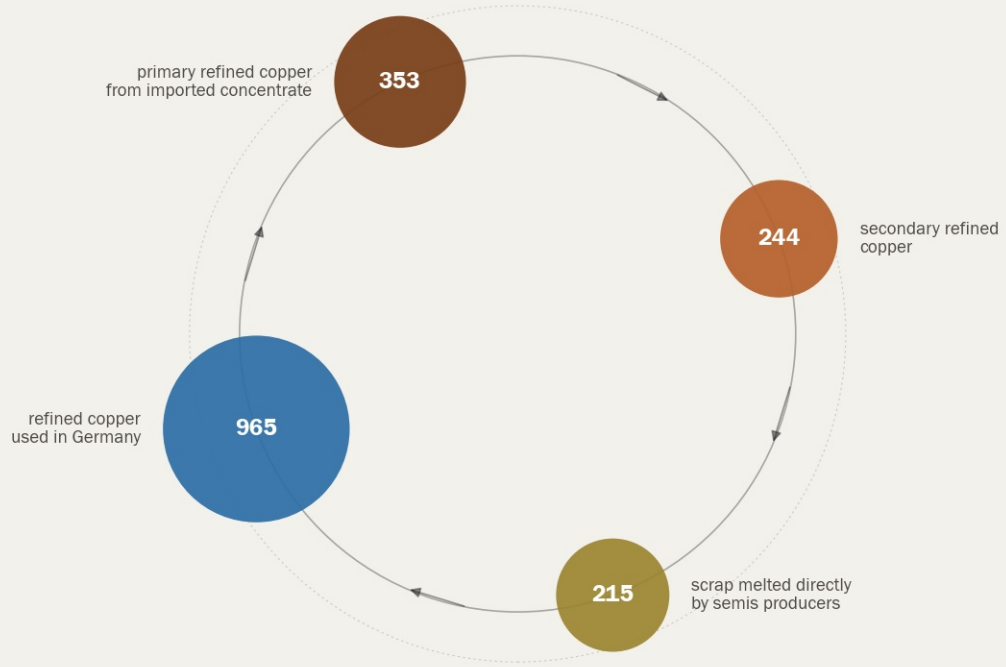
IGMNiR
Economic Chamber of Non-Ferrous Metals and Recycling

Copper in Germany, 2024 (kt Cu; circle area ∝ tonnes)



IGMNIR REPORT · NOVEMBER 2026

Copper in the German economy

Value, circularity and security of supply

An integrated assessment of the copper industry in Germany (CU-DE model)

Base year 2024 · Dynamic stock model 1960–2035 · Transparent, reproducible model

About this report. This report was prepared by the Economic Chamber of Non-Ferrous Metals and Recycling (IGMNiR). It presents CU-DE, an integrated model that estimates the economic, fiscal, environmental and strategic contribution of the copper industry to the German economy – from the collection and trading of copper scrap, through secondary and primary refining, to copper and copper-alloy semis, castings and the copper in wires and cables. A dynamic model of copper in use links the industry to the stock of copper in German buildings, infrastructure and products. The annexes list all parameters and sources; the model code and input data are available from IGMNiR on request. The report was prepared with the support of artificial-intelligence (AI) tools for data processing, modelling and drafting.

Data cut-off: statistics 31 October 2026; legal and policy status 8 November 2026. **Base year:** 2024 (latest year with complete structural business statistics and company accounts; Aurubis financial years ending in September are converted to the calendar year 2024 with weights 0.75 and 0.25); trade data to 2025. **Currency:** EUR, current prices. **Model version:** CU-DE v1.0 (run ID CUDE-1.0-d63adeda8b; random-number seed 20261118, a fixed numeric identifier); the model package – code, input data, scenarios and checks – is archived by IGMNiR. **Suggested citation:** IGMNiR (2026), *Copper in the German economy: value, circularity and security of supply. An integrated assessment of the copper industry in Germany (CU-DE model)*, Economic Chamber of Non-Ferrous Metals and Recycling, November 2026.

How to read the numbers. The report uses three kinds of figures. *Observations* (O) are published statistics and company data – Eurostat structural business statistics, national accounts, PRODCOM and Comext, the copper balance of BGR, the financial and environmental statements of Aurubis AG, the EU emissions trading registry and the recipient lists of the German Emissions Trading Authority (DEHSt). *Estimates* (E) combine observations with allocations or calibrated parameters – the copper shares of scrap trading, castings and cables, the split of the smelters into secondary and primary copper, and copper from scrap melted directly by semis producers. *Model results* (M) depend in addition on counterfactual or dynamic assumptions – supply-chain and induced effects, modelled taxes, the copper stock in use and the scrap it releases, the emissions and other burdens potentially avoided, their valuation and the scenarios. All economic results are gross contributions, not net effects of policy; value added is at basic prices for the smelters and at factor cost for the other segments, and excludes the electricity price compensation received by copper producers, which is shown separately as public support. Taxes combine the income taxes recorded by Aurubis AG with model estimates; they attribute public revenue to the activity and are not a net fiscal balance.

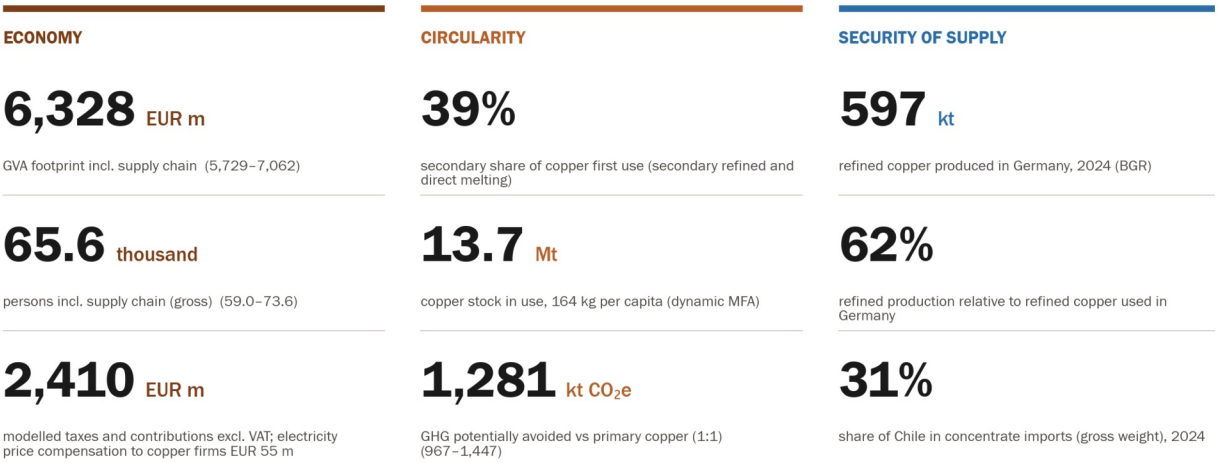
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Key findings

Germany has no copper mine, yet it is the largest user of refined copper in Europe and refines 597 kt of copper a year – 353 kt of primary copper from imported concentrate and anodes and 244 kt from scrap and other secondary materials. Together with about 220 kt of copper from scrap melted directly by semis producers, secondary copper supplied 39% of the copper first used in Germany in 2024.

FIGURE 1 The copper industry in Germany at a glance



Central estimates for 2024; ranges in brackets = P5–P95 of 10,000 Monte Carlo draws. Extended value chain: collection and trade of scrap, secondary and primary refined copper, semis and castings, copper in wires and cables. GHG: conditional, substitution-based estimate, mostly outside Germany. Source: IGMNiR CU-DE v1.0.

SEVEN FINDINGS

- **Value.** The extended copper value chain generated about EUR 4,070 million of gross value added in 2024 and employed about 41,400 people. Including the domestic supply chain the footprint is EUR 6,330 million and about 65,600 jobs (90% band EUR 5,730–7,060 million). Semis and castings (D4) account for 44% of direct value added.
- **Recycling.** The recycling chain – collection and trade of scrap and secondary refining – generated EUR 860 million of direct value added and about 5,800 jobs; EUR 1,550 million with the supply chain. Semis producers that melt scrap directly account for about EUR 340 million in proportion to their scrap input.
- **Public finances.** Activity in the extended chain is associated with about EUR 2,410 million of taxes and social contributions excluding VAT, mostly labour taxes. Copper producers received EUR 55.2 million of electricity price compensation for 2024, of which Aurubis AG EUR 30.1 million.
- **Copper in use.** The dynamic model estimates the copper stock in use in Germany at about 13.7 Mt (164 kg per person; 90% band 141–189). End-of-life products released about 500 kt of copper in 2024, of which about 260 kt was recovered. Together with new scrap this bottom-up supply of 362 kt is within 30 kt of the supply derived residually from smelter feed and trade.
- **Environment.** Replacing global average primary copper one-for-one, German secondary copper potentially avoided about 1,280 kt CO_2e in 2024 (90% band 970–1,450 kt), about 43 Mt of tailings and 26 million m^3 of blue water consumption, all mostly in mining countries; counting only copper of end-of-life origin, 530 kt CO_2e. The screening footprint of the Lünen secondary route is 1.52 t CO_2e per tonne against 3.64 t for global primary cathode (ICA data for 2023).

- **Security of supply.** Refined output equals 62% of refined copper used in Germany. Concentrate imports are concentrated (HHI 1,877; Chile 31%), while scrap is traded mainly within Europe in both directions, with net imports of 61 kt gross weight in 2024. Germany is a net exporter of copper semis, including wire (545 kt).
- **Outlook.** In the high-circularity scenario for 2035 secondary refining reaches the assumed capacity of 300 kt; the additional secondary feed exceeds the growth of domestic scrap projected by the dynamic model by about 68 kt of copper.

TABLE 1 Headline results: central estimate and 90% parameter-uncertainty band

Indicator (2024)	Status	Central	P5	P50	P95	Unit
Direct GVA – recycling chain (D1+D2)	E	859	729	875	1,032	EUR m
Direct GVA – copper industry (D1–D4)	E	3,013	2,883	3,028	3,185	EUR m
Direct GVA – extended value chain (D1–D5)	E	4,071	3,886	4,085	4,291	EUR m
GVA incl. supply chain (Type I)	M	6,328	5,729	6,369	7,062	EUR m
GVA incl. induced (Type II)	M	8,204	7,311	8,130	8,997	EUR m
Direct employment	E	41,364	39,208	41,511	43,808	persons
Jobs incl. supply chain	M	65,587	58,965	65,957	73,598	persons
Jobs incl. induced	M	87,051	76,796	86,092	96,133	persons
Taxes and contributions (attribution, not net balance)	M	2,410	2,261	2,560	2,911	EUR m
Electricity price compensation, copper firms (outside GVA)	O	55.2	55.2	55.2	55.2	EUR m
GHG potentially avoided – secondary copper produced	M	1,281	967	1,210	1,447	kt CO_2e
– of which secondary refined copper	M	585	427	547	634	kt CO_2e
GHG potentially avoided – collection-based	M	960	723	913	1,111	kt CO_2e
GHG potentially avoided – substitution 0.5	M	447	285	407	524	kt CO_2e
Tailings potentially avoided	M	42.9	38.1	43.2	48.6	Mt
Secondary copper (refined and direct melting)	E	459	415	462	511	kt Cu
Copper stock in use	M	13.7	11.8	13.7	15.8	Mt Cu
Old scrap recovered from end-of-life products	M	260	223	264	309	kt Cu
Secondary share of copper first use	E	39	37	39	41	%
Coverage: refined output / refined copper used	O	62	62	62	62	%

Source: IGMNiR CU-DE v1.0; Monte Carlo 10,000 draws with Gaussian copula; "central" is the deterministic run with modal parameter values. Status: O observation, E estimate, M model result. Segments D1–D5: see Chapter 4. GVA, jobs and taxes are gross contributions. GVA is at basic prices for the smelters (D2, D3) and at factor cost from structural business statistics for D1, D4 and D5; in both cases it excludes electricity price compensation (an other subsidy on production). Taxes exclude VAT; the income taxes of Aurubis AG are observed, the other taxes are model estimates. Emissions potentially avoided compare German secondary copper with 1:1 substitution of global average primary cathode; they occur largely outside Germany and are not changes of the national inventory; the emission perspectives are alternatives and are not additive. The secondary share and the coverage ratio use the BGR balance; refined output and use are observations, their ratio has no parameter uncertainty.

01 Introduction

Copper conducts electricity and heat better than any other non-precious metal, resists corrosion and can be recycled repeatedly without loss of quality. These properties make it essential for power grids, electric motors, buildings and vehicles. Germany has no copper mine – the last Kupferschiefer mine, near Sangerhausen, closed in 1990 – but it hosts a complete copper value chain: the primary smelter and refinery of Aurubis in Hamburg, the secondary smelter in Lünen, Europe's largest group of copper semis producers and a large cable industry. According to the Federal Institute for Geosciences and Natural Resources (BGR), Germany used 965 kt of refined copper in 2024, more than any other European country.

This report applies to Germany the integrated model that IGMNiR developed for copper, zinc and lead in Poland. It extends that model with a dynamic model of copper in use, route-level screening inventories for the Hamburg and Lünen smelters and a replication package. The report describes the industry and its results; it does not assess policy options.

1.1 Questions addressed

01 How large is the copper industry in Germany – in output, value added and jobs – and how is it organised along the value chain?

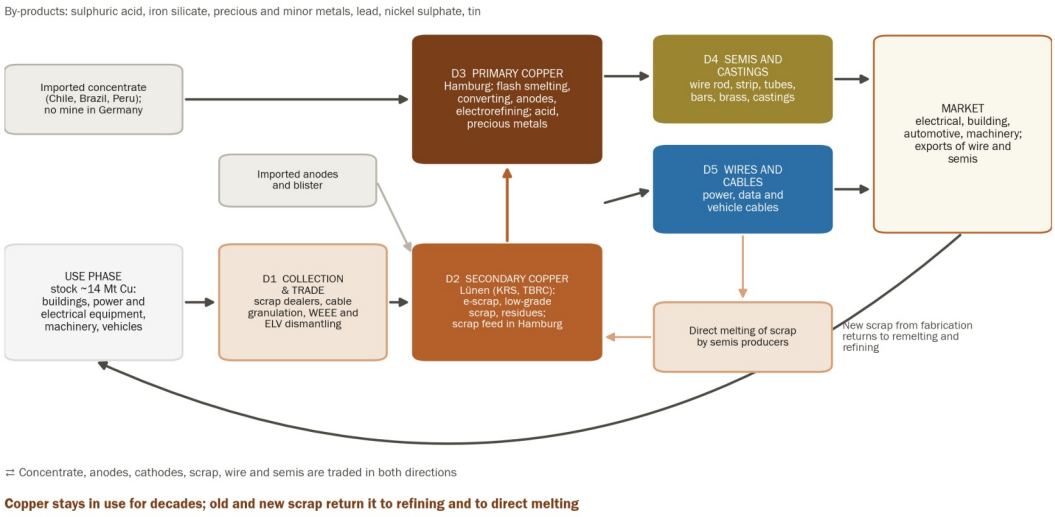
02 How much value added, employment and tax revenue does it support in the domestic supply chain and through household spending, and how much public support does it receive?

03 How much copper is in use in Germany, how much scrap does it release, and how does this compare with the scrap used and traded?

04 Which emissions and other burdens does secondary copper potentially avoid compared with primary copper, and how do the Hamburg and Lünen routes compare?

05 How dependent is the industry on imported concentrate, cathodes and scrap, and how might its contribution change to 2035?

FIGURE 2 The copper value chain in Germany and the five segments of the CU-DE model



Source: IGMNiR.

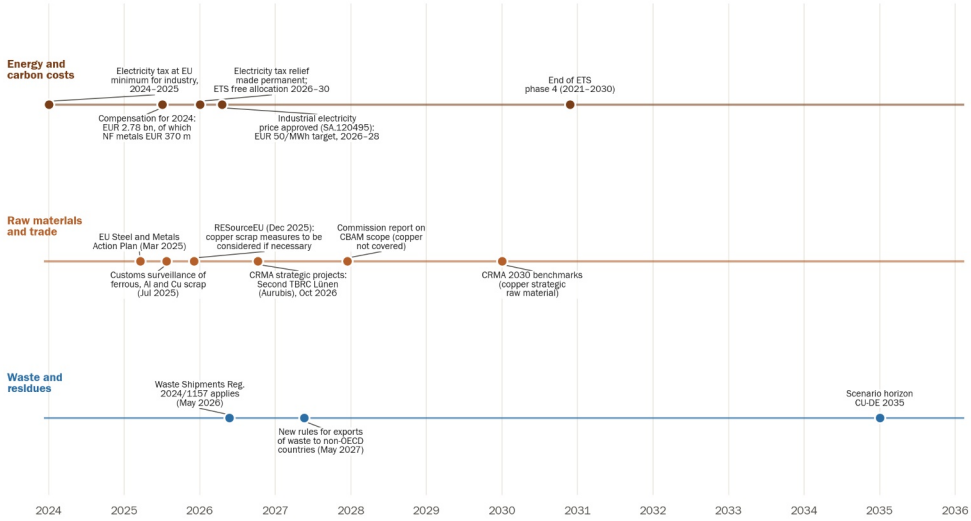
1.2 Structure of the report

Chapter 2 summarises the policy and regulatory context, Chapter 3 describes the industry and its trade, and Chapter 4 the CU-DE model. Chapters 5 to 8 present the economic and fiscal, physical, environmental and strategic results, Chapter 9 their uncertainty and limitations and Chapter 10 the scenarios to 2035. Chapter 11 summarises the results. The annexes document data sources, parameters, installations and terms.

02 Policy and regulatory context

Copper production in Germany is shaped by electricity costs and their compensation, by the EU emissions trading system, by EU raw-materials and trade policy and by the rules on waste shipments. Copper is a strategic and critical raw material under the Critical Raw Materials Act (Regulation (EU) 2024/1252). The figure below shows the main milestones to 2035.

FIGURE 3 Regulatory milestones for the copper value chain in Germany, 2024–2035



Source: StromStG and Strompreispaket (2023); BGBl. 2025 I No. 340; DEHSt evaluation report on electricity price compensation 2024; BAnz AT 06.05.2026; Directive 2003/87/EC; COM(2025) 125; COM(2025) 945; Regulations (EU) 2023/956, 2024/1252 and 2024/1157; European Commission, CRMA strategic projects (9 October 2026). Legal status 8 November 2026.

2.1 Electricity costs and electricity price compensation

The two Aurubis smelters used about 769 GWh of electricity in 2024 (610 GWh in Hamburg and 159 GWh in Lünen). Copper production (NACE 24.44) is eligible for the German electricity price compensation (Strompreiskompensation), which reimburses part of the indirect costs of emission allowances passed on in electricity prices under the EU state-aid guidelines. For 2024 the German Emissions Trading Authority (DEHSt) granted EUR 2.78 billion to 366 companies, of which EUR 370 million to non-ferrous metals. Copper firms identified in the recipient lists received EUR 55.2 million, of which Aurubis AG EUR 30.1 million (table below). Electricity used for electrolysis and metal production processes is relieved from electricity tax (§ 9a StromStG); for other uses manufacturing companies could reduce the tax to the EU minimum of EUR 0.50 per MWh in 2024 and 2025 (§ 9b StromStG), a relief made permanent from 2026. Reduced network charges for energy-intensive users and free allocation under the EU ETS are further forms of support that the model does not quantify. In April 2026 the European Commission approved an industrial electricity price scheme for 2026–2028 with a target price of EUR 50 per MWh on half of eligible consumption; it cannot be combined with the compensation for the same consumption.

TABLE 2 Electricity price compensation for copper firms, billing years 2023 and 2024 (EUR million)

Recipient	2023	2024	Treatment in CU-DE
Aurubis AG (Hamburg, Lünen)	31.56	30.12	D2 and D3, subsidy outside GVA
Other copper firms (Wieland, KME, Diehl, Schwermetall and others)	24.64	25.08	D4, subsidy outside GVA

Recipient	2023	2024	Treatment in CU-DE
Copper firms, total	56.2	55.2	
Non-ferrous metals, total (all recipients)	279.5	369.7	context

Source: DEHSt, evaluation reports and recipient lists for billing years 2023 and 2024. Recipients are listed with the three-digit code NACE 24.4; the assignment to copper is by IGMNiR (company names). Compensation for a billing year is paid in the following year; CU-DE attributes it to the year of the electricity costs.

2.2 Emissions trading and taxation

Both smelters are installations under the EU emissions trading system. In 2024 Hamburg emitted 136,900 t CO_2 against a free allocation of 307,300 allowances, Lünen 160,700 t against 126,500 allowances (DEHSt installation list). Copper is not covered by the carbon border adjustment mechanism (Regulation (EU) 2023/956); a further Commission report on its scope is planned for 2027. Germany levies no specific tax on copper extraction; the royalty under the Federal Mining Act (Förderabgabe, § 31 BBergG) would apply to future copper mining but currently yields no revenue from copper. Corporate income tax and solidarity surcharge together with the municipal trade tax amount to about 30% of taxable profit.

2.3 Raw materials and trade

The EU Steel and Metals Action Plan of March 2025 and the RESourceEU communication of December 2025 address the supply of metals and scrap. Since July 2025 the EU monitors imports and exports of ferrous, aluminium and copper scrap through customs surveillance. RESourceEU announces measures for aluminium scrap and states that similar actions for copper will be considered if necessary; no measure on copper scrap had been adopted by the cut-off date. In October 2026 the Commission selected the second top-blown rotary converter (TBRC) of Aurubis in Lünen as a strategic project under the Critical Raw Materials Act. In September 2023 the Joint Spatial Planning Department of Berlin and Brandenburg concluded that the spatial compatibility of the Kupferschiefer Lausitz project near Spremberg could not be established on the basis of the documents submitted; a new spatial compatibility review based on revised documents was announced in 2025.

2.4 Waste and scrap

Copper scrap that meets the specifications of the end-of-waste criteria or of traded grades moves freely within the EU; contaminated scrap, cable waste and electronic scrap are subject to the Waste Shipments Regulation (EU) 2024/1157, which applies from May 2026, with new rules for exports to non-OECD countries from May 2027. The Lünen smelter processes low-grade materials such as electronic scrap, shredder residues and slimes that many smelters cannot accept; part of these materials is imported under waste or precious-metal codes rather than as copper scrap.

03 The copper industry in Germany

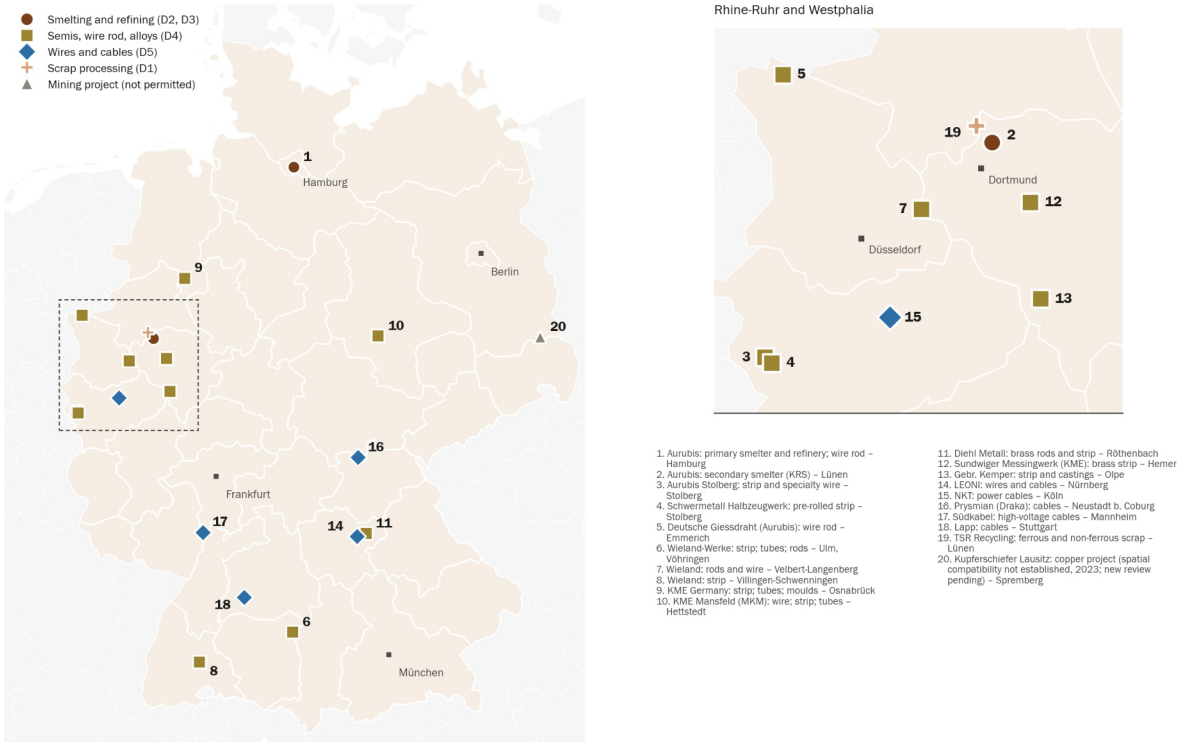
The German copper industry consists of one integrated producer of refined copper, Aurubis AG, with its primary smelter and refinery in Hamburg and its secondary smelter in Lünen, a group of semis producers – Wieland, KME, Diehl, Aurubis Stolberg and others – that make strip, tubes, rods, wire and brass products, and cable makers that turn copper wire rod into power, data and vehicle cables. Scrap dealers and recyclers collect, sort and process copper scrap for domestic smelters and remelters and for export.

TABLE 3 Main copper producers in Germany – key data, 2024

Company / site	Activity	Refined Cu, kt	Employees	Other data
Aurubis AG – Hamburg	Primary smelter and refinery; wire rod	441.5	2,841 (incl. head office)	Cathode 441 kt; concentrate 907 kt; ETS 137 kt CO_2
Aurubis AG – Lünen	Secondary smelter and refinery (KRS)	165.1	740	Recycling materials 313 kt; ETS 161 kt CO_2
Aurubis Stolberg, Deutsche Giessdraht	Strip, specialty wire; wire rod	–	564	Part of Aurubis group
Wieland-Werke AG	Strip, tubes, rods, wire	–	10,608 (group)	Group revenue EUR 6.6 bn (FY 2024/25); recycled content 82%
KME SE	Strip, tubes, moulds, wire	–	3,159	Revenue EUR 1.54 bn; copper sales 162 kt (2024)
Diehl Metall	Brass rods and strip	–	2,882	Revenue EUR 738 m (2024)
Cable makers	LEONI, NKT, Prysmian, Südkabel, Lapp	–	–	LEONI bought about 100 kt of copper (2024)

Source: Aurubis Annual Report 2024/25 (employees at 30 September 2025) and Environmental Statement 2026 (calendar 2024); DEHSt installation list 2024; Wieland Sustainability Report 2024/25; KME Group annual report 2024; Diehl annual report 2024; LEONI Sustainability Report 2024. Refined copper of the two sites (606.6 kt) includes anodes refined from other Aurubis plants and differs from the BGR national total (597.0 kt) in definition.

FIGURE 4 Main copper smelters, semi-fabricators, cable makers and recyclers in Germany



Source: IGMNiR; Aurubis annual report 2024/25 and Environmental Statement 2026; company websites and reports (Wieland, KME, Diehl, LEONI, NKT, Prysmian, Südkabel, Lapp, TSR); Gemeinsame Landesplanungsabteilung Berlin-Brandenburg (2023); GISCO boundaries. Locations approximate. Numbers refer to Annex C.

3.1 Official statistics

Eurostat structural business statistics report for copper production (NACE 24.44) in Germany in 2024 55 enterprises with 20,556 persons employed, production value of EUR 21,440 million and value added at factor cost of EUR 2,303 million. Manufacture of other electronic and electric wires and cables (NACE 27.32) employed 19,096 persons, and the wholesale of waste and scrap (NACE 46.77) and materials recovery (NACE 38.3), which cover all materials, 21,437 and 43,552 persons. The table below shows the national copper balance of BGR, the table after it the production of semis reported by the metals industry association WVMetalle.

TABLE 4 Refined copper balance of Germany, 2020–2024 (kt)

Item	2020	2021	2022	2023	2024
Refined copper production	643.0	615.0	609.0	596.0	597.0
– primary	389.7	383.8	364.0	340.1	353.4
– secondary	253.3	231.2	245.0	255.9	243.6
Refined copper use	1,046.0	1,009.0	1,004.5	980.3	965.0
Secondary share of production, %	39.4	37.6	40.2	42.9	40.8
Production / use, %	61.5	61.0	60.6	60.8	61.9

Source: BGR, Deutschland – Rohstoffsituation 2024 (2025), Table 35; use on the basis of the International Copper Study Group. Secondary production is refined copper from secondary feed; copper from scrap melted directly by semis producers is not included.

TABLE 5 Production of copper and copper-alloy semis and castings, 2022–2024 (kt, gross weight)

Product	2022	2023	2024
Rolled, pressed and drawn products	804.2	631.5	607.9
Continuous-cast wire rod	564.7	622.7	634.1
Powder and flake	15.7	11.8	12.4

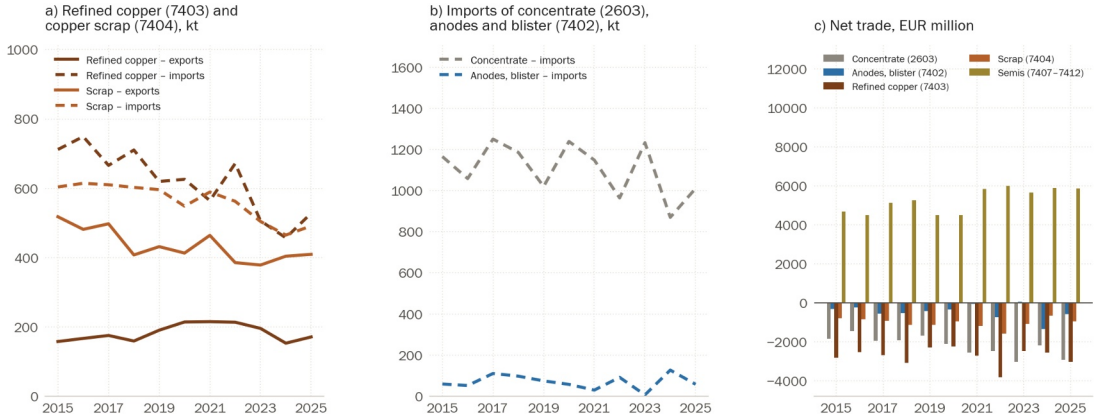
Product	2022	2023	2024
Semis, total	1,384.7	1,266.0	1,254.5
Copper casting alloys (ingot)	26.2	19.4	20.9
Copper and copper-alloy castings	65.1	66.7	69.9

Source: WVMetalle, Quartalsbericht 02/2025 (Kupferverband, Destatis, Federal Association of the German Foundry Industry); 2024 preliminary. Gross weight includes alloying elements such as zinc in brass. PRODCOM reports 650 kt of wire rod (code 24442330) for 2024.

3.2 Trade

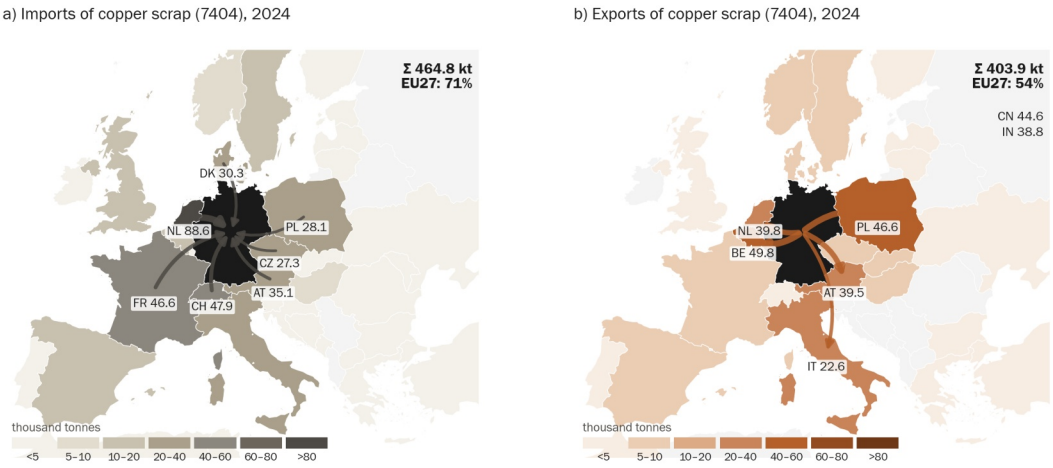
Germany imports copper at early stages of processing and exports it at later stages. In 2024 it imported 870 kt of copper ores and concentrates (gross weight), 127 kt of anodes and blister copper – mostly from the Aurubis smelter in Pirdop, Bulgaria – and 457 kt of refined copper, and exported 153 kt of refined copper. Exports of copper wire (405 kt) and of all semis (818 kt) far exceeded imports (274 kt). Scrap was traded in both directions: 465 kt imported and 404 kt exported. The trade balance was EUR −2,188 million for concentrate, EUR −2,560 million for refined copper, EUR −664 million for scrap and EUR +5,871 million for semis.

FIGURE 5 Foreign trade in copper by stage of processing, 2015–2025



Source: Eurostat Comext DS-045409 (gross weight); IGMNiR CU-DE.

FIGURE 6 Origins of copper scrap imports and destinations of copper scrap exports, 2024



Source: Eurostat Comext (DS-045409), CN 7404, gross weight; GISCO boundaries; IGMNiR CU-DE. Partners outside the map are listed at the top right.

3.3 Secondary feed and the recycling of copper

Copper from scrap reaches German production by two routes. Smelters refine scrap and other secondary materials to cathode: Lünen processed 313.5 kt of recycling raw materials in 2024 – electronic scrap, low-grade scrap, shredder residues, slimes and dross – and Hamburg 13.2 kt of copper scrap and 165.0 kt of other copper-bearing materials. BGR reports 244 kt of secondary refined copper. Semis producers and foundries melt clean scrap directly; their scrap use is not published. CU-DE estimates it at about 220 kt of copper from the difference between the copper in semis and the refined copper used (Chapter 4). In total about 478 kt of copper in secondary materials was used in Germany.

TABLE 6 Secondary copper and its supply, Germany, 2024 (kt Cu)

Item	kt Cu	Status	Source or basis
Secondary refined copper (BGR)	243.6	O	BGR Table 35
Copper from scrap melted directly	215	E	Semis (WVMetalle) less refined use (BGR)
Secondary copper, total	459	E	
Copper in secondary feed (at recovery rates)	478	E	Recovery 95% (smelters), 97% (melting)
Copper in net imports of scrap (CN 7404; 82% Cu in imports, 73% in exports)	86	E	Comext
Domestic supply, residual estimate	392	M	Feed less net imports
Domestic supply, bottom-up: old scrap recovered (dynamic model, M2b)	260	M	Chapter 6
Domestic supply, bottom-up: new scrap	102	M	9% of copper in semis
Difference (other secondary materials, stocks, error)	30	M	

Source: IGMNiR CU-DE v1.0; BGR; WVMetalle; Comext. Status: O observation, E estimate, M model result. Other copper-bearing secondary materials are imported under other codes: in 2024 net imports were 14 kt of copper ash and residues (CN 262030), 12 kt of electronic waste with circuit boards (CN 854929) and 15 kt of precious-metal waste and scrap (CN 711299), all in gross weight; at typical copper contents they contain an estimated 8–15 kt of copper.

Because direct melting is not reported, the table below shows the bridge from production statistics to the estimate. Wire rod is made from cathode; rolled, pressed and drawn products include brass and other alloys and are made partly from scrap. Refined copper used outside semis (casting alloys, chemicals, powders and master alloys) and stock changes are not reported separately and are taken as a residual of about 51 kt. Company data give independent indications of the scrap share of semis: KME reports 87.5 kt of recycled metal input for 229.8 kt of gross copper production in 2024 (38%), and Wieland a recycled content of 82% across its group.

TABLE 7 Bridge from semis production to copper from direct melting, Germany, 2024 (kt)

Item	kt	Source	Status
Semis production, gross weight	1,254.5	WVMetalle 2024 (Kupferverband, Destatis)	O
– wire rod (approx. 100% Cu)	634.1	WVMetalle; PRODCOM 24442330: 650.1 kt	O
– rolled, pressed and drawn products (approx. 80% Cu)	607.9	WVMetalle	O
– powder and flake (approx. 90% Cu)	12.4	WVMetalle	O
Copper in semis (average 90%)	1,129	IGMNiR	E
Refined copper used in Germany	965.0	BGR, Table 35 (ICSG basis)	O
– used outside semis, and stock change (residual)	51	IGMNiR	E
Refined copper in semis	914	IGMNiR	E
Copper from scrap melted directly (copper in semis less refined copper in semis)	**215**	IGMNiR; range 150–290	E

Source: IGMNiR CU-DE v1.0; WVMetalle Quartalsbericht 02/2025; BGR (2025); PRODCOM. Status: O observation, E estimate. Copper contents by product are IGMNiR assumptions; new scrap returned by domestic users is part of the scrap melted directly, while run-around scrap within the mills is not counted. The results for 150 and 290 kt are shown as structural cases in Chapter 7.

TABLE 8 Copper flows by node, Germany, 2024 (kt Cu)

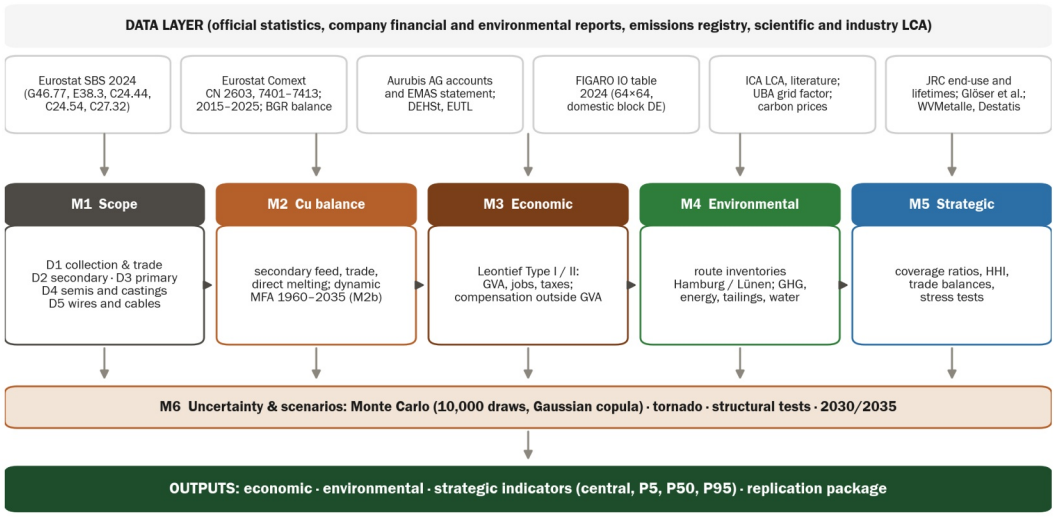
Node and flow	kt Cu	Status	Basis
Refined copper			
Production + imports − exports (CN 7403)	901	O	BGR; Comext
Use (BGR/ICSG)	965	O	BGR
Residual: stock change and statistical difference	−64	O	
Semis			
Copper in semis = refined copper in semis + direct melting	1,129 = 914 + 215	E	Identity (table above)
Scrap and secondary materials			
Supply: old scrap recovered (dynamic model)	260	M	Chapter 6
Supply: new scrap from domestic fabrication	102	M	9% of copper in semis
Supply: copper in imports of scrap (CN 7404)	381	E	Comext × 82% Cu
Supply: copper in other imported secondary materials (net)	12 (8–15)	E	CN 262030, 854929, 711299
Use: secondary feed of smelters	256	E	BGR / recovery 95%
Use: feed of direct melting	222	E	Recovery 97%
Use: copper in exports of scrap (CN 7404)	295	E	Comext × 73% Cu
Unaccounted-for copper (uses less identified supply)	**18**	M	90% band of the residual −50 to 79
End-of-life products			
End-of-life outflow = collected + not collected	501 = 352 + 148	M	Dynamic model
Collected = recovered + processing losses	352 = 260 + 92	M	Glöser et al. (2013) rates

Source: IGMNiR CU-DE v1.0. Status: O observation, E estimate, M model result. The residual and bottom-up estimates of domestic scrap share only the copper content of semis (through direct melting and new scrap); the other inputs come from separate sources. Trade statistics do not separate copper from brass scrap or new from old scrap, so these splits cannot be shown for traded scrap.

04 The CU-DE model

CU-DE follows the architecture of IGMNiR's integrated models for the non-ferrous metals and adapts it to copper in Germany. It links six modules: scope and allocation (M1), a copper mass balance with a dynamic model of copper in use (M2 and M2b), an input-output model of economic and fiscal effects (M3), an environmental module with route-level screening inventories (M4), strategic indicators and stress tests (M5) and an uncertainty and scenario module (M6). A replication script recomputes value added and employment from the published package files, and a quality-control script compares the key numbers of the English and Polish versions.

FIGURE 7 Architecture of the CU-DE model



Source: IGMNiR.

4.1 Scope and segments

The model distinguishes five segments. **D1** is the copper share of wholesale of waste and scrap (46.77) and materials recovery (38.3), allocated separately for value (20% and 5%) and employment (12% and 4.5%). **D2** and **D3** split the German smelting and refining operations of Aurubis AG (Hamburg and Lünen) by the secondary share of national refined output (40.8%, BGR). Their value added is computed from the company accounts as EBITDA plus personnel expenses plus other taxes on production, less electricity price compensation. **D4** is copper production (NACE 24.44) less the two smelters, plus the copper-alloy share (60%) of casting of other non-ferrous metals (24.54). Because D4 is a residual of an official total, the sum of D2 to D4 is anchored to structural business statistics. **D5** is the copper-conductor share (75%) of wires and cables (27.32).

TABLE 9 Segments of the CU-DE model, 2024 (central estimate)

Segment	Basis	Output, EUR m	GVA, EUR m	Persons	GVA per person, EUR k
D1 Collection and trade of scrap	SBS 46.77, 38.3 × copper shares	1,581	608	4,530	134
D2 Secondary refined copper	Aurubis AG × secondary share	5,202	251	1,310	191

Segment	Basis	Output, EUR m	GVA, EUR m	Persons	GVA per person, EUR k
D3 Primary refined copper	Aurubis AG × primary share	7,548	364	1,910	191
D4 Semis, wire rod and castings	SBS 24.44 − smelters + 24.54 share	9,648	1,790	19,290	93
D5 Copper in wires and cables	SBS 27.32 × copper share	4,562	1,058	14,320	74

Source: IGMNiR CU-DE v1.0; Eurostat SBS 2024; Aurubis AG financial statements (HGB), calendar 2024. Output of D2 and D3 is the revenue of Aurubis AG, which includes precious metals, by-products and copper products made in Hamburg. Smelter EBITDA is estimated at EUR 300 million (range 230–380) from the group's operating EBITDA and the HGB result of Aurubis AG, which does not publish EBITDA.

4.2 Copper mass balance

The physical module works in tonnes of copper. Secondary copper S is secondary refined copper (BGR) plus copper from scrap melted directly by semis producers and foundries (S_dm), which is estimated as copper in semis (1,254 kt gross weight at 90% copper) less refined copper used in semis. Copper in secondary feed C follows from S and recovery rates. The domestic supply of secondary copper is estimated in two independent ways: residually, as C less copper in net imports of scrap (CN 7404 at 82% copper in imports and 73% in exports, from unit values), and bottom-up, as old scrap recovered from end-of-life products (dynamic model, Chapter 6) plus new scrap from fabrication in Germany (9% of copper in semis; scrap from the fabrication of exported semis arises abroad). The difference indicates copper-bearing materials imported under other codes, stock changes and estimation error.

$$S = S_{ref} + S_{dm} \qquad A_{res} = C - cu_{7404} \cdot (M_{7404} - X_{7404}) \qquad A_{bu} = \text{Old scrap recovered} + r_{new} \cdot \text{Cu in semis}$$

4.3 Dynamic model of copper in use

Module M2b is an inflow-driven stock model for 1960 to 2035, started in 1900 to build up the stock in use. The inflow of copper into use equals population times a per-capita inflow, anchored to the EU-28 value for 2014 reported by the Joint Research Centre (5.91 kg per person) and scaled for Germany by a factor of 1.10. The per-capita inflow rises linearly from 55% of its later level in 1960 to that level in 1990, follows the BGR series of refined copper use from 2020 to 2024 and grows by 1.0% a year from 2025. The inflow is split into five end uses with the JRC shares; each cohort leaves use after a normally distributed lifetime with a standard deviation of 0.3 times the mean. Collection and recovery rates by waste stream are taken from Glöser et al. (2013). The model yields the stock in use, end-of-life outflows, collected and recovered old scrap by year.

TABLE 10 Parameters of the dynamic model of copper in use

End use	Share of inflow, %	Mean life, years	SD, years	Waste stream	Collection, %	Recovery, %
Buildings and construction	34	40	12.0	Construction and demolition	72	65
Electrical and electronic equipment	29	25	7.5	Industrial electrical	66	46
Industrial machinery	20	18	5.4	Industrial non-electrical	68	50
Transport	9	16	4.8	End-of-life vehicles	91	49
Consumer and general products	8	8	2.4	Waste electrical and electronic equipment	63	34

Source: Passarini et al. (2018), JRC, EU-28 2014 (shares and lifetimes); Glöser et al. (2013), global 2010 (collection and end-of-life recovery by waste stream). Assignment of end uses to waste streams by IGMNiR. In the Monte Carlo simulation lifetimes, collection and recovery rates are scaled jointly (Annex B).

4.4 Economic, fiscal, environmental and strategic modules

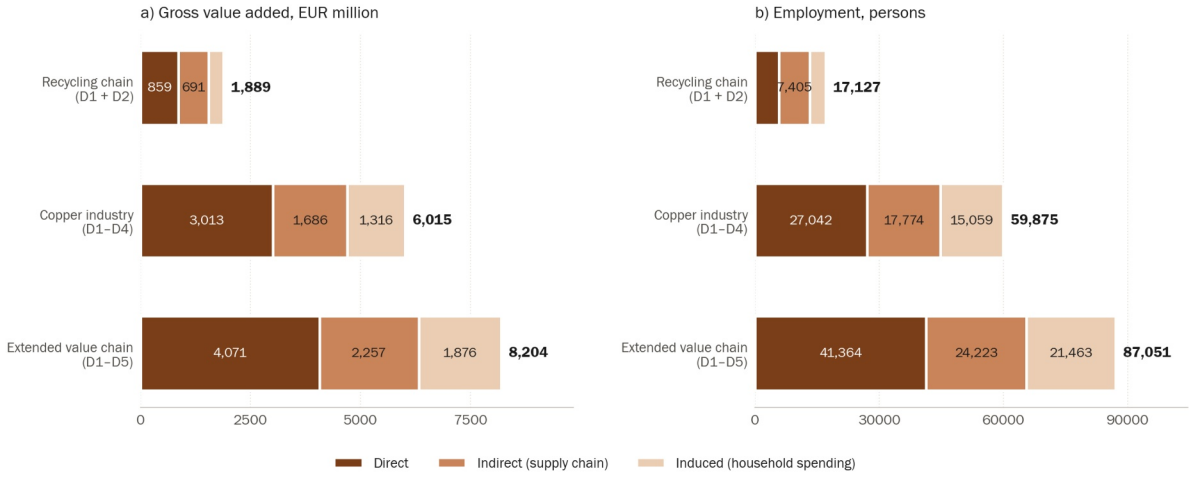
Indirect and induced effects are computed with Leontief Type I and Type II multipliers from the domestic block of the Eurostat FIGARO input-output table for Germany (2024, 64 products; for the latest year partly projected by Eurostat from macroeconomic statistics), closed for households with a tax rate on labour income of 36% (implicit tax rate on labour) and a propensity to consume of 0.88. Purchases within the chain – scrap, concentrate, anodes, cathodes and semis – are removed from the first-round demand: metal-bearing inputs are 90% of smelter output, 68% of semis output and 55% of the copper share of cable output. Employment coefficients come from national accounts for 2024 (by construction, total employment of 45,960 thousand persons is matched).

Taxes are estimated per segment: labour taxes and social contributions as the tax rate on labour applied to labour cost, corporate income and trade tax at 30% on a share of operating surplus, and taxes on production from FIGARO coefficients. For the smelters the observed income taxes of Aurubis AG (EUR 9.0 million in calendar 2024) and an estimate of other taxes (EUR 5.0 million) are used. The environmental module compares secondary copper with primary copper using route-level screening inventories for Hamburg and Lünen (Chapter 7). Uncertainty is propagated by a Monte Carlo simulation of 10,000 draws from triangular distributions of all parameters in Annex B, with correlated groups linked by a Gaussian copula, and complemented by one-at-a-time and structural sensitivity analysis.

05 Economic and fiscal contribution

In 2024 the extended copper value chain generated EUR 4,071 million of direct gross value added and employed 41,400 people. Domestic suppliers added EUR 2,257 million and 24,200 jobs, and household spending of the wages paid a further EUR 1,876 million and 21,500 jobs. The value-added multiplier is 1.55 (Type I) and 2.02 (Type II). The recycling chain (D1 and D2) has a higher Type I multiplier (1.80) because scrap trade and recovery buy more domestic services and transport per euro of value added.

FIGURE 8 Economic footprint of the copper value chain in Germany, 2024



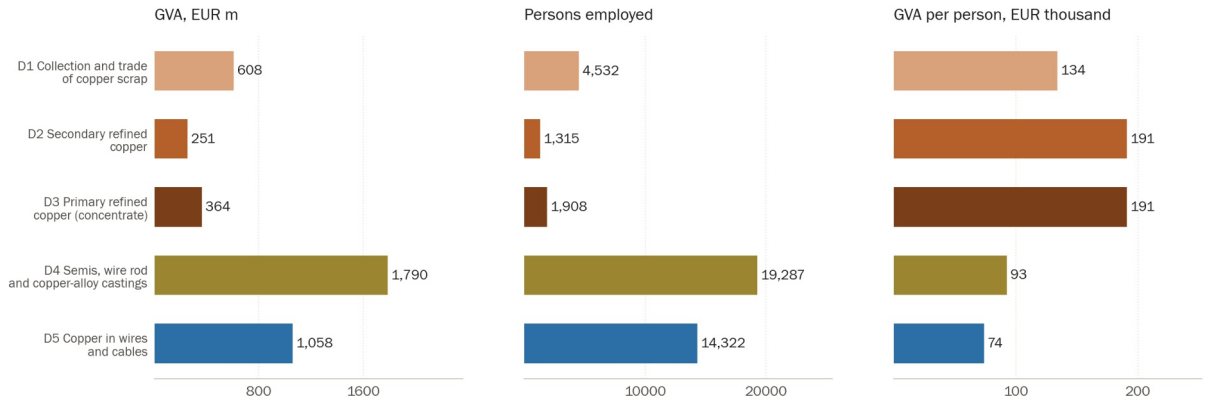
Source: IGMNiR CU-DE v1.0; Aurubis AG annual report 2024/25; Eurostat SBS 2024, FIGARO 2024, Comext; BGR; central estimate.

TABLE 11 Economic contribution by segment, 2024 (central estimate)

Segment	GVA direct	GVA Type I	GVA Type II	Jobs direct	Jobs Type I	Taxes
D1 Collection and trade of scrap	608	1,140	1,376	4,530	10,280	368
D2 Secondary refined copper	251	410	513	1,310	2,970	124
D3 Primary refined copper	364	594	744	1,910	4,310	180
D4 Semis, wire rod and castings	1,790	2,555	3,383	19,290	27,260	1,072
D5 Copper in wires and cables	1,058	1,629	2,188	14,320	20,770	666
Recycling chain (D1+D2)	859	1,550	1,889	5,850	13,250	492
Copper industry (D1–D4)	3,013	4,699	6,015	27,040	44,820	1,744
Extended value chain (D1–D5)	4,071	6,328	8,204	41,360	65,590	2,410

Source: IGMNiR CU-DE v1.0. EUR million and persons. Type I adds the domestic supply chain, Type II also household spending. Taxes: labour taxes and social contributions, income taxes and taxes on production in all rounds, excluding VAT.

FIGURE 9 Direct GVA, employment and productivity by segment, 2024



Source: IGMNiR CU-DE v1.0; Aurubis AG annual report 2024/25; Eurostat SBS 2024, FIGARO 2024, Comext; BGR; central estimate.

Value added per person is highest in the smelters (EUR 191 thousand) and lower in semis and castings (EUR 93 thousand); the average of NACE 24.44 is EUR 112 thousand. Semis producers that melt scrap directly are part of D4; in proportion to the copper they obtain from scrap (19% of copper in semis) they account for about EUR 341 million of value added and 3,700 jobs. These amounts are a share of D4, not an addition to the recycling chain. The attribution follows the copper input and is not the value added of remelting itself, which is not observed; scrap-based and cathode-based production differ in product mix and margins.

TABLE 12 Reconciliation of employment and turnover with industry and official statistics, 2024

Scope	Persons	Turnover, EUR m	Value added (factor cost), EUR m	Source
WVMetalle: copper industry (association statistics)	16,000	22,000	–	WVMetalle annual report 2024/25
SBS NACE 24.44 copper production (all enterprises)	20,556	22,432	2,303	Eurostat SBS 2024
– of which smelters (Aurubis AG, D2 + D3)	3,223	12,750	630	Aurubis AG (HGB), calendar 2024
– of which semis and wire rod outside the smelters (D4 part)	17,333	9,682	1,674	Residual
Copper-alloy castings (60% of NACE 24.54, D4 part)	1,954	–	–	Eurostat SBS 2024
D2–D4 (copper industry in CU-DE)	**22,510**			
D1 collection and trade of scrap (copper shares)	4,532	–	–	SBS 46.77, 38.3
D5 copper in wires and cables (75% of NACE 27.32)	14,322	–	–	SBS 27.32
D1–D5	**41,364**			

Source: WVMetalle annual report 2024/25; Eurostat SBS 2024; Aurubis AG. WVMetalle reports for the German copper industry nearly 16,000 persons employed in about 60 companies and about EUR 22 bn of turnover, of which over EUR 12 bn abroad; the scope is not stated, and the reported production of 1.5 Mt corresponds to semis, so refining is probably not included. SBS covers all enterprises classified to NACE 24.44. CU-DE adds copper-alloy castings to D4 and uses company data for the smelters. Turnover of Aurubis AG includes goods for resale.

TABLE 13 Definitions and results of the IGMNiR copper models for Germany and Poland, 2024

Item	CU-DE (Germany)	CU-PL (Poland)
Scope of the extended chain	D1–D5: scrap, secondary and primary refining, semis and castings, cables	C1–C5: scrap, secondary copper, mining and smelting (KGHM), semis, cables
Mining	none	included (KGHM mines)
Input-output table	FIGARO 2024, DE	FIGARO 2024, PL
Direct GVA, EUR m	4,071	3,085
GVA Type I, EUR m	6,328	4,401
Jobs Type I	65,600	53,000

Item	CU-DE (Germany)	CU-PL (Poland)
Secondary copper, kt	459	167

Source: IGMNiR CU-DE v1.0; IGMNiR CU-PL v1.2 (central estimates). The two models share their method but differ in scope: CU-PL includes mining and the mineral extraction tax, CU-DE has no mining but a larger semis and cable industry and direct melting of scrap. Values are gross contributions in each country and are not a ranking.

The input-output results depend on how purchases within the chain are separated from other inputs and on the aggregation of FIGARO into 64 products, in which copper is part of basic metals (CPA C24) and cables part of electrical equipment (CPA C27). The table below compares the central treatment with a conservative variant that also removes purchases of metal products, electronics, electrical equipment and machinery from the first round, with a variant that keeps domestic metal purchases (and therefore counts some transactions within the chain twice), with the FIGARO table for 2023 and with value added at basic prices for all segments. Exports matter for the interpretation: exports of refined copper and copper semis (CN 7403, 7407–7413) were worth EUR 10,361 million in 2024, against EUR 22,398 million of output of D2–D4, so a large part of the activity serves foreign demand.

TABLE 14 Sensitivity of the input-output results to construction choices, 2024

Variant	GVA direct, EUR m	GVA Type I, EUR m	Multiplier	Jobs Type I
Central: metals, ores, scrap and scrap trade removed	4,071	6,328	1.55	65,600
Conservative: also metal products, electronics, electrical equipment, machinery removed	4,071	6,093	1.50	62,900
Domestic metal purchases kept (double counting within the chain)	4,071	11,302	2.78	113,800
FIGARO 2023 instead of 2024	4,071	6,319	1.55	65,000
Basic prices for all segments (FIGARO net other taxes on production)	4,153	6,410	1.54	65,600

Source: IGMNiR CU-DE v1.0; FIGARO 2024 and 2023 (naio_10_fcp_ip4). The first-round vectors by 64 CPA products, the multiplier vectors and the extraction date and SHA-256 hash of the FIGARO file are part of the model package (Annex A). A comparison with the national input-output tables of Destatis was not made.

TABLE 15 Supply-chain value added by supplying product, extended value chain, 2024

Supplying product (CPA)	GVA, EUR m	Share, %
Legal, accounting and management consulting	188	8.3
Electricity, gas and steam	176	7.8
Real estate services	153	6.8
IT and information services	137	6.1
Land transport	127	5.6
Architectural, engineering and testing services	124	5.5
Security, building and office support services	117	5.2
Construction	109	4.8
Other products	1,126	49.9
Total supply-chain GVA	2,257	100.0

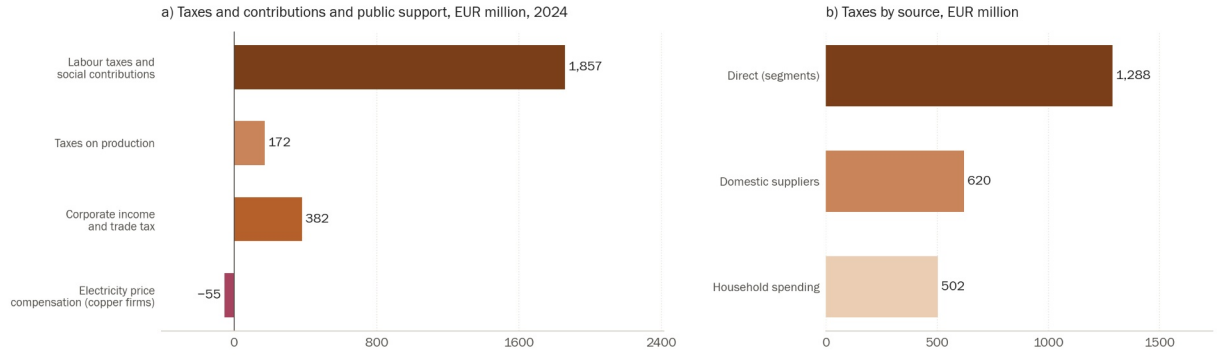
Source: IGMNiR CU-DE v1.0; Type I indirect effects (Leontief inverse of the domestic FIGARO block applied to the first-round vectors).

5.1 Taxes, public revenue and public support

Activity in the extended chain is associated with about EUR 2,410 million of taxes and social contributions excluding VAT: EUR 1,288 million in the segments themselves, EUR 620 million at domestic suppliers and EUR 502 million through household spending. Labour taxes and social contributions account for EUR 1,857 million, at a tax rate on labour of 36%; with the OECD tax wedge for a single worker at the average wage (47.9%) they would be higher, and induced effects lower, because the rate moves taxes and net income in opposite directions. Aurubis AG recorded EUR 9.0 million of income taxes in calendar 2024 (EUR 1 million in FY 2023/24

and EUR 33 million in FY 2024/25). Quantified public support to copper producers is the electricity price compensation of EUR 55.2 million for 2024; electricity-tax relief for process electricity, reduced network charges and free emission allowances (Hamburg held about 170 kt more allowances than it emitted in 2024) are not quantified. The amounts are attributions of public revenue to the activity and are not a net fiscal balance.

FIGURE 10 **Taxes and contributions linked to the copper value chain and public support, 2024**



Source: IGMNiR CU-DE v1.0; Aurubis AG 2024 (observed income taxes); DEHSt recipient lists (electricity price compensation for 2024); implicit tax rate on labour; FIGARO 2024. Taxes are model estimates except the observed income taxes of Aurubis AG; VAT excluded. Compensation is a public expenditure (other subsidy on production), shown separately.

TABLE 16 **Taxes, contributions and public support by category, 2024 (EUR million)**

Category	EUR m	Status	Basis
(i) Observed: income taxes of Aurubis AG (calendar 2024)	9.0	O	Aurubis AG financial statements
(ii) Modelled, segments: labour taxes and social contributions	1,018	M	36% × personnel costs
(ii) Modelled, segments: income taxes of other firms	132	M	30% × taxable share of operating surplus
(ii) Modelled, segments: taxes on production	128	M/E	FIGARO coefficients; Aurubis estimate
(iii) Modelled: domestic suppliers (Type I)	620	M	FIGARO
(iv) Modelled: induced by household spending (Type II)	502	M	FIGARO, closed for households
Taxes and contributions, total (excl. VAT)	**2,410**		
Public support: electricity price compensation (copper firms)	55.2	O	DEHSt recipient lists
Public support not quantified: electricity-tax relief for process electricity (§ 9a StromStG), reduced network charges, free EU ETS allocation	–		

Source: IGMNiR CU-DE v1.0. Labour cost is personnel costs as reported in structural business statistics and company accounts (gross wages and salaries plus employer social contributions). The rate of 36.3% is the implicit tax rate on labour for Germany in 2024 (Eurostat: taxes and compulsory social contributions on employed labour income relative to compensation of employees plus payroll taxes). Public support is shown separately and is not comparable with the modelled taxes.

5.2 Co-products and boundaries with other IGMNiR reports

The Hamburg smelter produces, besides copper, sulphuric acid (720 kt in 2024), iron silicate, precious metals (Ag, Au and platinum-group metals, 1,226 t), lead (10 kt), nickel sulphate and minor metals; Lünen produces tin composite, nickel sulphate, zinc oxide and iron silicate sand. CU-DE attributes all value added of the smelters to copper in the central case. In a copper-only view, by economic allocation (70% of the value of metal sales attributable to copper), direct GVA of the recycling chain falls from EUR 859 million to EUR 783 million and of the extended chain from EUR 4,071 million to EUR 3,886 million.

TABLE 17 **Effect of co-product allocation and of the secondary share on the results, 2024 (EUR million)**

Case	GVA D1+D2	GVA D3	GVA D1–D5	GVA Type I	Compensation
All smelter value added to copper (central)	859	364	4,071	6,328	55.2

Case	GVA D1+D2	GVA D3	GVA D1–D5	GVA Type I	Compensation
Copper-only, mass allocation of metals (97%)	851	353	4,052	6,298	54.3
Copper-only, economic allocation (70%)	783	255	3,886	6,027	46.2
Secondary share by employment (38.3%)	843	380	4,071	6,328	55.2
Secondary share by site energy use (46.5%)	894	329	4,071	6,328	55.2
Lünen only, by employment (20.7%)	735	488	4,071	6,328	55.2

Source: IGMNiR CU-DE v1.0. Economic allocation uses group metal sales in FY 2023/24 (copper, gold, silver, lead, nickel, tin, zinc, minor and platinum-group metals) at 2024 prices; sulphuric acid and iron silicate are treated as by-products. The secondary share by employment assigns Lünen fully and Hamburg by its secondary output to D2; the energy key uses site energy (Lünen 508 GWh, Hamburg 1,119 GWh, of which the secondary share of output); the Lünen-only key assigns only the Lünen site. Aurubis does not publish site results, so the keys bracket the split of value added between D2 and D3.

TABLE 18 Boundaries with other IGMNiR reports

Activity	CU-DE	Other IGMNiR report	Treatment
Copper industry in Poland	–	CU-PL	Separate country; no overlap
Lead, tin, zinc oxide and nickel sulphate from Aurubis smelters	D2, D3	–	Co-products within the smelters; shown in the allocation table
Brass (copper-zinc alloys)	D4	–	Included in copper semis by gross weight; zinc content not separated
Non-ferrous scrap trade in Poland	–	NF-REC-PL	Separate country; no overlap

Source: IGMNiR.

5.3 Comparison with other studies of copper in Germany

Other studies of copper in Germany use different units of analysis, years and boundaries. The table below shows what each covers and how it relates to CU-DE; the figures are not a ranking.

TABLE 19 Studies of copper in Germany: scope and relation to CU-DE

Study	Unit of analysis and year	Key figures	Relation to CU-DE
BGR (2025), Rohstoffsituation 2024	National balance of refined copper, trade, 2024	597 kt refined (353 primary, 244 secondary); 965 kt use	Input to CU-DE (Chapters 3 and 4)
USGS (2026), Minerals Yearbook 2024, Germany	Mineral industry, 2024	597 kt refined; 870 kt concentrate imports, Chile 31%	Independent confirmation of refined output and concentrate imports
WVMetalle (2025), annual report 2024/25	Copper industry (association), 2024	Nearly 16,000 persons, about EUR 22 bn turnover, export share about 56%	Reconciled with SBS and D2–D4 (Section 5)
Bähr et al. (2024), IW Consult and Fraunhofer ISI for KfW	Production of all copper-containing goods, 2022	EUR 216 bn GVA (30% of manufacturing), 1.8 m persons	Downstream exposure of all goods containing copper; CU-DE covers the copper chain up to cables
Pfaff et al. (2018)	Coupled macroeconomic and substance-flow model of copper in Germany	Scenarios of efficiency measures; delayed release of stocks creates trade-offs between primary demand and secondary supply	Closest national dynamic model; CU-DE uses a simpler inflow-driven model
Soulier et al. (2018); Passarini et al. (2018, JRC)	Dynamic and static copper flows, EU-28	EU stock about 82 Mt; end-use shares and lifetimes	Source of CU-DE end-use shares and lifetimes; EU, not German, boundary
BDE et al. (2024), Statusbericht der deutschen Kreislaufwirtschaft	Recycling indicators, Germany	Copper: real recycling rate about 80%, recycled content about 40%	Different definitions (Chapter 6)

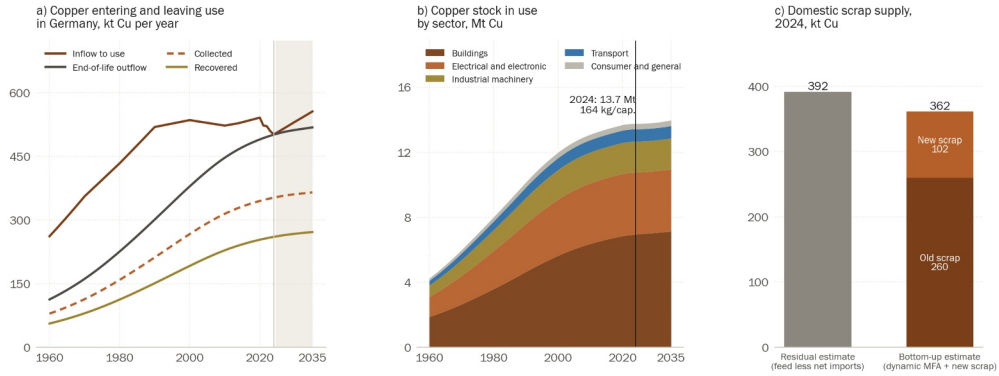
Study	Unit of analysis and year	Key figures	Relation to CU-DE
Icha and Lauf (2026), UBA Climate Change 16/2026	CO_2 factor of the German electricity mix	353 g/kWh in 2024 (provisional)	Input to the route inventories (Chapter 7)

Source: as listed; IGMNiR CU-DE v1.0. Pfaff et al. (2018) are cited from the published abstract; their quantitative results are not compared.

06 Copper in use and scrap supply

The dynamic model estimates that about 13.7 Mt of copper was in use in Germany at the end of 2024, or 164 kg per person (90% band 141–189 kg). Buildings hold 50% of the stock, electrical and electronic equipment 28% and industrial machinery 14%. About 501 kt of copper entered use in 2024 and 501 kt left it in end-of-life products; under the model assumption of a constant per-capita inflow from 1990 to 2019 the stock has stabilised, as outflows of earlier cohorts have caught up with the inflow. Semis production was higher around 2000–2007 (WVMetalle); a sensitivity case with 25% higher inflow in 1998–2008 is shown below. Of the end-of-life copper, 352 kt was collected and 260 kt recovered as old scrap (52% end-of-life recycling rate).

FIGURE 11 Copper in use in Germany, 1960–2035, and domestic scrap supply in 2024



Source: IGMNiR CU-DE v1.0, module M2b; inflow-driven stock model 1960–2035 with JRC (Passarini et al. 2018) end-use shares and lifetimes (normal, SD = 0.3 × mean), Glöser et al. (2013) collection and recovery by waste stream; population Destatis. Model estimates; 2025–2035 under the central inflow growth of 1% a year.

TABLE 20 Copper stock in use and end-of-life flows by end use, 2024 and 2035

End use	Stock 2024, Mt	End of life 2024, kt	Recovered 2024, kt	Stock 2035, Mt	End of life 2035, kt
Buildings and construction	6.94	153	100	7.13	171
Electrical and electronic	3.82	152	70	3.83	153
Industrial machinery	1.90	106	53	1.90	105
Transport	0.76	47	23	0.76	47
Consumer and general	0.34	43	14	0.34	41
Total	13.75	501	260	13.96	518

Source: IGMNiR CU-DE v1.0, module M2b, central parameters. 2035 under per-capita inflow growth of 1% a year from 2025.

The stock per person is within the range of European estimates: the JRC reports about 140 kg per person for the EU-28 in 2014, Ciacci et al. (2017) 160–200 kg, and Soulier et al. (2018) an EU stock of about 82 Mt, or about 160 kg per person; Glöser et al. (2013) estimate a global average of about 50 kg. The bottom-up domestic supply of secondary copper – 260 kt of old scrap and 102 kt of new scrap – differs by 30 kt from the residual estimate of 392 kt derived from smelter feed, direct melting and trade (90% band of the difference −38 to 91 kt). A positive difference is consistent with copper-bearing materials imported under codes other than copper scrap (an estimated 8–15 kt of copper), with an overestimate of direct melting or with an underestimate of old scrap if the inflow around 2000 was higher than assumed. Old scrap recovered rises by 4.3% to 2035 in the central case; the projection depends mainly on product lifetimes and on the level of the inflow (table below).

TABLE 21 Sensitivity of the dynamic model

Case	Stock 2024, kg/person	End of life 2024, kt	Recovered 2024, kt	EoL recycling rate, %	Recovered 2035, kt
Central	164	501	260	52	271
Lifetimes −20%	133	518	271	52	276
Lifetimes +20%	194	476	245	51	262
Inflow factor 0.9	135	410	213	52	222
Inflow factor 1.3	194	592	307	52	321
Inflow 1960 at 40%	164	493	255	52	270
Inflow 1960 at 70%	165	508	265	52	273
Collection and recovery +15%	164	501	299	60	312
No inflow growth after 2024	164	501	260	52	271
Inflow growth 2.5% a year	164	501	260	52	272
Inflow +25% in 1998–2008	175	547	283	52	287
Inflow follows semis production 1990–2024	162	508	264	52	266
Log-normal lifetimes	164	501	261	52	271
Recovery from vehicles −50% (used-car exports)	164	501	248	50	260
Buildings 40% of inflow	171	496	263	53	276

Source: IGMNiR CU-DE v1.0, module M2b. One parameter or assumption changed at a time; semis production from WVMetalle Metallstatistik (definitions change around 2008 and 2019). The inflow factor scales the per-capita inflow relative to the EU-28 value of the JRC.

Recycling indicators differ in definition. German industry sources report an end-of-life recycling rate of about 80% for copper; the Kupferverband, citing BGR and DERA, describes it as a real recycling rate that relates reused copper to the copper put on the market at the start of an average 35-year service life. This is a lagged ratio, not the ratio of recovered old scrap to end-of-life outflow in the same year used in CU-DE. The table below shows the CU-DE indicators on its own boundary and, as far as definitions allow, on the boundary of the published indicators.

TABLE 22 Copper recycling indicators: CU-DE and published values for Germany

Indicator and definition	CU-DE 2024	Published	Source of published value
Collection rate: collected / end-of-life outflow	70%	–	Glöser et al. (2013) rates by waste stream
Processing yield: recovered / collected	74%	–	
End-of-life recycling rate: recovered / end-of-life outflow (same year)	52%	–	UNEP-type definition
Lagged rate: old scrap recovered 2024 / inflow to use 1989 (35 years)	51% (59% with collection +15%)	about 80%	BGR/DERA via Kupferverband (2022); numerator and denominator not published
Recycled content: secondary copper / copper first used	39%	about 40%	BGR (2021–2022); BDE et al. (2024): 38% in 2021
Secondary share of refined copper production	41%	41% (2024)	BGR (2025)
End-of-life recycling input rate: old scrap recovered / copper first used	22%	–	

Source: IGMNiR CU-DE v1.0; BGR (2025); BDE et al. (2024), Statusbericht der deutschen Kreislaufwirtschaft 2024; Kupferverband (2024). The 80% figure and the CU-DE rates use different numerators, denominators and time references; they are shown side by side and are not converted into each other. Recycled-content indicators agree within a few percentage points.

07 Environmental contribution

According to data of the International Copper Association for 2023, as reported in the Aurubis Environmental Footprint Declaration (2026), a tonne of primary copper cathode produced worldwide carries a cradle-to-gate footprint of about 3.64 t CO_2e (3.96 t in the ICA Copper Environmental Profile, 2019 data), dominated by mining, concentration and smelting, together with about 94 t of tailings, 31 kg of SO_2 emissions and 57 m^3 of water. CU-DE compares German secondary copper with this global average under one-for-one substitution and compares the Hamburg and Lünen routes with screening inventories built from site data (table below). The inventories use location-based German electricity (353 g CO_2 per kWh in 2024, provisional, UBA 2026) and allocate part of the burden to co-products.

TABLE 23 Screening inventories of the German copper routes, t CO_2e per t Cu (2024)

Component	Hamburg primary	Hamburg secondary feed	Lünen secondary	Basis
Site Scope 1 (EU ETS)	0.31	0.31	1.10	136,900 t / 442 kt; 160,700 t / 146 kt
Electricity, location-based	0.49	0.49	0.38	610 GWh and 159 GWh × 0.353 t/MWh
Concentrate upstream (mining, concentration, transport)	2.00	–	–	IGMNiR estimate (ICA structure)
Scrap upstream (collection, transport, preparation)	–	0.30	0.30	IGMNiR estimate
Before allocation	2.80	1.10	1.79	
Share allocated to copper	0.75	0.75	0.85	Economic allocation, co-products
Footprint of copper	**2.10**	**0.82**	**1.52**	Direct melting: 0.40 (incremental)

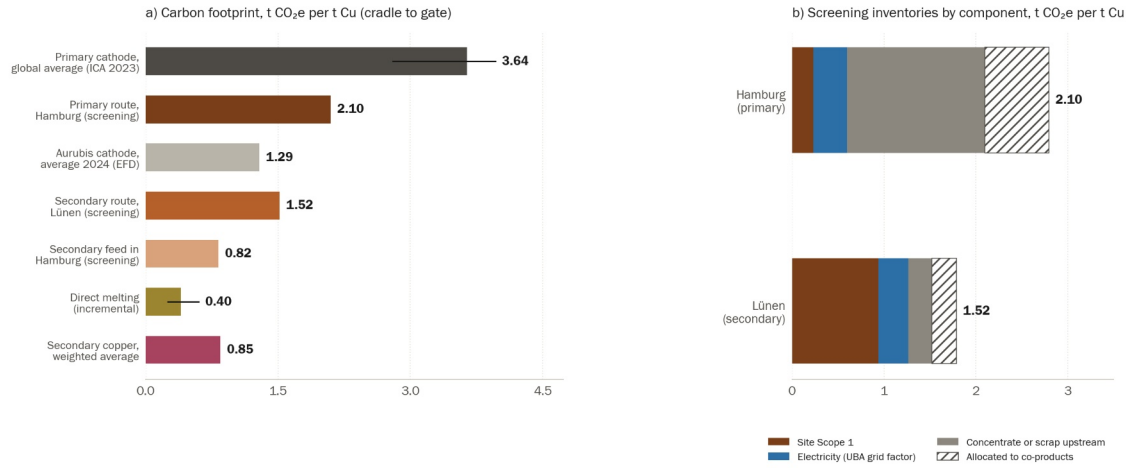
Source: IGMNiR CU-DE v1.0; Aurubis Environmental Statement 2026; DEHSt installation list 2024; UBA (2026). Hamburg data are divided by the copper output of 442 kt reported in the Environmental Statement for 2024, consistent with the BGR total; the Aurubis annual report gives about 350 kt of cathodes for the site in its financial years, which would raise the Hamburg primary footprint by about 0.2 t/t; Hamburg electricity also serves wire-rod casting and the precious-metal refinery. Lünen data are divided by copper produced from recycling feed (146 kt: copper products sold 174 kt less purchased anodes and blister). About half of the Scope 1 emissions of Lünen come from organic carbon in the feed (plastics in electronic scrap). The weighted footprint of secondary refined copper is 1.24 t CO_2e/t and of all secondary copper including direct melting 0.85 t CO_2e/t.

TABLE 24 Products and feed of the Hamburg site and their treatment in the screening inventory, 2024

Flow	Quantity	Treatment in CU-DE	Note
Copper (cathode and wire rod)	441.5 kt copper	Reference flow (denominator)	Wire rod is cast from cathode on site; group wire rod (869 kt) is not split by site
Sulphuric acid	719.6 kt	No burden, no credit	Aurubis credits it by system expansion
Iron silicate	534.2 kt	No burden	Construction material
Silver, gold, platinum-group metals	1,226 t	Economic allocation	Includes refining of group anode slimes
Lead, nickel sulphate, Te/Sn/Se compounds	10.0 / 0.9 / 0.4 kt	Economic allocation	
Feed: concentrate	906.7 kt gross	Upstream footprint estimated	About 28% Cu
Feed: anodes and blister from other smelters	126.6 kt gross (CN 7402, Germany)	Upstream smelting not added	Mainly from Pirdop, Bulgaria
Feed: copper scrap and other copper-bearing materials	13.2 / 165.0 kt	Secondary feed route (HS)	

Source: Aurubis Environmental Statement 2026 (calendar 2024); Aurubis Annual Report 2024/25; Comext. Because the upstream smelting of imported anodes is not added, the Hamburg primary footprint is a lower estimate for that part of the output.

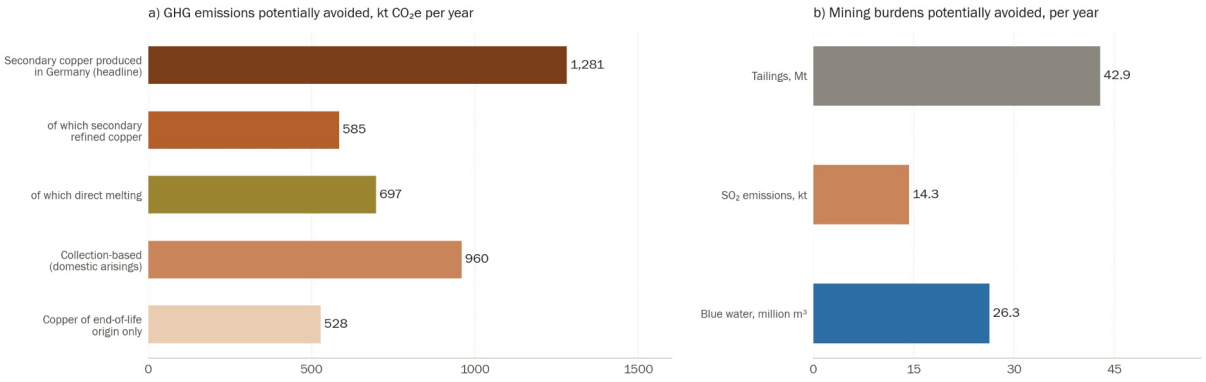
FIGURE 12 Carbon footprint of primary and secondary copper routes



Source: ICA data for 2023 as reported by Aurubis (2026); ICA (2023); Nuss and Eckelman (2014); Aurubis Environmental Statement 2026 and Environmental Footprint Declaration 2026; EUTL 2024; UBA 2026. Hamburg and Lünen: IGMNiR screening inventories with location-based electricity and economic allocation (Chapter 6); not ISO 14044 comparative LCAs. Lines show ranges in Annex B.

On this basis German secondary copper potentially avoided 1,281 kt CO_2e in 2024 (90% band 967–1,447 kt): 585 kt from secondary refined copper and 697 kt from direct melting, which avoids the refining step altogether. Counting only domestic arisings of scrap, the figure is 960 kt, counting only copper of end-of-life origin 528 kt, and with a substitution ratio of 0.5 – the market response estimated by Ryter et al. (2022) – 447 kt. The avoided burdens occur mostly in mining and smelting countries and are not reductions of the German emission inventory. Valued at the 2024 EU ETS price the headline figure corresponds to EUR 83 million, and at the shadow cost of carbon of the European Investment Bank to EUR 266 million.

FIGURE 13 Emissions and mining burdens potentially avoided by German secondary copper, 2024



Source: IGMNiR CU-DE v1.0, module M4; 1:1 substitution of global average primary copper cathode (ICA 2023) by German secondary copper; avoided burdens arise mostly outside Germany. Bars in a) are alternative attributions and are not additive, except the two sub-items of the headline.

7.1 Structural sensitivity

TABLE 25 Structural sensitivity of the emissions and tailings potentially avoided (2024)

Case	Headline, kt CO_2e	Refined only, kt CO_2e	Collection-based, kt CO_2e	Secondary footprint, t/t	Tailings, Mt
Central case	1,281	585	960	0.85	42.9
Substitution 0.8	947	407	710	0.85	34.3
Substitution 0.5 (market response)	447	141	335	0.85	21.4
Copper of end-of-life origin only	705	322	528	0.85	23.6
Displaced primary copper produced in Hamburg	574	209	430	0.85	42.9

Case	Headline, kt CO_2e	Refined only, kt CO_2e	Collection-based, kt CO_2e	Secondary footprint, t/t	Tailings, Mt
Primary footprint 2.80 (Nuss and Eckelman)	896	380	671	0.85	42.9
Primary footprint 3.96 (ICA, 2019 data)	1,430	664	1,072	0.85	42.9
Feed carbon of Lünen attributed to waste treatment	1,350	653	1,011	0.70	42.9
No allocation to co-products	1,215	519	911	0.99	42.9
EU average electricity (213 g/kWh)	1,314	618	985	0.77	42.9
Secondary footprint 1.8 (Nuss and Eckelman)	844	448	632	1.80	42.9
Direct melting 150 kt	1,071	585	935	0.92	36.8
Direct melting 290 kt	1,524	585	981	0.78	49.9

Source: IGMNiR CU-DE v1.0. All cases are positive: secondary copper has a lower footprint than primary copper for every boundary tested. If the displaced primary copper were produced in Hamburg (2.10 t CO_2e/t), the emissions potentially avoided would be 574 kt.

7.2 Boundaries and comparability

The screening inventories are not comparative life-cycle assessments under ISO 14044. They differ from the product footprint that Aurubis publishes for its cathode – a weighted average of 1.29 t CO_2e per tonne in 2024 and 1.25 t in 2025 for five smelters, verified by TÜV Nord – mainly in three respects. First, the Aurubis value is an average over primary and secondary production with a recycled content of about 44%; the implied footprint of Aurubis primary cathode is about 1.35–1.5 t CO_2e per tonne. Second, Aurubis credits sulphuric acid, steam and lead by system expansion, while CU-DE allocates by economic value and gives no burden or credit to acid. Third, Aurubis uses supplier-specific data for its concentrates, while CU-DE uses an estimated average upstream footprint. Electricity is not the cause: Aurubis reports Scope 2 on a market basis, which for Hamburg in 2024 was higher than the location-based value used here. Aurubis does not publish footprints for individual sites. The table below summarises the boundaries.

TABLE 26 System boundaries of the footprints compared

Footprint	Value, t CO_2e/t	Electricity	Co-products	Status
ICA global primary cathode (2023 data, as reported by Aurubis)	3.64	Regional grids	Mass at mining; system expansion and economic allocation at smelting	Industry LCA, ISO 14040/44
Aurubis cathode, weighted average 2024	1.29	Market-based	System expansion; economic allocation for precious metals	Company declaration, verified
CU-DE Hamburg primary route	2.10	Location-based DE	Economic, 75% to copper	Screening estimate
CU-DE Lünen secondary route	1.52	Location-based DE	Economic, 85% to copper	Screening estimate
Nuss and Eckelman (2014), secondary copper	1.8	ecoinvent	ecoinvent	Scientific literature

Source: ICA data for 2023 as reported by Aurubis (2026); ICA (2023); Aurubis Environmental Footprint Declaration (October 2026); Nuss and Eckelman (2014); IGMNiR CU-DE v1.0.

TABLE 27 Methodological characteristics of the footprints used

Element	ICA global primary	Aurubis cathode (EFD)	CU-DE Hamburg primary	CU-DE Lünen secondary	CU-DE direct melting
Functional unit	1 t cathode	1 t cathode (average of 5 smelters)	1 t copper output	1 t copper from recycling feed	1 t copper in semis
System boundary	Cradle to gate	Cradle to gate	Cradle to gate (screening)	Cradle to gate (screening)	Gate to gate, incremental to cathode melting

Element	ICA global primary	Aurubis cathode (EFD)	CU-DE Hamburg primary	CU-DE Lünen secondary	CU-DE direct melting
Allocation	Mass (mining); system expansion and economic (smelting)	System expansion; economic for precious metals	Economic, 75% to copper	Economic, 85% to copper	None
Upstream	Primary data of member mines	Supplier-specific	Estimated 2.0 t/t	Scrap preparation 0.30 t/t	Included in 0.40 t/t
Electricity	Regional grids	Market-based	Location-based, 353 g/kWh	Location-based, 353 g/kWh	Location-based
Recycled content / cut-off	Primary only	44% recycled content	Primary feed	Recycled feed, cut-off at scrap	Scrap, cut-off
Sensitivity in CU-DE	Range 2.8–3.965	Not applicable	Allocation, upstream, grid	Allocation, feed carbon, grid	Range 0.25–0.60
Data quality	Industry LCA (ISO 14040/44)	Company declaration, verified	Site data 2024 plus estimates	Site data 2024 plus estimates	IGMNiR estimate

Source: ICA (2023); Aurubis Environmental Footprint Declaration (2026); IGMNiR CU-DE v1.0.

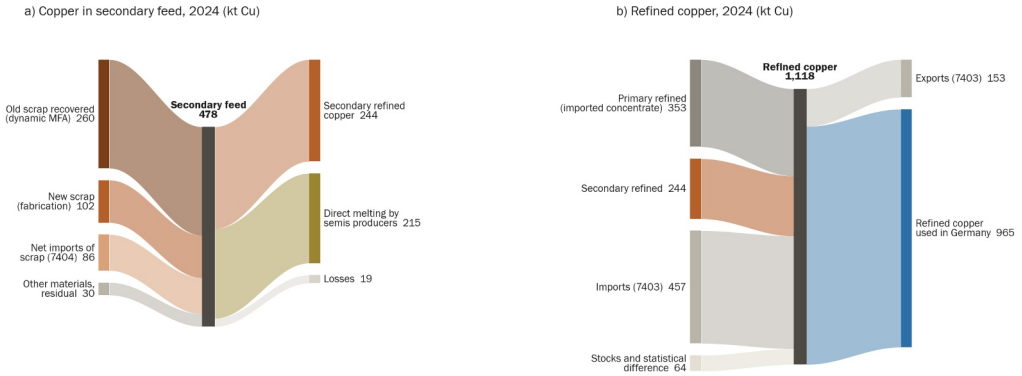
7.3 Uncertainty from the counterfactual

The emissions potentially avoided depend more on the counterfactual than on the inventories. Across the cases in Section 7.1 the headline result ranges from 447 to 1,524 kt CO_2e: a substitution ratio of 0.5 to 1.0 instead of one-for-one, displaced primary copper from Hamburg (2.10 t CO_2e/t) or from a higher-emitting primary supplier (3.965 t, ICA 2019 data) instead of the global average, and the EU electricity mix instead of the German one. Additional low-grade feed in the scenarios carries a 45% higher footprint (Chapter 10). A consequential assessment that identifies the marginal primary producer and the market response of scrap supply was not made. The blue water and tailings figures are potential burdens in mining regions and are not water or waste savings in Germany.

08 Strategic contribution

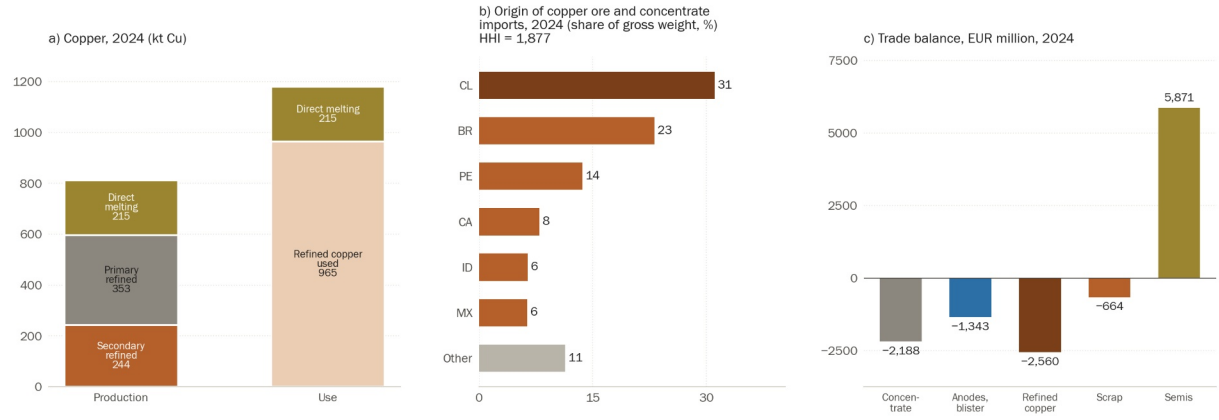
Germany refined 597 kt of copper in 2024, 62% of the 965 kt of refined copper it used. Including direct melting, secondary copper supplied 39% of copper first used. All primary copper is refined from imported concentrate (870 kt gross weight, about 240 kt of copper) and imported anodes (127 kt); Chile supplied 31% of concentrate imports and the five largest suppliers 82% (HHI 1,877). Refined copper imports are less concentrated (HHI 1,179) and come mainly from Belgium, the Netherlands and Poland. Scrap is imported mainly from the Netherlands, Switzerland and France and exported mainly to Belgium, Poland and China.

FIGURE 14 Secondary feed and refined copper in Germany, 2024



Source: BGR Rohstoffsituation 2024 (refined production and use); Eurostat Comext 2024 (CN 7403 at 100% Cu, CN 7404 at 82% Cu in imports and 73% in exports); IGMNiR CU-DE mass balance (M2) and dynamic MFA (M2b). Direct melting and residual items are model estimates.

FIGURE 15 Supply security indicators for copper, 2024



Source: IGMNiR CU-DE v1.0; BGR; Eurostat Comext (DS-045409; imports by country of origin for extra-EU and consignment for intra-EU trade). HHI: Herfindahl–Hirschman index of partner countries (0–10,000).

TABLE 28 Stress indicators for the German copper smelters, 2024 basis

Test	Size	Relative effect
Electricity price +EUR 50/MWh at both smelters	EUR 38.5 m a year	6.3% of smelter GVA; 12.8% of smelter EBITDA
Loss of the largest concentrate supplier (Chile)	75 kt of primary copper	EUR 77 m of D3 GVA if not replaced
Net imports of scrap fall to zero	82 kt of secondary copper	17.9% of secondary copper if not replaced

Test	Size	Relative effect
Interruption of anode and blister imports	113 kt of primary copper	32% of primary refined output; EUR 117 m of D3 GVA if not replaced
Outage of the Hamburg smelter for one month	37 kt of refined copper	6.2% of annual refined output; EUR 39 m of GVA
Outage of the Lünen smelter for one month	12 kt of secondary copper	5.0% of annual secondary refined output; EUR 13 m of GVA
EU ETS position of Lünen at the 2024 price	EUR 2.2 m	Emissions exceed free allocation by 34 kt; Hamburg holds 170 kt more allowances than it emits

Source: IGMNiR CU-DE v1.0. Static, first-order effects at 2024 volumes, without price, substitution or contractual responses; they are not forecasts. Electricity: 769 GWh of the two smelters before compensation. Concentrate: share of the largest partner in gross weight times the copper refined from concentrate (about 240 kt); primary copper from imported anodes is not affected. Outages: one twelfth of annual output, GVA in proportion. For extra-EU imports of concentrate the partner is the country of origin; ports of shipment, mine-level origin and the concentration of world mine production are not analysed.

TABLE 29 Strategic indicators for the copper value chain

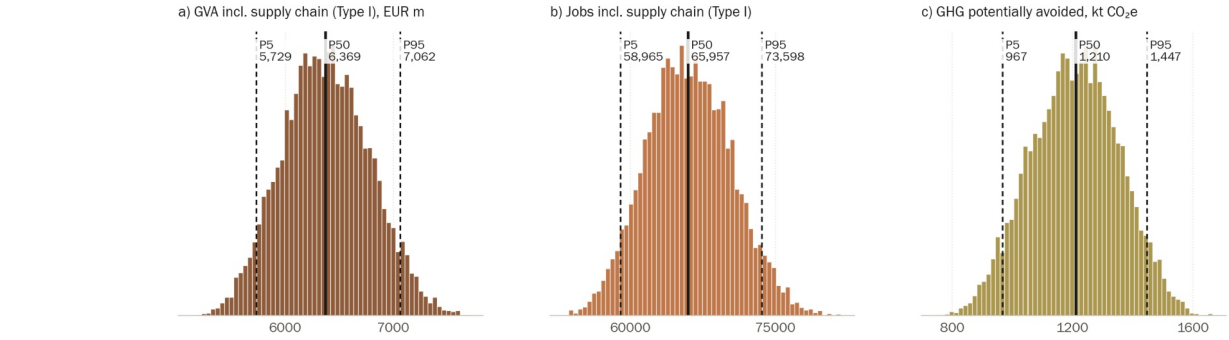
Indicator	Value	Source
Refined production / refined use	62%	BGR
Secondary refined / refined use	25%	BGR
Secondary share of copper first use	39%	CU-DE
Concentrate imports: HHI / top 5 share	1,877 / 82%	Comext
Refined copper imports: HHI / top 5 share	1,179 / 70%	Comext
Scrap imports: HHI / top 5 share	826 / 53%	Comext
Scrap exports: HHI / top 5 share	772 / 55%	Comext
Trade balance in semis (7407–7412), EUR m	+5,871	Comext

HHI by partner country as recorded in trade statistics, gross weight (country of consignment for intra-EU trade, origin for extra-EU imports); trade concentration differs from concentration of mine production, and intra-EU consignment hides the origin of re-exported material. The indicators describe 2024 and are production-based.

09 Uncertainty, checks and limitations

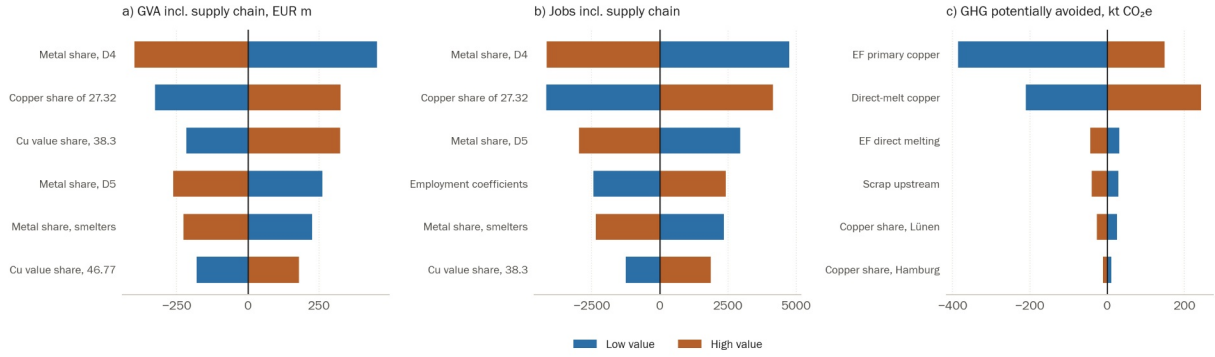
The 90% band of GVA including the supply chain is EUR 5,729–7,062 million, of jobs including the supply chain 59,000–73,600 and of the emissions potentially avoided 967–1,447 kt CO_2e. The economic results are most sensitive to metal share of semis output, copper share of 27.32 and copper value share, 38.3; the emissions to footprint of primary copper and copper from direct melting. The percentiles of these results change by at most 1.2% between random seeds and sample sizes, and little under alternative correlation assumptions and distributions (table below).

FIGURE 16 Monte Carlo distribution of key results



Source: IGMNiR CU-DE v1.0, module M6; 10,000 draws, triangular distributions with Gaussian copula (Annex B), seed 20261118. Parameter-uncertainty band, not a statistical confidence interval.

FIGURE 17 Sensitivity of results to individual parameters



Source: IGMNiR CU-DE v1.0, module M6; one-at-a-time sensitivity on Annex B ranges; extended value chain.

TABLE 30 Robustness of the uncertainty band to the statistical design

Design	GVA Type I, EUR m (P5–P95)	Jobs Type I (P5–P95)	GHG avoided, kt (P5–P95)
Reference (4,000 draws, seed 7)	5,721–7,040	58,900–73,400	966–1,441
No correlation	5,898–6,880	60,800–71,600	965–1,441
Correlation 0.95 in all groups	5,665–7,085	58,300–73,900	966–1,440
PERT distributions	5,746–6,957	59,200–72,600	1,031–1,454

Source: IGMNiR CU-DE v1.0, module M6. Separate test design (4,000 draws, seed 7) compared with the headline run (10,000 draws, seed 20261118).

TABLE 31 Structural tests of the economic and fiscal results

Case	GVA D1+D2	GVA D1–D5	GVA Type I	Jobs Type I	Taxes
Central case	859	4,071	6,328	65,600	2,410
Supply-chain effects −20%	859	4,071	5,876	60,700	2,253
Supply-chain effects +20%	859	4,071	6,779	70,400	2,566
FIGARO 2023 instead of 2024	859	4,071	6,319	65,000	2,361
Smelter EBITDA EUR 230 m	830	4,071	6,328	65,600	2,419
Smelter EBITDA EUR 380 m	891	4,071	6,328	65,600	2,399
Metal share of smelters 87%	859	4,071	6,553	67,900	2,485
Metal share of smelters 93%	859	4,071	6,102	63,200	2,334
Copper share of cables 60%	859	3,859	6,002	61,400	2,277
Copper share of cables 90%	859	4,282	6,653	69,700	2,543
Copper-only, economic allocation	783	3,886	6,027	63,400	2,319
Compensation kept in GVA	867	4,115	6,346	65,300	2,404
Joint parameter extremes, low	577	3,468	4,325	45,000	1,716
Joint parameter extremes, high	1,114	4,538	8,875	93,000	3,306

Source: IGMNiR CU-DE v1.0. EUR million and persons. Joint low: low copper value and employment shares of scrap trade and recovery, low copper share of cables, high metal shares of smelters, semis and cables, supply-chain effects −20%, economic allocation. Joint high: the opposite, without allocation. Each case combines several parameter extremes at once.

TABLE 32 Parameter-uncertainty band and range of structural cases

Result	P5	P95	Structural minimum	Structural maximum
GVA Type I, EUR m	5,729	7,062	4,325	8,875
Jobs Type I	59,000	73,600	45,000	93,000
GHG potentially avoided, kt CO_2e	967	1,447	447	1,524

Source: IGMNiR CU-DE v1.0. The structural range covers the cases in the tables above, which change boundaries, datasets or allocation rules or combine several parameter extremes at once; the Monte Carlo band reflects joint parameter uncertainty with correlations. The two ranges answer different questions and are not combined.

9.1 Consistency checks

TABLE 33 Consistency checks of the CU-DE model

Check	Model or source 1	Reference	Reference source
Refined copper: BGR national total vs Aurubis Hamburg + Lünen, kt	597.0	606.6	BGR; Aurubis ES 2026
Wire rod: WVMetalle vs PRODCOM, kt	634.1	650.1	WVMetalle; PRODCOM 24442330
Employment: model total vs national accounts 2024 (construction check), thousand	45,960	45,960	FIGARO; nama_10_a64_e
Smelters + D4, value added at factor cost vs SBS 24.44, EUR m	2,303	2,303	Identity by construction
Smelter employment vs SBS 24.44 employment, persons	3,223	20,556	Aurubis AG; SBS
Copper in cables (model) vs domestic availability of wire rod, kt	297	319	WVMetalle; Comext 7408
Domestic scrap supply: bottom-up vs residual, kt Cu	362	392	Dynamic model (M2b); feed and trade
EU ETS: verified emissions vs free allocation, kt CO_2	297.6	433.8	DEHSt
Copper firms' compensation vs non-ferrous total, EUR m	55.2	369.7	DEHSt

Source: IGMNiR CU-DE v1.0. Rows 1–2 compare independent sources; rows 3–5 test the construction; rows 6–7 compare model estimates with independent data; rows 8–9 give context.

9.2 Limitations

- **Smelter accounts.** Aurubis AG does not publish EBITDA or separate accounts for Hamburg and Lünen; smelter EBITDA is triangulated from group and single-entity data, and the split into secondary and primary copper uses the national output share.
- **Direct melting.** The quantity of scrap melted directly by semis producers is not published and is estimated from the difference between copper in semis and refined copper used; it drives the physical and environmental results for secondary copper.
- **Dynamic model.** The inflow history before 2020 is reconstructed from an EU anchor and a linear path, the lifetimes are EU averages and the collection rates global averages; many end-of-life vehicles leave Germany as used cars, so recovery from transport may be lower. The stock and scrap flows are model results, not observations.
- **Environmental inventories.** The route inventories are screening estimates with estimated upstream footprints and allocation shares; they are not ISO 14044 comparative assessments. Substitution of primary copper is assumed one-for-one in the headline case.
- **Input-output model.** FIGARO 2024 is partly projected by Eurostat; multipliers assume fixed technical coefficients and unconstrained supply; results are gross contributions.
- **Economic structure.** FIGARO aggregates copper with other basic metals (CPA C24) and cables with other electrical equipment (CPA C27); German national input-output tables were not used. The split of the smelters into D2 and D3 uses keys, as site results are not published.
- **Scenarios.** The scenarios have no feedback between scrap prices, scrap quality, export decisions, product replacement and plant capacities.
- **Trade data.** HHI uses partner countries in trade statistics; intra-EU trade is recorded by consignment, and gross weight of concentrate and scrap differs from copper content.

10 Scenarios to 2035

The scenarios are illustrative combinations of assumptions, not forecasts. They keep 2024 prices and input-output coefficients and change volumes, footprints and labour productivity (+1% a year). Old scrap recovered follows the dynamic model. S1 (2030) assumes moderate growth of secondary refining – for example through the second TBRC furnace in Lünen – and of cable production for grid expansion; S2 (2035) a high-circularity path with secondary refining at the assumed capacity and lower footprints of both routes; S3 (2030) a stress path with lower primary and secondary output and lower semis production.

TABLE 34 Scenario assumptions (change versus 2024)

Driver	S1 2030	S2 2035	S3 2030
Secondary refined copper	+10%	+25%	−15%
Direct melting of scrap	+5%	+10%	−10%
Scrap collection and trade (D1)	+5%	+12%	−10%
Primary refined copper (D3)	0%	−5%	−20%
Semis and castings (D4)	0%	+5%	−10%
Copper in cables (D5)	+10%	+20%	0%
Footprint of primary copper	−5%	−12%	−5%
Footprint of secondary copper	−15%	−30%	−5%

Source: IGMNiR CU-DE v1.0. Secondary refining is limited to 300 kt and total refining to 650 kt. Additional secondary feed has a lower recovery (90%) and a 45% higher footprint than the 2024 feed mix, reflecting the higher organic carbon of low-grade electronic scrap per tonne of copper. The capacity of the smelting furnaces for low-grade raw materials is not modelled separately.

TABLE 35 Copper balance in the scenarios (kt Cu)

Item	2024	S1 2030	S2 2035	S3 2030
Secondary refined copper	244	268	300	207
Direct melting	215	226	237	194
Primary refined copper	353	353	336	283
Old scrap recovered (dynamic model)	260	267	271	267
Additional copper in secondary feed vs 2024	0	38	85	−61
Additional domestic scrap vs 2024 (old and new)	0	7	16	−3
Difference to be met by imports or higher collection	0	31	68	−58

Source: IGMNiR CU-DE v1.0. In S2 secondary refining reaches the assumed capacity; at 20–30% copper in additional low-grade feed, the additional raw material would be about 190–280 kt a year, compared with 313 kt of recycling raw materials processed in Lünen in 2024. A positive difference means that the scenario requires more secondary feed than the dynamic model projects from domestic sources at constant collection and recovery rates; a negative difference means that domestic scrap is freed for other uses or exports.

TABLE 36 Physical interpretation of a lower secondary footprint in S2 (example for Lünen)

Component	2024	S2 2035, example	Change assumed
Lünen Scope 1, t CO_2/t	1.10	0.83	Lower fuel and reductant use, partly biogenic reductants (−25%)
Electricity, t CO_2/t	0.38	0.22	Grid factor 200 g/kWh in 2035
Scrap upstream, t CO_2e/t	0.30	0.26	Lower-carbon transport (−15%)
Lünen footprint after allocation, t CO_2e/t	1.52	1.10	Scenario assumption for all secondary routes: 30% lower (1.06 for Lünen)

Source: IGMNiR CU-DE v1.0. The changes are examples consistent with the assumed reduction; their technical and economic feasibility has not been assessed.

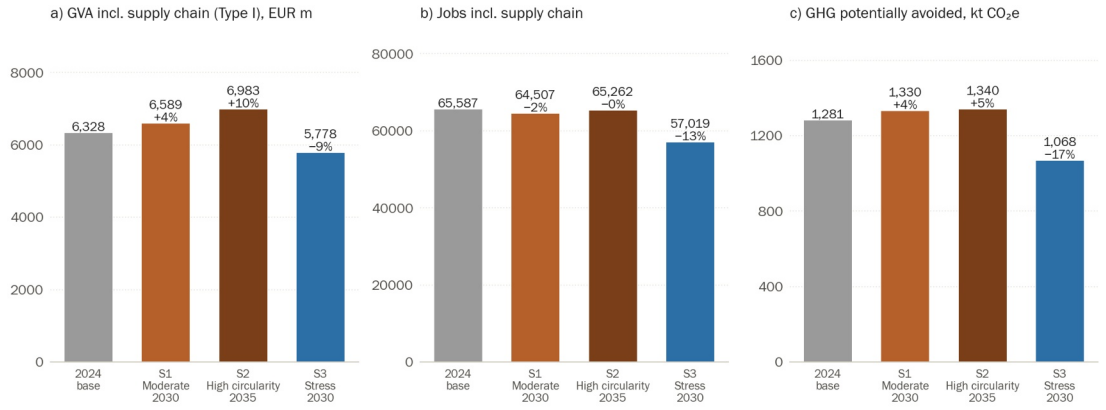
TABLE 37 Decomposition of the change in emissions potentially avoided from 2024 to scenario S2, kt CO_2e

Step	Emissions avoided	Change
2024 base	1,281	–
More secondary copper (volume)	1,486	205
Lower-grade marginal feed	1,455	−31
Lower secondary footprint	1,574	119
Lower primary footprint	1,340	−234
S2 2035	1,340	58

Source: IGMNiR CU-DE v1.0; sequential decomposition in the order shown. A lower footprint of primary copper reduces the emissions avoided by each tonne of secondary copper.

In S1 direct value added rises to EUR 4,232 million and in S2 to EUR 4,485 million; in S3 it falls to EUR 3,721 million. Employment including the supply chain changes less than value added because labour productivity grows by 1% a year; without this adjustment jobs including the supply chain would be 72,800 in S2. Emissions potentially avoided rise to 1,340 kt in S2: the effect of more secondary copper and of its lower footprint is partly offset by a lower footprint of the primary copper it replaces.

FIGURE 18 Scenario results: change versus 2024



Source: IGMNiR CU-DE v1.0; 2024 prices; assumptions in the scenario table; labour productivity +1% a year; footprints of both routes decline over time.

11 Summary

The copper value chain is a significant part of German manufacturing. It generated about EUR 4,070 million of direct value added in 2024 and EUR 6,330 million with its domestic supply chain, and supported about 65,600 jobs including the supply chain. Semis, castings and cables account for most of the value added and employment; the two smelters account for 15% of direct value added and process mostly imported concentrate, anodes and secondary materials.

Secondary copper – 244 kt refined and about 220 kt melted directly – supplied 39% of copper first used in Germany. The copper stock in use of about 13.7 Mt releases about 500 kt a year at end of life, of which about half is recovered. Replacing primary copper, German secondary copper potentially avoided about 1,280 kt CO_2e and 43 Mt of tailings in 2024, mostly outside Germany. Refined output covers 62% of refined copper used; concentrate comes mainly from Chile, Brazil and Peru, while scrap is traded mainly within Europe.

The results depend most on the copper shares of scrap trading and cable production, on the metal shares of semis and smelters and, for emissions, on the footprint of primary copper and the quantity of scrap melted directly. In the scenarios to 2035 direct value added ranges from EUR 3,720 million (stress, 2030) to EUR 4,480 million (high circularity, 2035). In the high-circularity scenario secondary refining reaches the assumed capacity and the additional secondary feed exceeds the growth of domestic scrap projected by the dynamic model by about 68 kt of copper.

A Data sources and trade

TABLE 38 Main data sources of the CU-DE model

Domain	Source	Use in CU-DE
Company accounts and environmental reports	Aurubis AG annual reports 2023/24 and 2024/25 (incl. HGB statements of Aurubis AG); Environmental Statement 2026 (EMAS); Environmental Footprint Declaration 2026; Wieland, KME, Diehl, LEONI, NKT reports	D2–D3: revenue, personnel, employment, taxes; site production, energy and emissions; company context
Copper balance and production	BGR, Deutschland – Rohstoffsituation 2024; WVMetalle Quartalsbericht 02/2025 and Metallstatistik	Refined production (primary, secondary) and use; semis and castings
Structural business statistics	Eurostat sbs_ovw_act, 2021–2024	Output, value added, employment, labour costs (46.77, 38.3, 24.44, 24.54, 27.32)
Input-output and national accounts	Eurostat FIGARO naio_10_fcp_ip4, 2024 (2023 as test); nama_10_a64(_e)	Domestic coefficients, value added, household demand; employment
Foreign trade and production	Eurostat Comext DS-045409, 2015–2025; PRODCOM 2024	CN 2603, 7401–7413, 262030, 7112, 8549; wire rod and semis
Emissions and aid	DEHSt installation list 2024 and electricity price compensation reports 2023–2024; UBA grid factor	Verified emissions, free allocation; compensation; electricity CO_2 factor
Dynamic model of copper in use	Passarini et al. (2018, JRC); Glöser et al. (2013); Destatis population	End-use shares, lifetimes, collection and recovery rates
Life-cycle data	ICA (2023); Nuss and Eckelman (2014); Aurubis (2026)	Footprints, energy, tailings, acidification, water

Eurostat data as available on 31 October 2026.

TABLE 39 Foreign trade in copper by product, 2024

CN	Product	Imports, kt	Exports, kt	Imports, EUR m	Exports, EUR m	Balance, EUR m
2603	Copper ores and concentrates	869.9	38.7	2,284	96	−2,188
7401	Copper mattes, cement copper	3.1	11.4	14	57	43
7402	Unrefined copper, anodes	126.6	5.7	1,423	80	−1,343
7403	Refined copper and alloys, unwrought	456.9	152.7	3,859	1,298	−2,560
7404	Copper waste and scrap	464.9	403.9	2,951	2,287	−664
7405	Master alloys of copper	6.0	0.7	52	8	−45
7406	Copper powders and flakes	6.0	8.2	67	121	54
7407	Copper bars, rods and profiles	61.7	116.5	504	966	462
7408	Copper wire	90.7	405.3	813	3,683	2,870
7409	Copper plates, sheets and strip	59.4	194.5	580	2,209	1,628
7410	Copper foil	5.0	5.8	88	113	25
7411	Copper tubes and pipes	33.1	69.8	363	784	421
7412	Copper tube or pipe fittings	23.7	26.6	486	951	465
7413	Stranded wire and cables of copper	20.0	37.4	200	357	157

Source: Eurostat Comext (DS-045409), 2024. Quantities in gross weight. Flows include re-exports. BGR reports slightly different quantities for some codes (e.g. scrap imports 460 kt) because of a different trade concept.

TABLE 40 First-round domestic demand by segment and product group, 2024 (EUR m)

Product group (CPA)	D1	D2	D3	D4	D5
Electricity, gas, steam	20.6	41.7	60.5	201.1	24.3
Coke and refined petroleum	11.1	9.2	13.3	44.2	3.1
Chemicals	4.5	7.1	10.3	34.3	2.9
Rubber and plastics	5.0	0.7	0.9	3.1	23.6
Transport and storage	130.2	30.9	44.9	149.1	63.2
Repair and installation	2.2	21.4	31.0	103.0	23.3
Fabricated metal, machinery	16.7	9.3	13.5	44.8	66.4
Professional and support services	212.4	35.9	52.1	172.9	166.5
Trade (excl. scrap wholesale)	18.8	4.7	6.8	22.4	42.6
Other products	216.8	41.1	59.6	198.1	299.4
Total domestic first-round demand	638.2	201.9	293.0	973.1	715.3
Non-metal intermediate consumption incl. imports	973.5	269.2	390.6	1,297.4	995.2
Domestic share of non-chain intermediate consumption	66%	75%	75%	75%	72%

Source: IGMNiR CU-DE v1.0; FIGARO 2024 domestic and all-origin coefficients. Purchases of metals, ores, scrap and scrap wholesale (CPA_C24, CPA_B, CPA_G46, CPA_E37-39) are excluded as purchases within the chain; the domestic share follows the FIGARO input structure of the parent product. The full vectors by 64 CPA products are in the model package (file 04).

TABLE 41 Specification of the input-output module

Element	Specification
Table	Eurostat FIGARO, product-by-product, 2024 (naio_10_fcp_ip4, edition of July 2026); 2023 table as a structural test; domestic block (origin DE), 64 CPA products
Multipliers	Type I: $L = (I - A_d)^{-1}$; Type II: households endogenised – labour income × (1 − tax rate on labour) × propensity to consume, spent with the domestic household consumption structure of FIGARO
Employment	Persons employed 2024 (nama_10_a64_e) per unit of output, by CPA product
D1 first round	Input structure of CPA_G46 (46.77) and CPA_E37-39 (38.3), scaled to output minus GVA of the copper share
D2–D5 first round	Non-metal intermediate inputs = output − GVA − metal share × output; distributed with the all-origin structure of CPA_C24 (D2–D4) or CPA_C27 (D5) excluding metals, ores and scrap; domestic part enters the Leontief model
Taxes and subsidies	Tax rate on labour × labour cost; income taxes 30% × taxable share of operating surplus (Aurubis AG: observed income taxes); taxes on production from FIGARO coefficients; electricity price compensation as an other subsidy on production, deducted from GVA

Model package. The CU-DE package archived by IGMNiR contains the model modules M1–M6 and M2b (Python), all input data with extraction dates and dataset codes, the parameter file with sources and ranges (Annex B), scenario definitions, automated consistency checks and the run log. Machine-readable files accompany each run: results by segment, first-round demand vectors, the copper balance and dynamic-model series, route inventories, parameters with reliability classes and the correlation matrix, Monte Carlo summaries and a SHA-256 manifest. A replication script recomputes direct and Type I value added and employment from these files (largest difference 0.001); a quality-control script checks the key numbers in both language versions. Run ID: CUDE-1.0-d63adeda8b.

TABLE 42 Input data files of the model package

File	Content	Size, KB	SHA-256 (first 16 characters)
comext_de_other_sec.csv	Comext, other secondary materials	13	8f43f6e3b8cb9e81
comext_de_partners.csv	Comext, copper trade by partner	189	339272d58b7deb57
comext_de_world.csv	Comext, copper trade with the world	40	d94762085e5dc3cc
de_facilities.csv	Installations (Annex C)	2	6677227d32fe1d6b

File	Content	Size, KB	SHA-256 (first 16 characters)
figaro_de_2023.csv	FIGARO 2023, use by Germany (naio_10_fcp_ip4)	9,490	eb8622e8cff41789
figaro_de_2024.csv	FIGARO 2024, use by Germany (naio_10_fcp_ip4)	9,489	7e5784cf9455ac7d
nama_emp.csv	Employment by industry (nama_10_a64_e)	10	6a0609739ba3fbe2
nama_gva.csv	Output and value added by industry (nama_10_a64)	28	5e7983191eaeba4c
prodcom_de.csv	PRODCOM, copper products	12	2d524781a4246bf3
sbs_de.csv	Structural business statistics, Germany (sbs_ovw_act)	18	0858d2710d14f64a

Source: IGMNiR CU-DE v1.0, package file 09 (full hashes of code, data and results). Eurostat data extracted on 31 October and 8 November 2026.

B Parameters and uncertainty ranges

Each uncertain parameter is described by a triangular distribution (low, central, high) within one dataset family; alternative datasets, boundaries and allocation rules are treated as structural cases (sections 7.1 and 9). Reliability classes: A – official statistics, scientific literature or company financial statements; B – industry or company data; C – IGMNiR assumption or derived value.

TABLE 43 CU-DE parameters

Parameter	Central	Low	High	Class	Basis and source
Copper value share, 46.77	0.200	0.140	0.260	A/C	NF share of 46.77 value ($_{0.45}$) x copper share of NF scrap value handled in Germany ($_{0.45}$; Comext CN 7404 imports and exports EUR 5.2 bn in 2024)
Copper employment share, 46.77	0.120	0.080	0.170	C	NF employment share of 46.77 ($_{0.30}$) x copper share of NF scrap tonnage handled ($_{0.4}$)
Copper value share, 38.3	0.050	0.030	0.080	C	copper share of value of NACE 38.3 in Germany (materials recovery of all waste streams: ferrous, paper, plastics, glass, NF): cable granulation, WEEE and ELV dismantling
Copper employment share, 38.3	0.045	0.025	0.070	C	copper share of 38.3 employment
Secondary share of refining	0.408	0.370	0.450	A/C	secondary share of German refined copper production: 243.6 of 597.0 kt in 2024 (BGR Rohstoffsituation 2024, Table 35); low end Lünen and Hamburg secondary by employment, high end incl. secondary anodes from other Aurubis sites
EBITDA of smelters, EUR m	300	230	380	B/C	EBITDA of the German smelting and refining operations (Hamburg, Lünen), EUR m: group operating EBITDA EUR 614 m (calendar-2024 weighted, Aurubis AR 2024/25) x German share of group cathode output 0.55 = 338; Aurubis AG (HGB) EBT EUR 153 m + estimated depreciation and net interest ~110 = 263
Metal share of smelter output	0.900	0.870	0.930	B/C	metal-bearing materials (concentrates, anodes, blister, scrap and residues) / output of the smelters: payable metal value bought at LME less treatment and refining charges (Aurubis group cost of materials ~90% of revenue)
Metal share of semis output	0.680	0.600	0.750	A/C	metal share of output value of copper and copper-alloy semis: KME SE 2024 revenue EUR 1,540.8 m, revenue net of metal EUR 499.0 m (KME Group annual report 2024)
Copper-alloy share of 24.54	0.600	0.450	0.750	B/C	copper-alloy share of NACE 24.54 (casting of other non-ferrous metals; rest mainly zinc die-castings): BDG 69.9 kt copper castings 2024
Copper share of 27.32	0.750	0.600	0.900	C	copper-conductor share of activity of NACE 27.32 (wires and cables; rest aluminium conductors and optical fibre)
Copper share of cable output value	0.550	0.450	0.650	A/C	copper share of output value of wires and cables: implied copper ~300 kt (m5 x cu_cable x output / LME), in line with domestic availability of wire rod (634 kt produced, WVMetalle, less 315 kt net exports of wire CN 7408)

Parameter	Central	Low	High	Class	Basis and source
Copper from direct melting, kt	215	150	290	C	copper from scrap melted directly by semis producers and foundries, kt Cu: copper in semis 1,130 kt (1,254 kt gross, WVMetalle 2024, x 0.90 Cu; brass about half of rolled, pressed and drawn products) less refined copper used 917 kt (965 kt, BGR/ICSG, x 0.95 to semis)
Copper recovery, smelters	0.950	0.920	0.970	C	copper recovered in refined copper per t of copper in secondary feed of smelters
Copper content of scrap (CN 7404)	0.820	0.720	0.900	A/C	copper content of imported scrap CN 7404: unit value EUR 6,350/t = 0.75 of LME at a payable ratio of ~0.91; exports have a content 0.09 lower (unit value EUR 5,660/t = 0.67 of LME)
New scrap per t of copper in semis	0.090	0.060	0.130	C	new (fabrication) scrap arising in Germany per t of copper in semis: wire drawing 3% of domestically used wire rod (319 kt) and 30% of domestically used rolled, pressed and drawn products (378 kt gross, 86% Cu), about 107 kt; scrap from fabrication of exported semis arises abroad
Per-capita inflow vs EU-28	1.10	0.90	1.30	C	German per-capita inflow of copper into use relative to EU-28 2014 (5.91 kg/cap: 2,997 kt, JRC Passarini et al. 2018); top-down check: first use 1,180 kt less net exports of semis 545 kt and of copper in products
Inflow 1960 vs 1990	0.550	0.400	0.700	C	per-capita inflow in 1960 relative to 1990-2019
Inflow growth 2025–2035, per year	0.010	0.000	0.025	C	annual growth of per-capita inflow 2025-2035 (electrification, grids, e-mobility)
Scaling of product lifetimes	1.00	0.80	1.20	A/C	scaling of mean product lifetimes (JRC: building 40, electrical 25, machinery 18, transport 16, consumer 8 years; SD 0.3 x mean)
Scaling of collection and recovery	1.00	0.90	1.15	A/C	scaling of end-of-life collection and recovery rates by waste stream (Glöser et al. 2013, global 2010) for Germany
Propensity to consume	0.880	0.840	0.920	C	average propensity to consume out of net labour income; household saving ratio Germany ~11%
Tax rate on labour	0.363	0.350	0.479	A/C	tax rate on labour income incl. social contributions: implicit tax rate on labour, Germany 2024, 36.3% (Eurostat, Data on Taxation Trends 2026; 36.0% in 2023); upper bound OECD tax wedge for a single worker at the average wage, 47.9% (Taxing Wages 2025, 2024)
Scaling of employment coefficients	1.00	0.90	1.10	C	uncertainty of FIGARO employment coefficients
Taxable share of operating surplus	0.450	0.300	0.600	C	operating surplus net of production taxes, depreciation, interest and losses
Footprint of primary copper, t CO_2e/t	3.64	2.80	3.96	B/A	primary copper cathode, global average, cradle-to-gate: ICA (2023 data, as reported in the Aurubis Environmental Footprint Declaration 2026) 3.64 t CO2e/t; ICA Copper Environmental Profile 2023 (2019 data) 3.965; Nuss and Eckelman 2014 2.8
Concentrate upstream, t CO_2e/t	2.00	1.40	2.80	C	mining, concentration and transport of concentrate per t of copper cathode, t CO2e (ICA: mining and concentration dominate the cradle-to-gate footprint)

Parameter	Central	Low	High	Class	Basis and source
Copper share of Hamburg burden	0.750	0.650	0.850	C	share of the Hamburg burden allocated to copper: economic allocation by value of copper, precious metals (precious-metal refinery, 1,226 t Ag, Au, PGM), lead, nickel sulphate and minor metals (group copper share of metal value ~0.70); sulphuric acid and iron silicate carry no burden
Scrap upstream, t CO_2e/t	0.300	0.150	0.500	C	collection, transport, shredding and sorting of copper scrap and e-scrap per t of copper, t CO2e
Copper share of Lünen burden	0.850	0.750	0.950	C	share of the Lünen burden allocated to copper: tin, nickel sulphate, zinc oxide (KRS oxide) and precious metals in slimes from electronic scrap; electrorefining in ecoinvent 97.5% to cathode
Direct melting, incremental, t CO_2e/t	0.400	0.250	0.600	C	scrap collection and preparation (as up_scrap) plus additional melting and refining of directly melted scrap relative to melting cathode, t CO2e/t Cu
German grid factor, t CO_2/MWh	0.353	0.330	0.380	A	German electricity mix, direct CO2 per MWh: UBA Climate Change 16/2026: 353 g/kWh in 2024 (provisional; 363 in the 2025 edition), 344 in 2025 (estimate), 379 in 2023
Primary energy, primary copper, GJ/t	53.7	42.1	68.6	A	primary energy (cumulative energy demand), primary copper, GJ/t: Nuss and Eckelman 2014, 53.7 (42.1-68.6)
Primary energy, secondary copper, GJ/t	22.0	17.0	28.1	A/C	primary energy, secondary copper (Lünen route), GJ/t: site final energy 2.92 MWh/t (ES 2026) with electricity at primary-energy factor ~2.5, scrap upstream; Nuss and Eckelman 2014 secondary 28.1
Primary energy, direct melting, GJ/t	5.00	3.00	8.00	C	additional primary energy of direct melting relative to cathode, GJ/t
End-of-life share of secondary feed	0.550	0.450	0.650	B/C	share of copper in secondary feed originating from end-of-life products (ICA Europe: old scrap 27% and new scrap 28% of EU demand)
Tailings per t, t	93.5	84.0	103.0	B/C	t of flotation tailings per t of primary cathode: ICA global 93.5, +/-10%
SO_2 per t, kg	31.2	15.0	35.0	B	kg SO2 emitted per t of primary cathode, ICA global life-cycle inventory
Blue water per t, m^3	57.3	40.0	75.0	B	blue water consumption of primary copper, m3 per t (ICA 2023 LCA)
EU ETS price, EUR/t	64.8	60.0	74.0	A	EU ETS average 2024 (EEA)
Shadow cost of carbon, EUR/t	208	164	314	A	EIB shadow cost of carbon 2025, EUR 165/t (130-250) in 2016 prices, rebased to 2024 prices with the euro-area HICP (126.07/100.23)

Correlated groups (Gaussian copula parameter): copper shares of scrap trade and recovery (ρ = 0.8); primary footprint, primary energy and concentrate upstream (0.7); allocation shares of the two smelters (0.5); metal shares of smelters, semis and cables (0.7); direct melting and new-scrap rate (0.3); lifetimes and per-capita inflow (−0.3). Fixed inputs: copper price EUR 8,446/t (LME 2024 at the ECB rate), company and site data for 2024 (Chapter 3), BGR balance, dynamic-model shares and rates (Chapter 4), capacities in the scenarios (Chapter 10).

C Installations of the copper value chain

TABLE 44 Main copper installations in Germany

No.	Installation and activity	Town	Segment
1	Aurubis: primary smelter and refinery; wire rod	Hamburg	D2, D3
2	Aurubis: secondary smelter (KRS)	Lünen	D2, D3
3	Aurubis Stolberg: strip and specialty wire	Stolberg	D4
4	Schwermetall Halbzeugwerk: pre-rolled strip	Stolberg	D4
5	Deutsche Giessdraht (Aurubis): wire rod	Emmerich	D4
6	Wieland-Werke: strip; tubes; rods	Ulm, Vöhringen	D4
7	Wieland: rods and wire	Velbert-Langenberg	D4
8	Wieland: strip	Villingen-Schwenningen	D4
9	KME Germany: strip; tubes; moulds	Osnabrück	D4
10	KME Mansfeld (MKM): wire; strip; tubes	Hettstedt	D4
11	Diehl Metall: brass rods and strip	Röthenbach	D4
12	Sundwiger Messingwerk (KME): brass strip	Hemer	D4
13	Gebr. Kemper: strip and castings	Olpe	D4
14	LEONI: wires and cables	Nürnberg	D5
15	NKT: power cables	Köln	D5
16	Prysmian (Draka): cables	Neustadt b. Coburg	D5
17	Südkabel: high-voltage cables	Mannheim	D5
18	Lapp: cables	Stuttgart	D5
19	TSR Recycling: ferrous and non-ferrous scrap	Lünen	D1
20	Kupferschiefer Lausitz: copper project (spatial compatibility not established, 2023; new review pending)	Spremberg	outside model

Locations at town level. The list covers major installations identified in company reports and websites (2024–2026); it is not exhaustive for semis producers, foundries, cable makers and recyclers.

D Glossary

- **Potentially avoided burden** – environmental credit for displacing primary production with secondary material, conditional on the substitution assumed.
- **Coverage ratio** – output relative to use; not a measure of self-sufficiency.
- **Direct melting** – melting of clean copper and copper-alloy scrap by semis producers and foundries without refining to cathode.
- **Dynamic material-flow model** – model that tracks copper entering use by year and end use and its release at end of life after a distributed product lifetime.
- **Electricity price compensation (Strompreiskompensation)** – state aid compensating part of the indirect emission costs passed through in electricity prices; in national accounts an other subsidy on production (D.39), outside value added at basic prices.
- **End-of-life recycling rate** – share of copper in end-of-life products that is recovered as secondary copper.
- **GVA** – gross value added: output minus intermediate consumption; for the smelters estimated as EBITDA plus personnel expenses plus other taxes on production, less operating subsidies.
- **Gross contribution / net effect** – activity associated with the chain at fixed coefficients / change that would result from a policy or shock after resources are reallocated; the report shows gross contributions only.
- **HHI** – Herfindahl–Hirschman index of concentration (0–10,000).
- **New and old scrap** – scrap from fabrication of semis and products / scrap from products at the end of their life.
- **Observation / estimate / model result (O/E/M)** – status of a figure: published data / data combined with allocations or calibrated parameters / result depending on counterfactual or dynamic assumptions.
- **TBRC** – top-blown rotary converter, a furnace used to smelt complex secondary materials.
- **Type I / Type II effects** – direct plus supply-chain effects / plus effects induced by household spending.

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Izba Gospodarcza Metali Nieżelaznych i Recyklingu

CU-DE is a transparent, reproducible model linking official German and EU statistics, company financial and environmental reports, the EU emissions registry, a dynamic model of copper in use and the process metallurgy of copper. It estimates the gross economic and fiscal contribution of the copper industry in Germany – collection and trade of scrap, secondary and primary refined copper, semis, castings and cables – the public support it receives, the emissions and other burdens potentially avoided by secondary copper, and the industry's importance for the security of supply.

SUGGESTED CITATION

IGMNiR (2026), Copper in the German economy: value, circularity and security of supply. An integrated assessment of the copper industry in Germany (CU-DE model). Economic Chamber of Non-Ferrous Metals and Recycling, November 2026.