium aluminide ingots, TiAl semi-finished products, sheets, powders	Yes	TiAl circulating scrap	
LuxChemtech GmbH	Production	Recycling, remelting	Semi-finished products and alloys	Yes	Solar panels	
MFG Metall- und Ferro-legierungs-gesellschaft mbH	Trade, processing	Production of alloy briquettes	Cupola furnace briquettes, alloys	(Yes)		
RW silicium GmbH, Werk Pocking	Production	Electric arc furnace	Metallurgical silicon	No		
SiC Processing (Deutschland) GmbH	Production	Recycling	Ready-to-use SiC slurry	Yes	Used slurry from wafer production	
SilverTeam Recycling GmbH	Production	Recycling	Precious metal semi-finished products	Yes	Precious metal scrap, CuBe materials, NiBe materials	

Details of capacity/ output	Recy-cled content	Publication	Other metals	No. em-ployees	German state	Location	Post-code	Street ad-dress and number	IED	URL
	30–70 %	Recycling content from website	Gallium,	350	Saxony	Freiberg	09599	Am Junger-Löwe-Schacht 5		www.freiberger.com
			Titanium, vanadium, chromium,	346; 500 (group)	Bavaria	Nürnberg	90431	Höfener Str. 45	2.5(a)	www.gfe.com
			Indium, tellurium, silicon, silver	17	Saxony	Freiberg	09599	Alfred-Lange-Straße 18		www.lc-freiberg.de
			Silicon	23	North Rhine-Westphalia	Meer-busch	40670	Rudolf-Diesel-Str. 9		www.mfg-germany.org
			Silicon	120	Bavaria	Pocking	94060	Wöhlerstr. 30	2.5(a)	www.silicium.de
			Silicon	7	Saxony	Bautzen	02625	Neuteich-nitzer Straße 46		www.sic-processing-bautzen.de
			Beryllium	9	Bavaria	Sulzberg See	87477	Gewerbe-park 27		www.silverteam-recycling.com

Multi-metal batteries

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
ACCUREC-Recycling GmbH	Production	Recycling (pyrolysis)	Nickel-iron concentrates, nickel-cobalt concentrates	Yes	Rechargeable batteries (e. g. NiCd or NiMH batteries), lithium-ion batteries (LIBs) from consumer electronics and from electric vehicle batteries (e. g. NiCd or NiMH batteries)	60,000
Li-Cycle Germany GmbH	Production	Mechanical process	Black mass	Yes	Li-ion batteries	30,000
BASF Schwarzheide GmbH	Production	Mechanical and hydrometallurgical reprocessing	Cathode material	Yes	Black mass	15,000
Redux GmbH	Production	Discharging, disassembly, thermal pretreatment, mechanical reprocessing	Active mass, iron, copper, aluminium	Yes	Li-ion, alkaline, zinc-carbon or NiMH batteries	10,000
Redux GmbH	Production	Discharging, disassembly, thermal pretreatment, mechanical reprocessing	Active mass, iron, copper, aluminium	Yes	Li-ion, alkaline, zinc-carbon or NiMH batteries	10,000
EMR	Production	Discharging, disassembly			Li-ion batteries	10,000
Roth International GmbH	Production	Discharging, disassembly			Li-ion batteries	9,000
Nickelhütte Aue GmbH	Production	Melting plant, production of non-ferrous crude metals	Concentrates (Cu, Zn, Co, V, Mb, Ni, W); Ingot alloys (Al, Cu), metals and metal alloys (Al, Cu, Pb, Zn, Sn, Ni, Co, W, Ti), precious metals, chemicals	Yes	Li/NiMH batteries from the automotive industry	10,000
ACCUREC-Recycling GmbH	Production	Recycling (pyrolysis)	Nickel-iron concentrates	Yes	Batteries (e.g. NiCd and NiMH)	4,000
Primobius GmbH	Production	Mechanical and hydrometallurgical reprocessing		Yes	Li-ion batteries	3,650
ECOBAT Solutions Europa GmbH (Promesa)	Production	Mechanical process		Yes	Li-ion batteries	3,200
Duesenfeld GmbH	Production	Shredding, hydrometal-lurgical processing of the black mass	Fe and Non-Fe metals, electrolytes, black mass	Yes	Li battery systems	3,000
Fortum Batte-rie Recycling GmbH	Production	Mechanical reprocessing, hydrometallurgy	Metal concentrates	Yes	Li-ion batteries	3,000

Details of capacity/ output	Recycled content	Other metals	No. employees	German state	Location	Post-code	Street address and number	IED	URL
Battery intake capacity, of which 3,000 t Li-ion batteries	100 % (recycling process)	Nickel, cadmium	71	North Rhine-Westphalia	Krefeld	47809	Bataverstr. 21		www. accurec.de
Li-ion battery intake capacity	100 % (recycling process)			Saxony-Anhalt	Sülzetal	39171	Lange Göhren 4		www. li-cycle.com
Li-ion battery intake capacity	100 % (recycling process)		2,087	Brandenburg	Schwarzheide	01986	Schipkauer Strasse 1		www. basf.com
Li-ion battery intake capacity (2 plants)	100 % (recycling process)		74 (2 plants)	Hesse	Offenbach	63073	Carl-Legien-Str. 15		www. redux-recycling. com
Li-ion battery intake capacity (2 plants)	100 % (recycling process)		74 (2 plants)	Bremen	Bremerhaven	27568	Batteriestraße 94		www. redux-recycling. com
	100 % (recycling process)			Hamburg	Hamburg	22113	Borsigstrasse 1		www.emr-group.com
Li-ion battery intake capacity	100 % (recycling process)		–	Bavaria	Wernberg-Köblitz	92533			www.roth-international. de
Li-ion battery input capacity with 95,000 t of secondary raw materials	> 95 %	Titanium, hafnium, tantalum, tungsten, nickel, cobalt, molybdenum, niobium, vanadium, chromium, aluminium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE	> 400	Saxony	Aue-Bad Schlema	08280	Rudolf-Breitscheid-Straße 65–75	2.5(a)	www. nickelhuette-aue.de
Initial throughput lithium-ion batteries	100 % (recycling process)		74 (2 plants)	North Rhine-Westphalia	Mülheim an der Ruhr	45472	Wiehagen 12–14		www. accurec.de
Productive capacity (10 t/ day)	100 % (recycling process)		–	North Rhine-Westphalia	Hilchenbachen	57271	Wiesenstraße 30		www. primobius. com
Approved capacity	100 % (recycling process)		20	Saxony-Anhalt	Hettstedt	03476	Gewerbering 16		www. ecobat.com
Li-ion battery input capacity	100 % (recycling process)	Lithium, cobalt, nickel, manganese	45	Lower Saxony	Wendeburg	38176	Rothbergstraße 8		www. duesenfeld. com
Li-ion battery input capacity	1	Lithium, cobalt, nickel, manganese		Baden-Württemberg	Kirchardt	74912	Industriestrasse 48		www. fortum.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Mercedes/ Primobius	Production			Yes	Li-ion batteries	2,500
Volkswagen AG	Production	Mechanical processes	Black mass, aluminium, copper	Yes	Li-Ion batteries from EV of the VW group	1,500
Lars Walch GmbH & Co. KG	Production				Li-ion batteries, mainly cathode foil	1,000
Erlos Produktion und Montagen GmbH	Production	Storage, discharging, disassembly, partly automated opening and stripping of the cells, hydrometallurgical processing	Separate powders from anode and NMC cathode masses	Yes	Li-ion NMC batteries (from automotive batteries); processing of single or pouch cells	950
Stena Recycling GmbH	Production			Yes	Li-ion batteries	350
Aurubis AG – Standort Hamburg	Production	Mechanical reprocessing, hydrometallurgy	Metal concentrates	Yes	Li-ion batteries, black mass	100
REELEMENTS GmbH	Production	Shock wave technology		Yes	Aged and defective Li-ion batteries from any area of application	

Details of capacity/ output	Recycled content	Other metals	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
Li-ion battery input capacity	100 % (recycling process)		50	Baden-Württem-berg	Kuppenheim	76456	Mercedes-Straße 1		www.mercedes-benz.de
Li-ion battery input capacity	100 % (recycling process)	Lithium, cobalt, nickel, manganese	6,500	Lower Saxony	Salzgitter	38239	Industriestraße N		www.volkswagen.com
Li-ion battery input capacity	100 % (recycling process)		14	Bavaria	Baudenbach	91460	Raiffeisen-straße 24		www.walch-recycling.de
Li-ion battery input capacity	100 % (recycling process)		–	Saxony	Zwickau	08056	Reichenbacher Str. 67		www.wphgroup.de
Li-ion battery input capacity				Lower Saxony	Wangerland	26434	Fuhlrieger Allee 1A		www.stena-recycling.com
Li-ion battery input capacity	1	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth, antimony	2,600	Hamburg	Hamburg	20539	Hovestraße 50	2.5(a)	www.aurubis.com
	100 % (recycling process)		14	Saxony	Radebeul	01445	Wilhelm-Eichler-Straße 34		www.reelements.com

Nickel

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
CRONIMET Envirotec GmbH	Recycling	Recycling	Nickel briquettes	Yes	Grinding sludge (metal processing + cooling lubricants), dry grindings, used blasting agents, grinding dust, filter dust (metal processing/metal production), furnace filter dust, slag, mill scale, ultrafine swarf, filter cake, industrial sludge containing metal, catalysts, battery residues and other residues containing metal	50,000
VDM Metals GmbH	Processing	EF steelmaking plant: melting plant, electric arc furnace, ladle furnace …	Nickel alloys and superalloyed special stainless steels	Yes		40,000
Siegfried Jacob Metallwerke GmbH & Co. KG	Production	Hydro- and pyrometallurgical processes	Different metals and metal alloys	Yes	Industrial residues and production waste	15,000
VACUUMSCHMELZE GmbH & Co. KG	Processing	Remelting	Nickel alloys	Yes	Only Mo and Ti; own scrap sorted	5,000
Aurubis AG – Standort Lünen	Production	Remelting: Secondary copper smelter	Nickel sulphate	Yes	E-waste, scrap copper, alloy scrap, PCBs, industrial residues, lead slurry, filter dust	3,863
Nickelhütte Aue GmbH	Production and processing	Melting plant, production of non-ferrous crude metals	Concentrates (Cu, Zn, Co, V, Mb, Ni, W); Ingot alloys (Al, Cu), metals and metal alloys (Al, Cu, Pb, Zn, Sn, Ni, Co, W, Ti), precious metals, chemicals	Yes	Catalysts (recycling scheme with manufacturers of catalysts), sludge, filter cake, dust, ash, salt, acids and solutions from surface engineering and metal processing, nickel plating sludge and residues from metal processing, and batteries and used catalysts, e. g. from the food, petrochemical and chemical industries	5,000
Aurubis AG – Standort Hamburg	Production	Remelting: Primary smelter East and North plants, copper electrolysis	Nickel sulphate	Yes	E-waste, waste copper	3,863

Details of capacity/ output	Recycled content	Other metals	No. em- ployees	German state	Location	Post- code	Street address and number	IED	URL
Nickel products	100 %		21	Saxony-Anhalt	Bitterfeld-Wolfen	06749	Säurestraße 3		www.cronimet-envirotec.com
Supply volume			2,000 (group)	North Rhine-Westphalia	Unna	59425	Formerstraße 17	2.2	www.vdm-metals.com
Annual capacity		Titanium, hafnium, tantalum, tungsten, nickel, cobalt, niobium, vanadium, chromium, aluminium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE, bismuth	300; 1,000 (group)	North Rhine-Westphalia	Ennepetal	58256	Jacobstraße 41–45		www.jacob-metall.de
Alloys	< 2 %		3,100 (4,300 group)	Hesse	Hanau	63450	Grüner Weg 37		www.vacuum-schmelze.de
Nickel content	45 % group average	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth	660	North Rhine-Westphalia	Lünen	44532	Kupferstrasse 23	2.5(a)	www.aurubis.com
Nickel content	> 95 %	Titanium, hafnium, tantalum, tungsten, nickel, cobalt, molybdenum, niobium, vanadium, chromium, aluminium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE	> 400	Saxony	Aue-Bad Schlema	08280	Rudolf-Breitscheid-Straße 65–75	2.5(a)	www.nickel-huette-aue.de
Nickel content	0,45	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth, antimony	2,600	Hamburg	Hamburg	20539	Hovestraße 50	2.5(a)	www.aurubis.com

Zinc

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
DK Recycling und Roheisen GmbH	Production	DK process (sintering plant)	Pig iron, zinc concentrate	Yes	Oxidic residues from the iron and steel industry: BOF or oxygen dust, gas sludge and different types of mill scale and used foundry sand	580,000
Nordenhamer Zinkhütte GmbH	Production	Fluidised bed furnace, electrolysis	High-grade zinc, sulphuric acid			164,700
Befesa Steel Services GmbH/Befesa Zinc Duisburg GmbH	Production	Rolling process	Waelz oxide	Yes	Zinc waste, steelmaking dust	87,000
Befesa Zinc Freiberg GmbH	Production	Rolling process	Waelz oxide	Yes	Zinc waste, steelmaking dust	194,000
Nickelhütte Aue GmbH	Processing	Melting plant, production of non-ferrous crude metals	Concentrates (Cu, Zn, Co, V, Mb, Ni, W); Ingot alloys (Al, Cu), metals and metal alloys (Al, Cu, Pb, Zn, Sn, Ni, Co, W, Ti), precious metals, chemicals	Yes	Catalysts (recycling scheme with manufacturers of catalysts), sludge, filter cake, dust, ash, salt, acids and solutions from surface engineering and metal processing, nickel plating sludge and residues from metal processing, and batteries and used catalysts, e. g. from the food, petrochemical and chemical industries	95,000
Harzer Zinkoxide GmbH	Production and processing	New Jersey distillation process	Zinc oxide, zinc dust	Yes	High-grade zinc, scrap zinc, remelted zinc	19,200
Aurubis AG – Standort Lünen	Production	Remelting: Secondary copper smelter	Crude zinc oxide	Yes	E-waste, scrap copper, alloy scrap, PCBs, industrial residues, lead slurry, filter dust	18,000
Grillo-Werke AG Produktionsstätte Duisburg	Production	Zinc melting, casting and forming plant	Finished and semi-finished products made from zinc and its alloys, e. g. anodes, strips, wire rod, powders, ZAMAK® and bars			
Grillo-Zinkoxid GmbH	Production	Melted zinc	Finished and semi-finished products made from zinc and its alloys, e. g. anodes, strips, wire rod, powders, ZAMAK® and bars			
Günther Metall GmbH & Co. KG	Production	Rolling process	High-grade zinc, remelted zinc, zinc aluminium alloys	Yes	Zinc residues, residues from zinc spraying, production residues from the zinc die casting industry, others from the zinc industry and scrap trade	
Harz Oxid GmbH	Production	Rolling process	Waelz oxide	Yes	Zinc dust and residues	

	Details of capacity/ output	Recycled content	Other metals	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
	Residues from the iron and steel industry	> 98 %	Iron	> 300	North Rhine-Westphalia	Duisburg	47053	Werthauser Str. 182	2.1	www.dk-duisburg.de
	Installed productive capacity		Pb-Ag, Cd, Cu	400	Lower Saxony	Nordenham	26954	Johannastraße 1		www.glencore-nordenham.de
	Crude steel dust	1	Fe	31/48	North Rhine-Westphalia	Duisburg	47249	Richard-Seiffert-Straße 1		www.befesa-steel.com
	Crude steel dust	1	Fe	82	Saxony	Freiberg	09599	Alfred-Lange-Straße 10		www.befesa-steel.com
	Secondary raw materials	> 95 %		> 400	Saxony	Aue-Bad Schlema	08280	Rudolf-Breitscheid-Straße 65–75	2.5(a)	www.nickelhuette-aue.de
	Metal resources containing zinc	> 90 %		57	Lower Saxony	Goslar	38644	Landstrasse 93	2.5(b)	www.hzo-europe.eu
	Zn products (group)	45 % group average	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth	660	North Rhine-Westphalia	Lünen	44532	Kupferstrasse 23	2.5(a)	www.aurubis.com
				601 (1,272 group)	North Rhine-Westphalia	Duisburg	47166	Buschstraße 95	2.5(b)	www.grillo.de
					Lower Saxony	Goslar	38644	Halberstädter Str. 17	67	www.grillo.de
				20	Lower Saxony	Goslar	38644	Halberstädter Str. 4	2.5(b)	www.guenther-metall.com
				51	Lower Saxony	Goslar	38642	Hüttenstr. 6		www.harzoxid.com

Tin

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Aurubis AG – Standort Lünen	Production	Remelting: Secondary copper smelter	Tin composite (Pb-Sn alloy)	Yes	E-waste, scrap copper, alloy scrap, PCBs, industrial residues, lead slurry, filter dust	1,700
Feinhütte Halsbrücke GmbH	Production and processing	Tin and lead smelting	Semi-finished products (bars, ingots, anodes, wire rod)	Yes	Metals and scrap containing tin, lead and antimony	2,000
Metallverwer-tungsgesell-schaft mbH	Processing, trade	Sorting, separation and storage	Trade in non-Fe metals	Yes	Non-Fe scrap metal, tin dross	1,000
Siegfried Jacob Metall-werke GmbH & Co. KG	Production		Different metals and metal alloys	Yes	Tin scrap and residues	200
Nickelhütte Aue GmbH	Production and processing	Melting plant, production of non-ferrous crude metals	Concentrates (Cu, Zn, Co, V, Mb, Ni, W); Ingot alloys (Al, Cu), metals and metal alloys (Al, Cu, Pb, Zn, Sn, Ni, Co, W, Ti), precious metals, chemicals	Yes	Catalysts (recycling scheme with manufactur-ers of catalysts), sludge, filter cake, dust, ash, salt, acids and solutions from surface engineering and metal processing, nickel plating sludge and residues from metal processing, and batteries and used catalysts, e.g. from the food, petrochemical and chemical industries	100
MTM Ruhrzinn GmbH	Trade	Assessment, sorting, resale	Tin-copper, Tin-silver-copper etc. for reuse in foundries	Yes	Waste solder, skimmed tin, solder dross, tin oxides, ash from the solder recovery systems, waste strips, copper copper pins, pins, high-grade contacts, chips, plugs and connectors	430
Balver Zinn Josef Jost GmbH & Co. KG	Processing	Foundry for non-Fe metals (zinc, tin)	Tin solder, Sn, SnPb and Zn anodes, wire for flame and arc spraying	Yes	Dross and ash, waste solder, anode residues	
Felder GmbH Löttechnik	Processing	Melting plant for tin solder	Soft solders, hard solders, soldering past, fluxes	Yes	Solder dross and ash, waste solder	
Felder GmbH Recycling	Processing	Melting furnaces for non-Fe metals	Block tin, tin solder, lead (grains), anodes, ingots	Yes	Solder dross and ash, waste solder, skimmed tin	
JL Goslar GmbH & Co. KG	Processing	Rolling process	Tin and tin alloys: olled material, pipes ..., tin granulates, round tin blanks	Yes	Anode recycling programme	

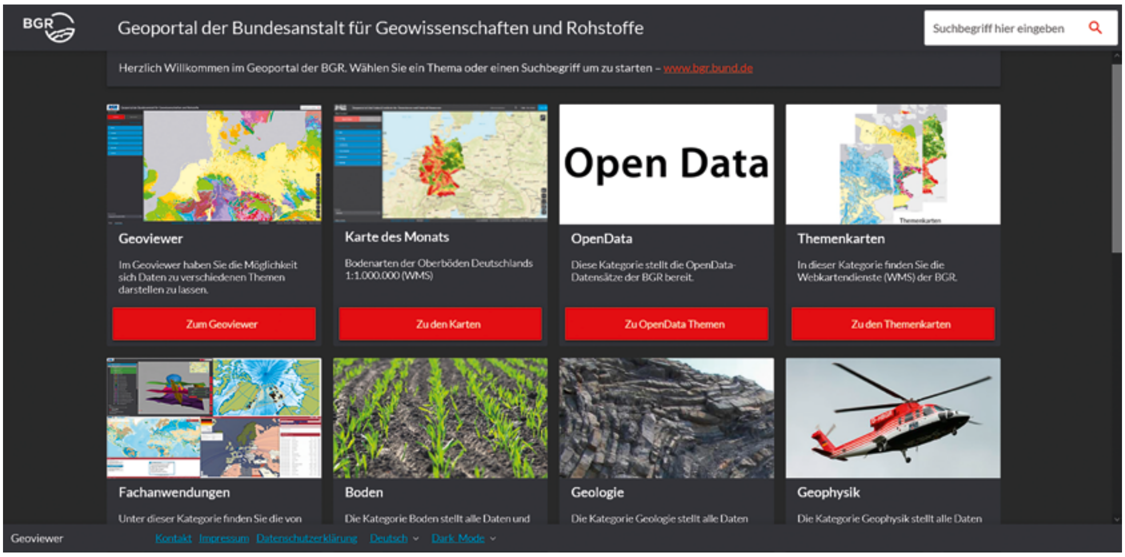
Details of capacity/ output	Recycled content	Other metals	No. em- ployees	German state	Location	Post- code	Street address and number	IED	URL
Tin output (group)	45 % group average	Tin, lead, gold, silver, nickel, zinc, PGM, bismuth	660	North Rhine-Westphalia	Lünen	44532	Kupferstrasse 23	2.5(a)	www.aurubis.com
Annual output	1	Lead, antimony	90	Saxony	Halsbrücke	09633	Krummen-hennersdorfer Straße 2	2.5(a), 2.5(b)	www.feinhuette.de
	100		80	Baden-Würt-temberg	Gottenheim	79288	Buchheimer Str. 9		www.mvgotten-heim.de
Secondary raw materials		Titanium, hafnium, tantalum, tungsten, nickel, cobalt, niobium, vanadium, chromium, alumin-ium, copper, zinc, tin, lead, gallium, germanium, indium, manganese, tellurium, silicon, REE, bismuth	300, 1,000 (Konzern)	North Rhine-Westphalia	Ennepetal	58256	Jacobstraße 41–45		www.jacob-metall.de
Secondary raw materials	> 95 %	Titanium, hafnium, tantalum, tungsten, nickel, cobalt, molybdenum, niobium, vanadium, chromium, alumini-um, copper, zinc, tin, lead, gallium, germanium, indium, manganese, telluri-um, silicon, REE	> 400	Saxony	Aue-Bad Schlema	08280	Rudolf-Breitscheid-Straße 65–75	2.5(a)	www.nickelhuette-aue.de
Waste tin used	100 % (recycling operati-on); 30 % reuse; otherwise recycling		10	North Rhine-Westphalia	Essen	45239	Ruhrtalstraße 19		www.ruhrzinn.com
		Lead, silver, wismuth, copper, nickel, bismuth	100	North Rhine-West-phalia	Balve	58802	Blintroper Weg 11	2.5(b)	www.balverzinn.com
			115	North Rhine-Westphalia	Oberhausen	46047	Im Lipperfeld 11	2.5(b)	www.felder.de
		Lead, antimony, silver, copper	9	Baden-Würt-temberg	Loffenau	76597	Obere Dorfstr. 93		www.felder.de
	99 % raw material recycling rate		> 200	Lower Saxony	Goslar	38640	Im Schleeke 108		www.jlgoslar.de

Company	Production or processing	Process	Product	Use of SRMs Yes/No	SRMs used	Annual capacity or output (t/a)
Zinnrecycling und Metall-handel Ramm / MET-ALLOY Production + Trading GmbH	Processing, trade	Remelting	White and bearing metal ingots, solder and bearing metal master alloy ingots	Yes	Waste (dross, ash, paste) and tin tableware	
Stannol GmbH	Processing	Remelting	Solders and fluxes	Yes	Solder dross, ash and waste solder	
Stannol GmbH	Processing	Remelting	Solders and fluxes	Yes	Solder dross, ash and waste solder	
Wilhelm Grillo Handels-gesellschaft mbH, Duisburg	Trade	Sorting, separation and storage	Trade in non-Fe metals	Yes	Non-Fe scrap metal	

Details of capacity/ output	Recycled content	Other metals	No. em-ployees	German state	Location	Post-code	Street address and number	IED	URL
		Copper, zinc, lead, aluminium, nickel, iron, precious metals	–	Lower Saxony	Hambergen	27729	Ohlenstedter Straße 2		www.zinn-metall.de
			83 (2 plants)	North Rhine-Westphalia	Velbert	42551	Haberstr. 24		www.stannol.de
			83 (2 plants)	Bavaria	Schroben-hausen	86529	Königslachener Weg 18		www.stannol.de
		Zinc, copper, lead, tin, aluminium, nickel	89 (group)	North Rhine-Westphalia	Duisburg	47169	Am Grillopark 5		www.grillohandel.de

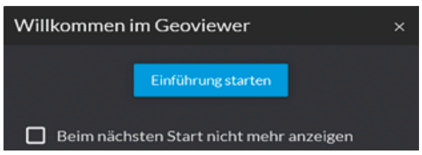
Map of metal recycling sites in Germany on the BGR geoportal – user guide

1. Open your browser and go to "https://geoportal.bgr.de" to start the BGR geoportal web app.

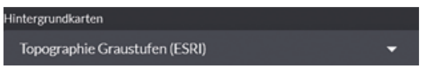


2. Click the "To the Geoviewer" button on the top left tile to open the map viewer.

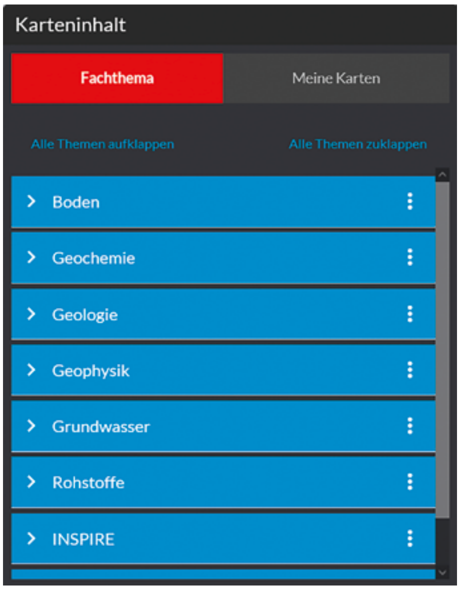
3. In the "Welcome to the Geoviewer" dialogue, click the "Start Intro" button for an introduction or click [✗] to close the dialogue.



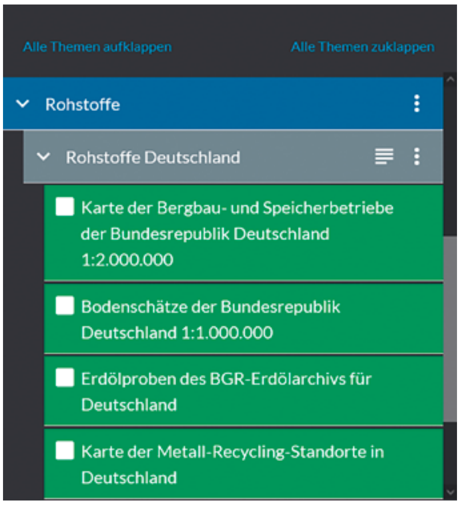
4. In the "Basemaps" drop-down menu, choose a background map. The recycling sites for a metal or group of metals will be displayed on this.



5. On the “Special Topics” tab of the “Map Content” window, click [>] or [:] on the topic “Re-sources” …

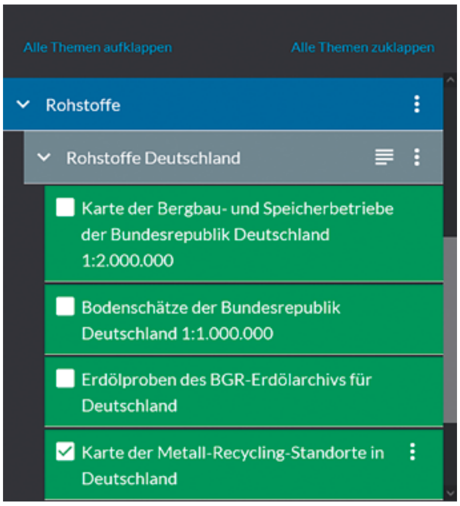


… and expand the regional topic “Resources Germany”.



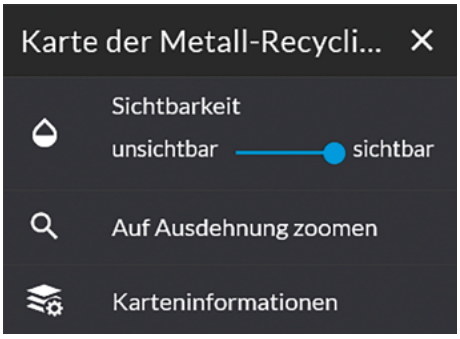
6. Scroll down to the map service “Map of Metals Recycling Locations in Germany” and tick the checkbox [✓] to activate it.

At a smaller scale, the spatial differentiation of the recycling sites and their productive capacities is not helpful.

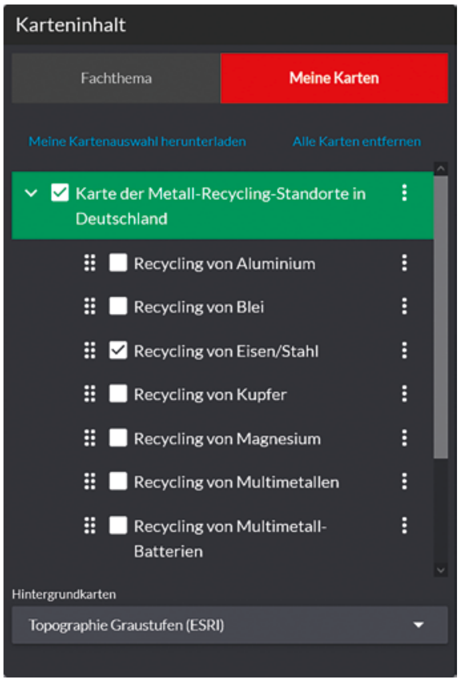


7. Clicking [⋮] on the right lets you …

   7.1. adjust the opacity of the map service;
   7.2. zoom out to display a larger map section;
   7.3. display the map information.



8. In the "Map Content" window, switch to the "My Maps" tab and click [>] to expand the "Map of Metals Recycling Locations in Germany" map service.

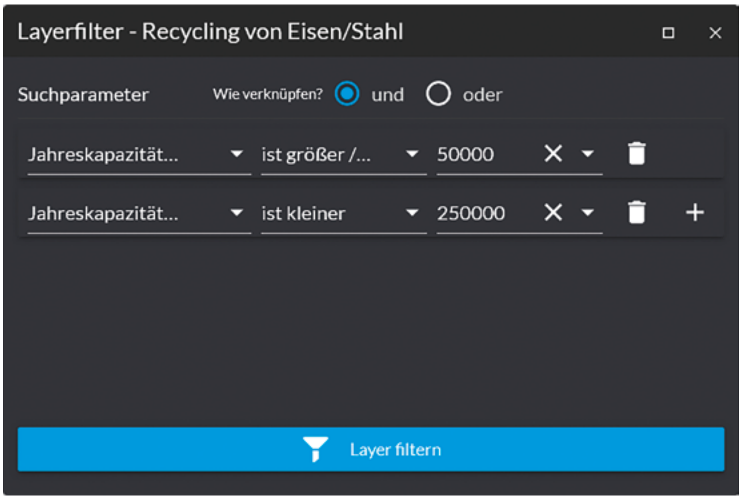


9. Tick the boxes for the recycling locations of the metal or group of metals you are interested in.

10. Clicking [⠿] to the left of an entry lets you change the order of the map layers. Although it is theoretically possible to display the recycling sites for different metals or groups of metals, this was not taken into account in the map generalisation.

11. Clicking [⋮] on the right lets you …

11.1. zoom out to display a complete map layer;
11.2. display the map information;
11.3. in the “Layerfilter” dialogue, define one or more constraints and link them using “and” and “or” to display only recycling sites matching these criteria;



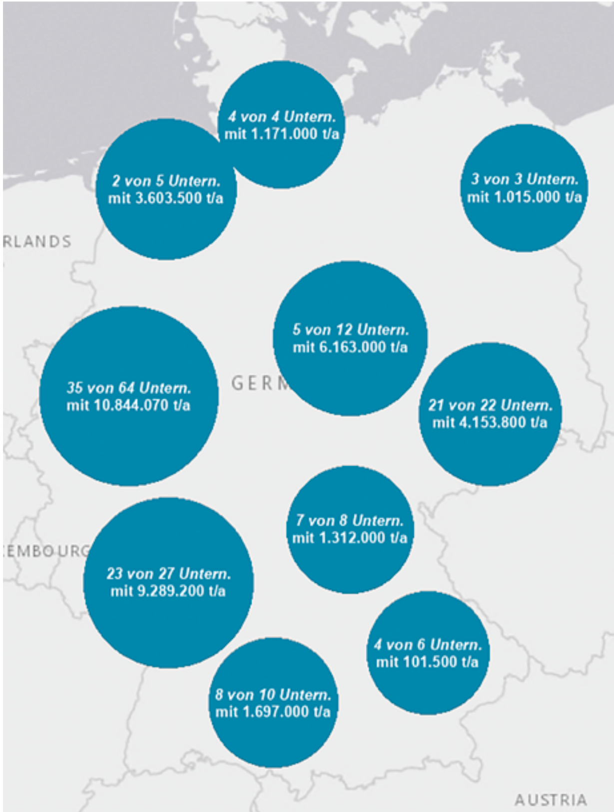
11.4. open the attribute table in the “Result Center” dialogue. This gives details of the company name, number of employees, location, annual capacity, recycled content and a link to the company website. You can also filter these data using search terms.

OBJECTID	Unternehmen	Mitarbeiteranzahl	Standort	Bundesland	Jahreskapazität oder -produktion (t/a)	Bezug Kapazität/Produkti	Recyclinganteil in %	Kommentar zum Recyclinganteil	Link	Kommentar
29	BGH Edelstahl Siegen GmbH (Stahlwerk Eintracht)	650	Siegen	Nordrhein-Westfalen	200000	Stahl			https://www.bgh...	-
30	BGH Edelstahl Freital GmbH	1.711	Freital	Sachsen	200000	Stahl			https://www.bgh...	-
31	Eisenwerk Brühl GmbH	1.520	Brühl	Nordrhein-Westfalen	197000	Fe-Guß-Absatz			https://www.eb-bruehl.com/	-

12. When “Map Content” is selected, an Info button is visible at the top of the toolbar on the right. Click it to open a dialogue with links to fact sheets about the individual recycling sites for each metal or group of metals.

13. The next toolbar button opens the project website for the recycling atlas in a new browser tab.
Here you can find more information about the map service.

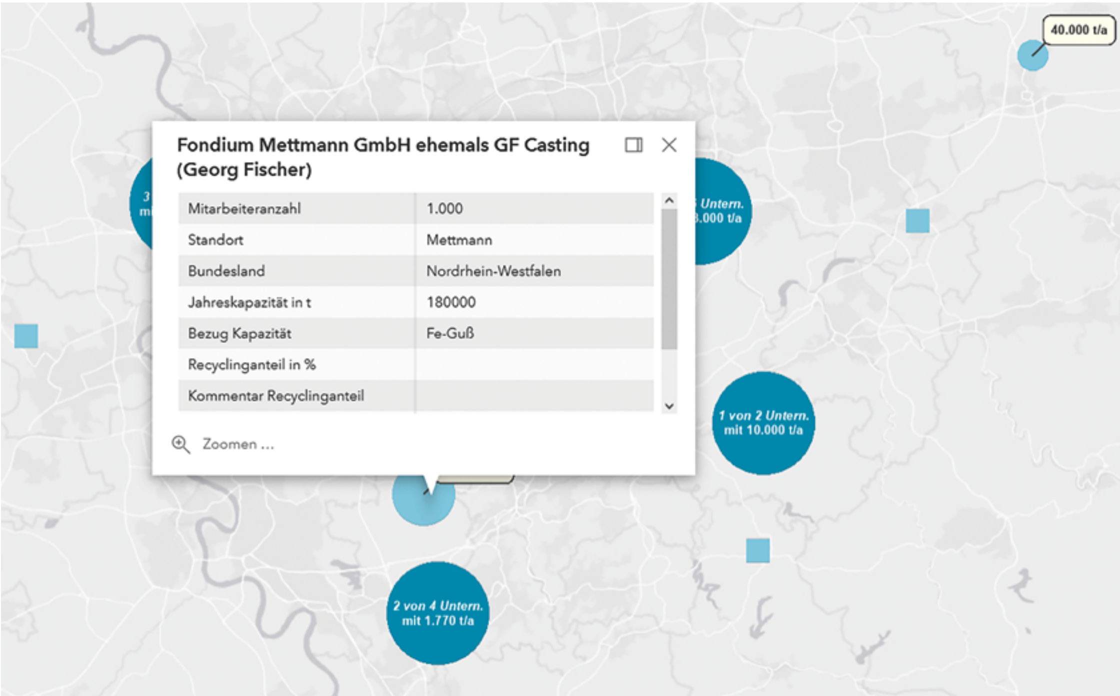
When you select a map layer, the recycling sites for a metal or group of metals in Germany are shown (see item no. 9). At smaller scales (i. e. larger numbers), sites are clustered based on their size and proximity. Several individual sites (light blue) are combined into a site cluster (dark blue), to ensure the map display is not cluttered and there is no overlapping at this scale. The cluster symbols indicate the number of sites in a group and their combined productive capacity.



14. The mouse wheel lets you zoom in and out of the map.
    When you zoom in slowly, the clusters are gradually broken up to display the individual sites at their precise locations.

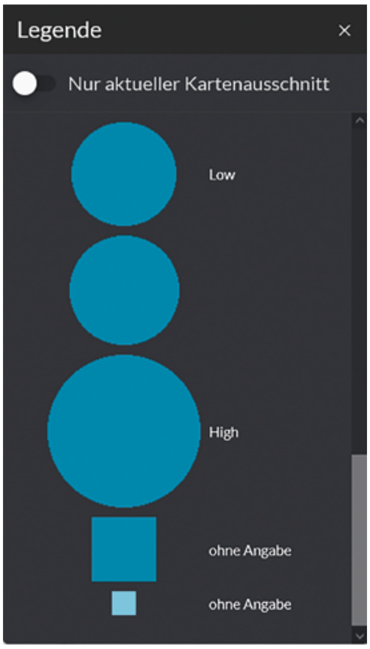
15. Moving the mouse while keeping the left mouse button pressed lets you adjust the visible map section, in this example, to the Ruhr region. When you left-click an individual site, a pop-up dialogue opens, showing the company name, number of employees, location, annual capacity, recycled content and a link to the company website. To open the pop-up dialogue for an individual site, please click the centre of the symbol.

    We regret that pop-up dialogues for clusters are not currently working. Instead, the key information for each cluster is shown in the circular symbol. When you click a cluster, the pop-up dialogues for the individual sites contained in the cluster may open. We are working to fix this bug for the next version of our map service.



16. Click the last button in the toolbar on the right to open the legend for the recycling atlas.

The upper section of the legend shows the symbols for the individual sites, the lower section those for the cluster symbols. Both individual sites and clusters without capacity figures are listed at the end of the legend. Cluster symbols are computed dynamically and are therefore labelled only as "High" and "Low", without indicating absolute class limits.



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