Project report

RWI – Leibniz Institute for Economic Research

Economic Significance of the Steel Scrap Recycling Industry

Study commissioned by Bundesvereinigung Deutscher Stahlrecycling- und Entsorgungsunternehmen e.V.

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RWI Project report

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Economic Significance of the Steel Scrap Recycling Industry
Final report
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1. Initial situation

Steel is a key input for numerous industrial sectors in Germany and the EU. In crude steel production, the central importance of recycling steel scrap for resource conservation and process optimization was recognized early on (Berg 2014). The implementation of circular economy goals increasingly requires the establishment of closed cycles for steel as a material to conserve resources and reduce CO_2 emissions. These developments have led to (stainless) steel scrap[1] becoming an important sustainable resource for the German and European economy and gaining great economic significance for numerous industries and the economy.

The key advantages of (stainless) steel recycling are obvious:

- The use of steel and stainless-steel scrap in the production of new steels is a prerequisite for manufacturing the quantities of steel required and in demand in Germany and the EU.
- Steel and stainless steel can be remelted indefinitely without any loss of quality, apart from minor melting losses (Neugebauer et al. 2013, Hiebel, Nühlen 2016). This raw material recovered through recycling is therefore ideal for establishing a *circular economy*. After reaching the end of its life, steel scrap can be sustainably used as a raw material from recycling in the production of climate-friendly steel in blast furnaces or electric arc furnaces (EAF). Steel scrap also plays a central role as an input factor in the direct reduction process, which will become increasingly important in the future.[2]
- In terms of the diffusion of innovations, the steel recycling industry in Germany and the EU is making an important contribution by exporting (research) expertise on the circular economy as well as corresponding successful and professional business models. This also applies to countries where the circular economy is still in its infancy or in a phase of professionalization or industrialization, and where the end-of-life volume of "old scrap" is expected to rise sharply in the future.

Against this background, this study examines the economic significance of the steel recycling industry for Germany and the EU. The aim of the study is to shed light on this significance in its various dimensions. The key aspects addressed are:

- The contribution of steel recycling to value creation and employment in the industry itself, but also in related intermediate industries.
- The contribution of the industry to reducing economic costs through savings in raw materials and reduced environmental impact, particularly in the form of CO_2 emissions savings.
- The importance of the steel recycling industry for the competitiveness of key sectors of the German economy. In addition to the steel industry, this includes in particular the customer industries in which steel products are used.

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[1] *While steel scrap is mostly made of unalloyed or simply alloyed steel, stainless steel scrap is made of particularly pure and alloyed steel with an alloy of chromium and often nickel or molybdenum and is characterized by its high corrosion resistance and durability. In the following, both are meant unless explicitly distinguished.*

[2] *In this environmentally friendly process, iron ore is reduced using a gas mixture of carbon monoxide and hydrogen, producing solid sponge iron (direct reduced iron – DRI), which can be used together with steel scrap in an EAF for steel production.*

- The contribution of the steel recycling industry to raw material security and thus to the economic resilience of the German/European economy (reducing the steel industry's dependence on raw material imports).

Based on the analysis, economic policy implications are developed with a view to strengthening the steel recycling industry in Germany.

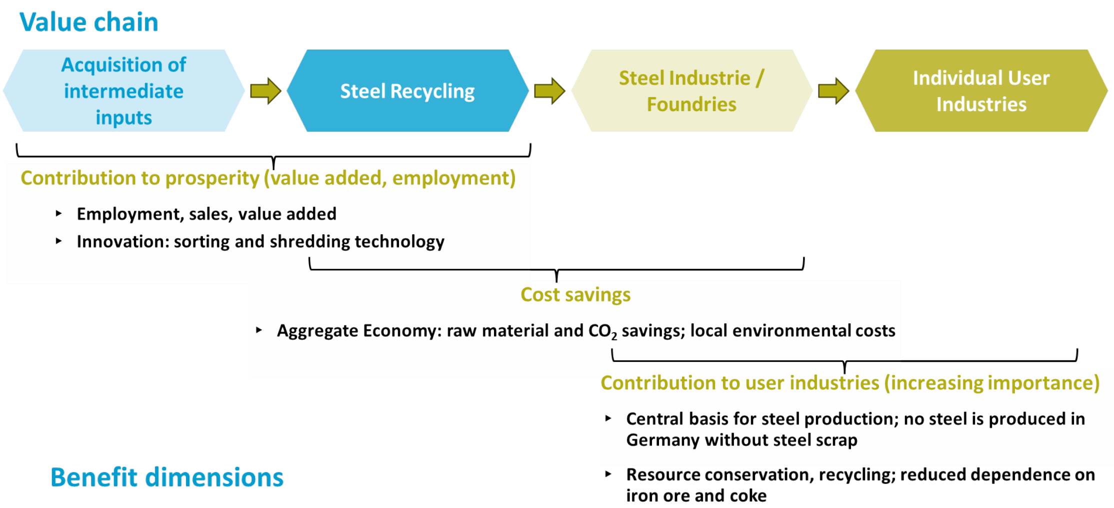
2. Research concept

The investigations focus on the economic context in Germany on the one hand, and on the economic significance of the steel recycling industry in the EU[3] on the other. The following approach was taken:

First, the role of the steel recycling industry in value creation in Germany and the EU, as well as its market and competitive dynamics, were examined. Existing data sources were evaluated for this purpose. In addition, the market and competitive mechanisms that determine the development of the steel recycling industry were examined. This was based on an industrial economics approach, with the findings forming the basis for the subsequent assessment of the economic significance of the steel recycling industry.

The benefits of steel recycling were examined along the value chain in three dimensions (Figure 1). The first step was to examine the **contribution of steel recycling to prosperity** by the industry itself and its interdependence with various upstream industries. An input-output analysis was carried out to examine this aspect in more detail. First, the demand-side interdependence with supplier and service sectors was examined. This includes, among other things, shredding, separation, and sorting machines, compaction and pressing machines (including shredders, hammer mills, hydraulic shears, magnetic separators, sorting systems, scrap presses), as well as transshipment, handling, and transport machines (excavators, wheel loaders, forklifts, trucks).

Figure 1: Benefits of steel recycling along the value chain



Source: Own depiction.

[3] *Unless expressly stated otherwise, the EU with its current 27 member states (EU-27) is considered here.*

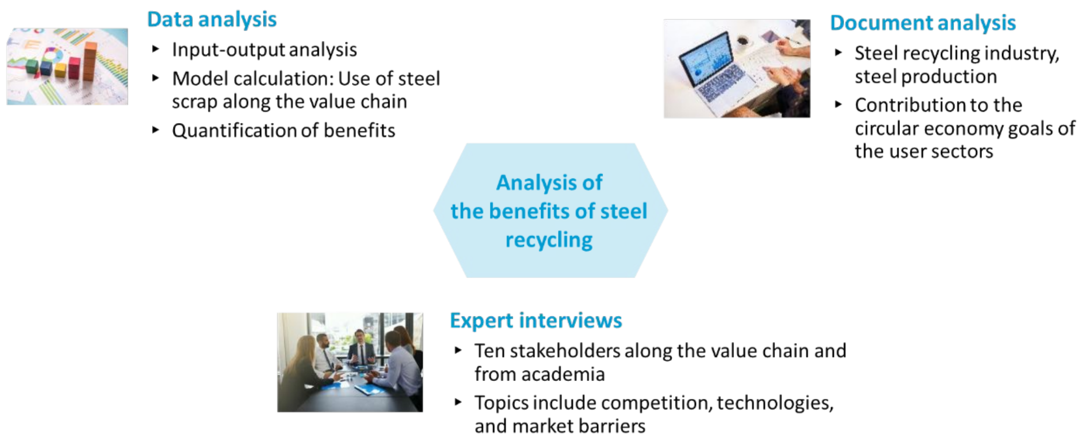
In a second step, the economic and ecological **cost savings** were determined. The extent to which the use of steel scrap leads to raw material savings and the negative effects of steel production through CO_2 emissions are considered and internalized was examined. The role of steel recycling in the context of climate targets has already been discussed in detail (Fraunhofer IMWS 2019). Therefore, the results of these studies were reflected in order to arrive at an economic assessment of this aspect. In addition, local environmental costs were also included in the study.

In a third step, the **importance of the steel recycling industry for economically significant customer industries** was examined, focusing on different sectors. First, the role of the steel recycling industry for the steel industry and thus for steel supply was examined. The analysis drew on industry-specific data and studies and supplemented these with findings from expert interviews. The results were summarized in **industry profiles**. Major consumer industries such as construction and mechanical engineering were included.

Based on these findings, the study examined obstacles to the development of steel recycling. These obstacles have economic policy implications with regard to a suitable framework for the further development of the steel recycling industry in Germany and the EU.

The investigations focused on **the** following **analytical elements** (Figure 2): The **data analysis** included an input-output analysis, the development of a model and the performance of a model calculation for the use of steel scrap along the value chain, and the quantification of the various dimensions of the benefits of steel recycling, also along the value chain. The **document analysis** included an evaluation of existing literature on steel production and steel recycling, as well as the contribution to the circular economy goals of the consumer industries. In addition, ten **semi-standardized interviews** were conducted with representatives of companies in the steel recycling industry, the steel industry, the automotive sector as consumer industries, and academia. The content of the interviews focused on topics such as market dynamics and the significance of the steel recycling industry, market barriers, and future development prospects for steel recycling. The expert interviews were conducted via Microsoft Teams and transcribed with the consent of the interviewees.

Figure 2: Elements of analysis



Source: Own depiction.

3. The steel recycling industry

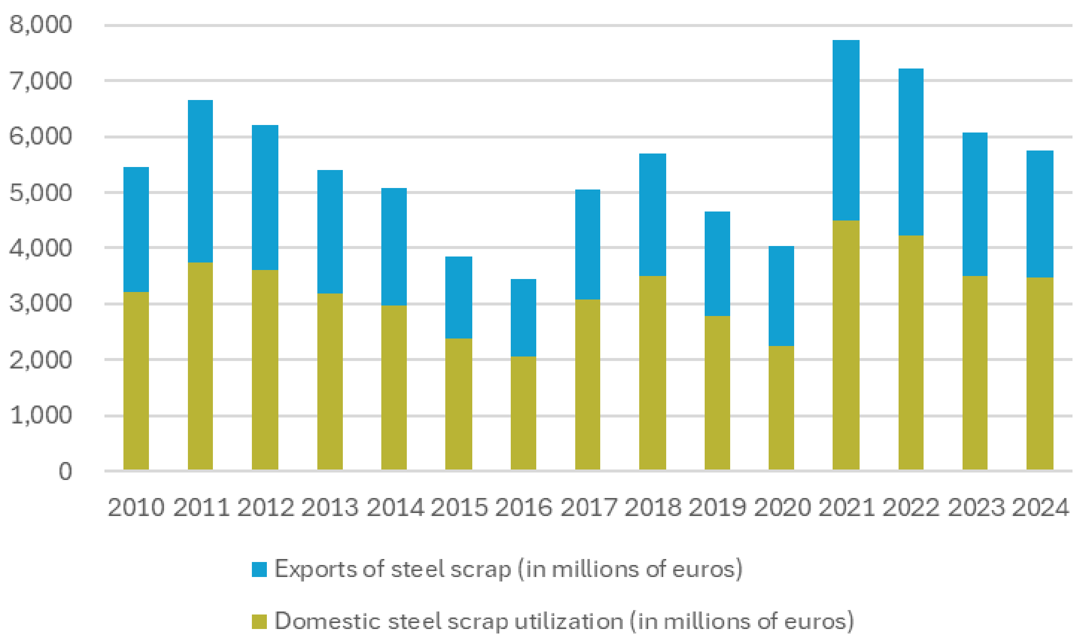
3.1 Industry and sales development

The steel recycling industry primarily involves the collection, sorting, and processing of steel scrap. In addition, logistics and delivery in connection with steel scrap are an important area of value creation. The industry consists of many medium-sized companies and a few larger ones, with competition largely driven by access to scrap sources and the use of modern technologies.

Technological innovations focus on improved sorting and processing methods as well as process optimizations with the aim of increasing sustainability and resource efficiency and improving the quality of recycled steel. The quality of the material is a decisive criterion, especially in view of the need for high-quality scrap grades for modern climate-friendly production processes such as direct reduction or EAF. This is largely determined by the overall system, i.e., the implementation of design for recycling, collection and dismantling infrastructures, and the willingness of customer industries to pay.

In 2024, industry sales amounted to €5.7 billion, of which around 40% (€2.3 billion) was accounted for by exports, mainly to the EU-27 (82%), with the remaining 18% of exports going to third countries such as Turkey. Sales in the industry show considerable fluctuations (Figure 3). After peaking due to a special economic situation caused by high steel production and scrap demand combined with high prices for steel scrap at the end of the coronavirus pandemic in 2021, sales declined again by 2024, with the share of exports in total sales falling slightly.

Figure 3: Sales development in the steel recycling industry



Source: Own calculations. Sales were calculated based on price information and information on quantities according to different scrap qualities. The definition of the industry is based on the group of companies with sales from steel recycling.

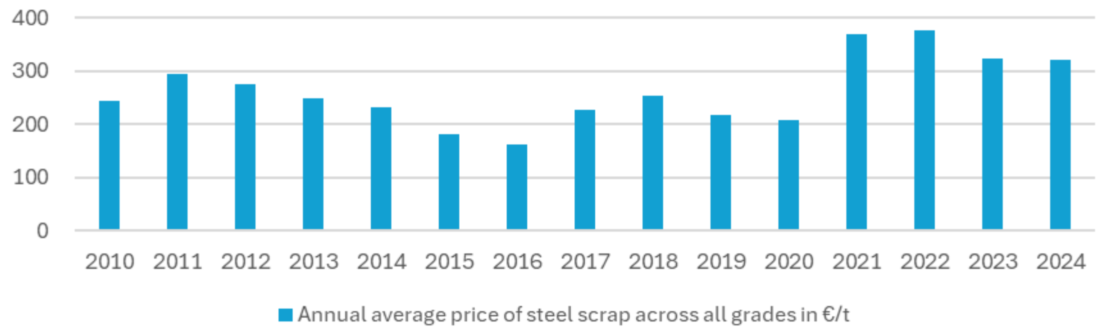
While the current market situation is characterized by an economic downturn and high cost-pressure, studies predict a significant long-term increase in demand for steel scrap, driven by the transformation of the steel industry towards climate neutrality (Hartung et al. 2025; Schmidt

2024). This is conditional on the European Commission's current plans for decarbonising the steel industry being implemented as planned, which is anything but certain at present. [4]

3.2 Price development

Steel scrap prices are a key driver of revenue growth in steel recycling. As Figure 4 shows, the average price of steel scrap[5] is subject to considerable fluctuations. After a significant price jump in 2021, the average price has been around €320 per ton since 2023. At the same time, if the current plans for decarbonising the steel industry are implemented, demand for high-quality steel scrap will increase, which can be sold at higher prices. The reason for this is that scrap is a substitute for corresponding primary raw materials, whose prices are also interdependent with the price of scrap.

Figure 4: Comparison of price trends (2021 = 100)



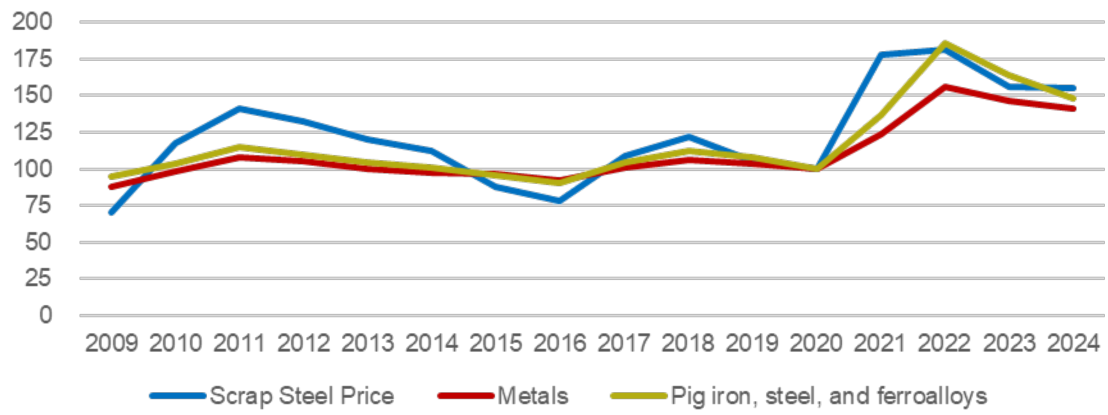
Source: Own calculations based on data from the BDSV and Fraunhofer UMSICHT (Hiebel, Nühlen 2016).

The development of the average price for steel scrap is closely linked to the price of crude steel, which in turn is highly dependent on the economic cycle. The price difference to primary steel is therefore decisive for the competitiveness of steel recycling (Figure 5). The economic benefits of recycling steel scrap primarily consist of cost savings, which also take into account savings in terms of environmental costs. Whether the incentives for recycling are sufficient depends on the extent to which these economic benefits are reflected in prices in their various dimensions. The greater this benefit, the more attractive the use of steel scrap in crude steel production becomes. The price development for steel scrap is indirectly influenced by imports of semi-finished products, such as slabs and billets, which enter the European market at low cost, leading to a reduction in demand for steel scrap.

[4] https://germany.representation.ec.europa.eu/news/eu-kommission-legt-aktionsplan-fur-die-stahl-und-metallindustrie-vor-2025-03-19_de https://www.handelsblatt.com/politik/deutschland/klimaneutralitaet-warum-der-stahlbranche-die-klimaneutrale-umstellung-so-schwerfaellt/100136244.html; *Abruf vom 10.12.12025.*

[5] *The average price for steel scrap was calculated on the basis of information provided by the BDSV on prices for steel scrap types 0 to 8 (including various grades of old steel scrap, new steel scrap, and shredder scrap) (https://bdsv.de/de/resources/aktuelle%20Stahlschrottsortenliste%20Deutschland_nL.pdf, accessed on November 13, 2025). These were weighted using the volume shares from the Fraunhofer UMSICHT study (Hiebel, Nühlen 2016).*

Figure 5: Comparison with producer price indices (2020=100)



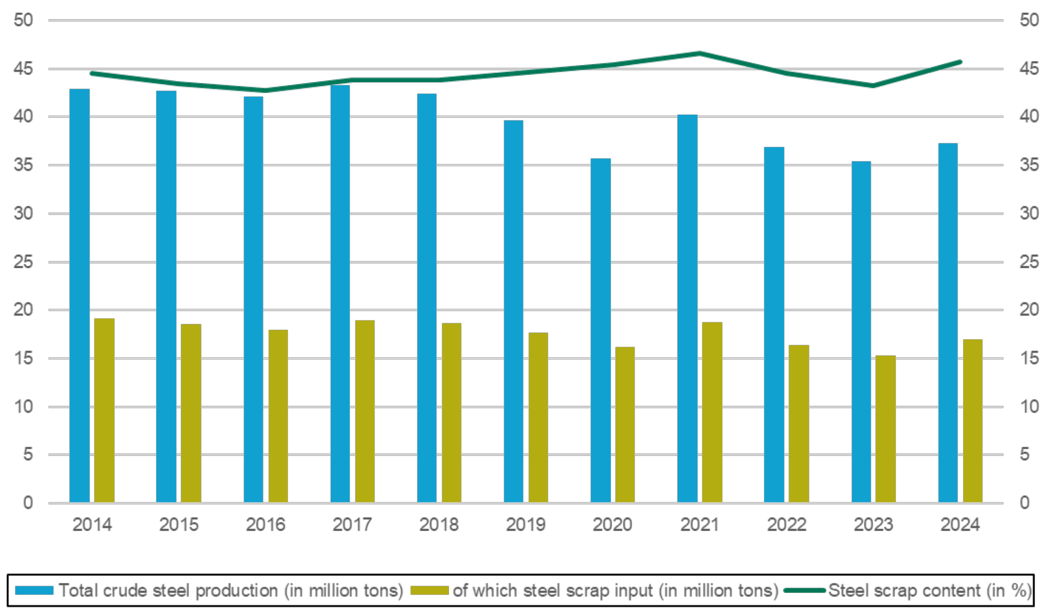
Source: Own calculations based on data from the BDSV and the Federal Statistical Office. Indices, 2021=100. Steel scrap price: annual average across all types. – Comparative indices: producer price indices.

3.3 Development of the steel scrap utilization rate

The steel scrap utilization rate serves as an indicator of the importance of steel scrap in crude steel production. It is calculated from the ratio of steel scrap input to total crude steel production and thus shows the proportion of steel scrap in crude steel production. Since the use of steel scrap varies depending on the production route, the indicator provides an indication of whether a particular production process for crude steel is gaining or losing importance in an economy.

Figure 6 shows crude steel production in Germany (blue bars), steel scrap input (olive bars), and the resulting share of steel scrap in crude steel production, i.e., the steel scrap utilization rate (green curve), for the period from 2014 to 2024.

Figure 6: Steel scrap share of crude steel production in Germany

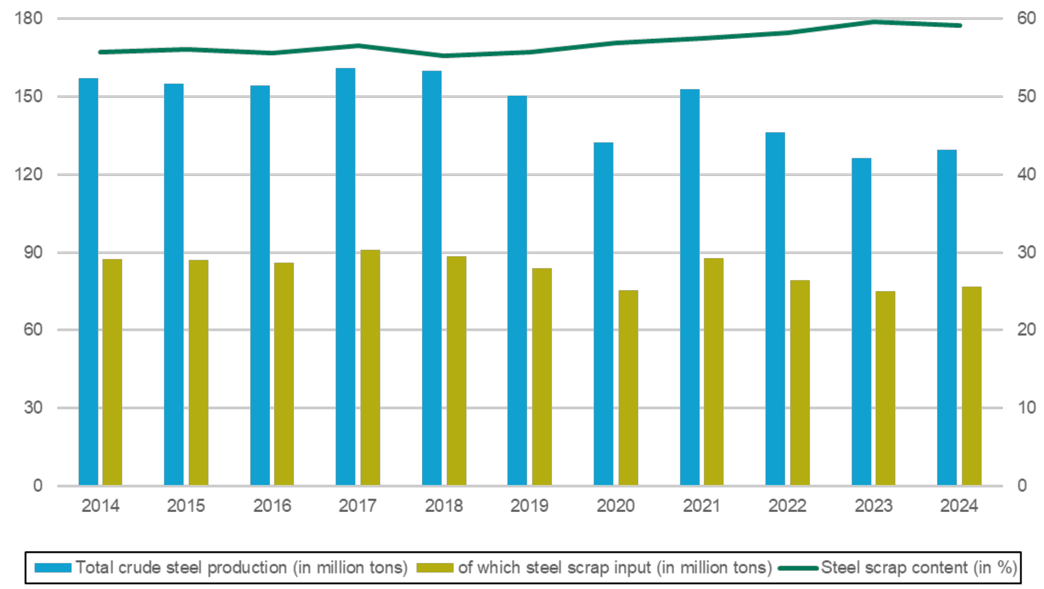


Source: Own representation and calculation based on data from the BDSV steel scrap balance sheet (BDSV, 2025); left scale: million tons; right scale: %.

Crude steel production averaged just under 40 million tons during the period under review but tended to decline over time. The highest crude steel production was achieved in 2017 with 43.3 million tons, and the lowest in 2023 with 35.4 million tons. In 2024, production recovered slightly to 37.2 million tons, but crude steel production was still 13% lower than in 2014. The use of steel scrap also declined, from 19.1 million tons in 2014, the highest level of steel scrap use recorded in the period under review, to 17 million tons in 2024 (-11%). As the decline in steel scrap input was lower than that in crude steel production, the steel scrap utilization rate in 2024 was 45.7%, higher than in 2014 (44.6%) and thus at its highest level in the period under review. On average, the steel scrap utilization rate was 44.3%, which proves that steel recycling makes a significant contribution to crude steel production in Germany. The expansion of EAFs and crude steel production based on direct reduction could lead to a further increase in the steel scrap utilization rate in the future.

For comparison, Figure 7 shows the corresponding developments for the EU. Crude steel production in the EU fell from 157.1 million tons in 2014 to 129.6 million tons in 2024 (-18%) during the period under review. Like Germany, steel scrap usage also declined, from 87.5 million tons in 2014 to 76.6 million tons in 2024 (-12%). However, as the decline in steel scrap input was also lower in the EU than the decline in crude steel production, the steel scrap utilization rate rose from 55.7% in 2014 to 59.1% in 2024. The average rate for the period under review was 56.9%. This means that steel recycling in the EU makes a significantly higher contribution to crude steel production than in Germany, which is due to the fact that electric arc furnaces play a more important role in the EU, accounting for 45% of total crude steel production, than in Germany (29%). A key reason for this is that Germany's dominant steel manufacturer has historically committed to the blast furnace route, meaning that, given the long-term nature of investments in such furnaces, a switch in technology can only take place over the longer term.

Figure 7: Steel scrap share in crude steel production in the EU



Source: Own representation and calculation based on data from EUROFER (EUROFER, 2025); left scale: million tons; right scale: %.

3.4 Future use of recycled steel scrap in the steel industry

The steel industry is facing a fundamental change: as part of decarbonization, the climate-damaging blast furnace process is to be increasingly replaced by the direct reduction process, which uses hydrogen instead of coal. With government support, large steel companies in Germany such as Salzgitter AG and Thyssenkrupp Steel are already investing heavily in the construction of appropriate facilities. The traditional blast furnace process releases significant amounts of CO_2 because coking coal is used as a reducing agent. In combination with EAF, the switch to direct reduction drastically reduces these emissions because hydrogen is used as a reducing agent and the electricity for the electric furnaces can come from renewable energies (WV Stahl 2024: 16).

This development has the following implications for the use and demand for steel scrap:

- **Flexibility in scrap use:** Direct reduction plants do not produce a stream of liquid pig iron, but rather solid sponge iron, which is then processed into steel in the EAF. This route allows for the flexible addition of steel scrap as a raw material. Unlike the classic blast furnace process, however, the use of scrap is planned from the outset and is technically easier to integrate. However, the resulting demand for scrap depends on market conditions, in particular the price ratio between iron ore, DRI, and scrap. It is therefore difficult to forecast the exact demand for scrap.
- **Presumed increase in demand for high-quality steel scrap:** With the increasing spread of direct reduction and EAFs, the overall demand for steel scrap will rise, as scrap is a key raw material for electric steel production. High-quality steel scrap that is as free as possible from impurities (e.g., copper, tin) will be in particular demand in order to ensure steel quality in production. The addition of scrap is also another important lever for reducing CO_2 emissions, as its use reduces the quantities of pig iron required and thus the energy and resources consumed.
- The **economic benefits** of steel scrap will increase significantly in the future, as it will become more important not only as a cost-effective source of raw materials, but also as an essential component of climate-friendly steel production. Scrap will therefore remain a key component of the circular economy in the steel industry as demand continues to grow.
- The rising demand for steel scrap requires **technical advances** in collection, sorting, and separation to ensure the quality and availability of the material. Digitalization and artificial intelligence can help to sort and process scrap more efficiently and keep it in circulation. At the same time, the need for imports—especially of high-quality scrap—will increase, as domestic supply is unlikely to be sufficient.

Table 1 shows scenarios for future demand for steel scrap and high-quality steel scrap for the year 2030 based on a study by Hartung, Pothen, and Hundt (2025) through the introduction of the direct reduction process and compares these values with the average for the years 2015 to 2023. The projection is subject to uncertainty, particularly due to the flexibility of the direct reduction process with regard to the use of steel scrap.

Nevertheless, it is clear that, on average across the scenarios, the use of steel scrap in general and high-quality steel scrap in particular will increase significantly in the coming years if the introduction of direct reduction processes is pursued. The domestic circular economy will be strengthened, while at the same time the requirements for grade purity, logistics, and international procurement strategies will increase. The economic benefits of steel scrap will increase significantly, while technical innovations and a more efficient value chain will remain decisive competitive factors.

Table 1: Results of scenario calculations for future steel scrap demand

Steel scrap demand	2015-2023	Scenarios 2030
Total steel scrap (in million tons)	17	17
High-quality steel scrap (in million tons)	4.8	4.3 – 7.7

Source: Hartung et al., 2025.

4. Contribution of steel recycling to prosperity

4.1 Approach

Steel recycling has a wide range of positive effects on prosperity, which can be measured in terms of its contribution to value creation and employment. The starting point here is the steel recycling industry and the iron and steel industry. In addition to the direct contribution to prosperity made by these two sectors, there are further indirect effects on prosperity among suppliers of intermediate products, as well as among consumers of steel and steel products. In this section, based on an input-output analysis, the contribution to prosperity generated by the supply of steel scrap from companies in the steel recycling industry to the iron and steel industry is quantified. The approach used in the input-output analysis is explained in the appendix. Data from the Federal Statistical Office and Eurostat were used for input-output analysis. Input-output tables were available for Germany for the year 2021 (Destatis 2025b) and for the EU-27 for the year 2020 (Eurostat 2025).

The contribution of the industry to value added and employment attributable to the demand for steel scrap by the steel industry was calculated using the input-output tables. The result consists of the direct contribution (value added and employment in the steel recycling industry) and the contribution generated by the demand-side link to the input industries. The model also provides multipliers for the waste management industry as a whole, based on data from the respective input-output table for Germany in 2021 and for the European Union in 2020.[6]

4.2 Contribution to prosperity in Germany and Europe

The results of the input-output analysis are shown at**Fehler! Verweisquelle konnte nicht gefunden werden.** as contributions to prosperity from steel recycling in Germany and the EU. The starting point for the calculation is the respective production value, for which the industry turnover with steel scrap was used as an approximate value. For **Germany**, data from the BDSV on steel scrap quantities and prices for the various types of steel scrap were evaluated for this purpose. Using the volume shares of the individual types from a study by Fraunhofer UMSICHT (Hiebel, Nühlen 2016), an annual average price of around €322/t was calculated for 2023. Based on the 18.9 million tons of steel scrap available domestically, this results in an industry turnover of €6,082 million in 2023[7]. According to the input-output table, this includes approximately 38% gross value added. The direct contribution to prosperity through steel recycling thus amounts to €2.3 billion in gross value added.

To determine steel scrap turnover in the **EU-27**, the amount of steel scrap in 2023 published by EUROFER (2025) of 75.2 million tons was multiplied by an annual average price of €346.70/ton (Steelprices.com 2024). The European steel scrap turnover calculated in this way amounted to

[6] *The authors assume that these multipliers are fundamentally transferable to the steel recycling industry. The interdependent structures of an economy, which describe its overall production technologies, are generally subject to only slow changes over time. For this reason, the multipliers calculated here can also be applied to subsequent years. The results on the contribution of steel recycling to prosperity refer to the year 2023, for which all the necessary data was available.*

[7] *The values also include steel scrap exports, as these contribute to the industry's turnover, which is used in the I/O calculations. For the benefit calculations, however, exports were not considered and only the steel scrap used for domestic crude steel production was used as a basis. However, this value also includes imported steel scrap and steel scrap from inventories.*

around €26.1 billion in 2023. According to Eurostat's input-output tables, this included approximately 43% value added, resulting in a European contribution to prosperity through steel recycling of €11.2 billion in value added (table 2).

Table 2: Contribution of steel recycling to prosperity in Germany and the EU in 2023

	Germany		EU	
	Gross value added	Employment	Gross value added	Employment
Direct contribution to prosperity	€2.3 billion	14,800 persons	€11.2 billion	71,600 persons
Indirect contribution to prosperity (advance payment effects)	€2.5 billion	22,000 persons	€11.7 billion	100,500 persons
Contribution to overall economic prosperity (direct + indirect)	€4.8 billion	36,800 persons	€22.9 billion	172,100 persons

Source: Own calculations. Input-output analysis based on data from Eurostat, Destatis, and BDSV. – [1] Definition: Group of companies with revenues from steel recycling ("narrow" industry definition), figures in FTEs.

The multiplier for gross value added from steel recycling in Germany is 2.1, i.e., €1 million in value added generated from recycling steel scrap leads to further indirect value added of €1.1 million through intermediate consumption links in the overall economy. In the EU-27, the corresponding multiplier is slightly lower at 2.0. This indicates that, on average, the steel recycling industry in Europe is more integrated than in Germany and has outsourced fewer production steps or procures intermediate products (especially services) from other industries to a lesser extent.

The **total effects of steel recycling** can be derived from the direct contributions to prosperity using the multipliers described above. For **Germany**, this results in a **total economic contribution to prosperity of €4.8 billion** in **added value**, and for the **EU**, **€22.9 billion**. If the direct contribution is deducted from the overall effects, this results in an indirect value-added contribution of €2.5 billion for Germany, which arises from the respective interdependence of intermediate inputs in the industries that provide these intermediate inputs for steel recycling; in the EU-27, the indirect value-added contribution is €11.7 billion.

The number of employees in the steel recycling industry was calculated based on labor productivity for the "recovery of sorted materials" sector (WZ08 38.32)[8]. In 2023, this stood at €411,190 in production value per employee in Germany[9]. Based on steel recycling sales of around €6 billion in **2023**, this results **in** an **employment volume in the steel recycling industry of around 14,800 people** (table 2); this corresponds to a share of 5.5% of the total number of employees in the waste management industry. If employment in the European waste management industry is distributed similarly to that in Germany, **around 71,600 people** are **employed in the steel recycling**

[8] See also the appendix to the input-output analysis.

[9] Own calculations based on Destatis (2025a). – For input-output analyses, labor productivity is usually related to production value and not, as in many other studies, to gross value added. This is due to the fact that data on production and employment at the industry level are available for more recent years and earlier than data on gross value added. Ultimately, this makes no difference, as production and value added in an industry for a given year are in a fixed ratio to each other.

industry across the EU. In relation to a turnover of around €26.1 billion, this results in a slightly lower labor productivity for the industry in the EU-27 in 2023 than in Germany, at €364,217 per employee.

The employment multiplier for Germany is 2.5, which is slightly higher than for the EU-27 at 2.4. This means that for every ten employees in the steel recycling industry (calculated in full-time equivalents, FTE), there are a further 15 and 14 employees in the intermediate industries, respectively.

The indirect and total contribution to overall economic employment through steel recycling is calculated in the same way as the value-added contribution: based on direct employment in **Germany** of around 14,800 people, a multiplier of 2.5 results in a **total economic employment contribution of 36,800 people**. Excluding direct employment, steel recycling indirectly employs around 22,000 people in Germany. **Across Europe**, steel recycling has a total employment effect of 172,100 people. Of these, 100,500 are employed in the intermediate sectors of steel recycling.

A comparison between Germany and the EU shows that steel recycling contributes to value added and employment in the EU, with a good fifth of this contribution attributable to steel recycling in Germany. If the contribution to prosperity in terms of value added and employment is put into relation, this results in a measure of labor productivity in the steel recycling industry. In Germany, this amounts to €155,405 in value added per person, which is similar to the EU-27 figure of €156,425 per person.

5. Economic cost savings through steel recycling

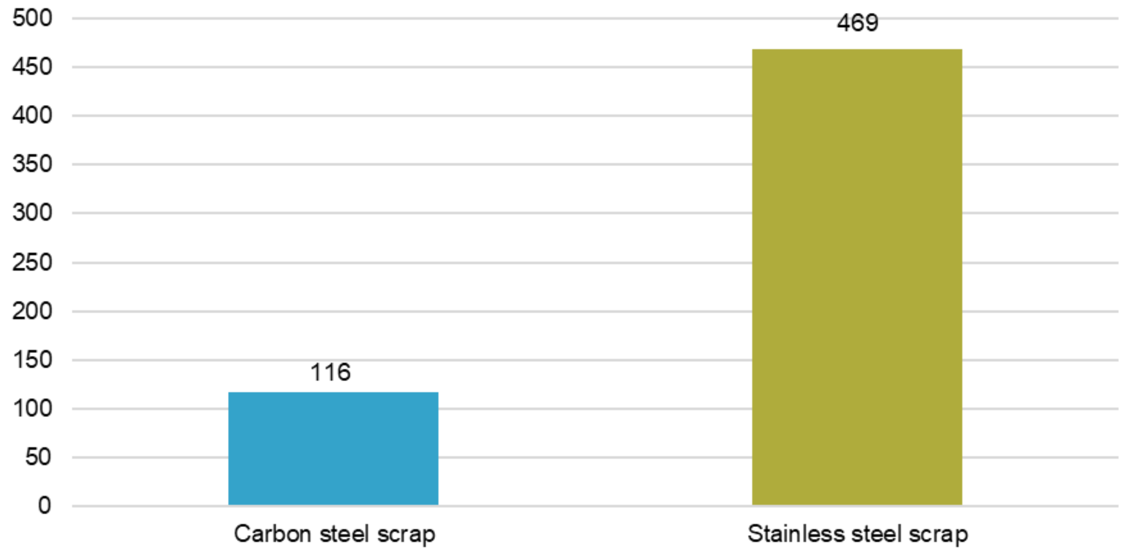
5.1 Components of cost savings

This chapter examines the various cost-saving components associated with the use of steel scrap in crude steel production that led to cost savings. Where possible, these are then quantified. One benefit results from the savings in CO_2 and environmental costs (chapter 5.2) and from the savings in primary raw materials (chapter 5.3). The resulting cost savings are then compared with the average market price for steel scrap to determine the total cost savings achieved using steel scrap in crude steel production (chapter 5.4).

5.2 Savings on CO_2 and local environmental costs

The use of steel scrap in crude steel production saves CO_2. These savings amount to 1.7 t CO_2 per ton of carbon steel scrap and 6.7 t CO_2 per ton of stainless-steel scrap (Hiebel, Nühlen 2022). The resulting savings in CO_2 costs are assessed here using the price of CO_2 emission allowances, i.e., a factual market price, which seems more sensible than an assessment using fictitious climate costs, for example. From mid-2024 to mid-2025, the price of emission allowances averaged approximately €70 per ton of CO_2. By way of comparison, the study calculating the scrap bonus assumed "climate costs" of €30, €70, and €110 per ton of CO_2 in three scenarios (Fraunhofer IMWS 2019). The CO_2 emission allowance price of €70 per ton of CO_2 thus corresponds to the middle scenario in the scrap bonus study. The benefit per ton of steel scrap calculated in this way is shown in Figure 8.

Figure 8: Economic CO_2 cost savings in € per ton of steel scrap



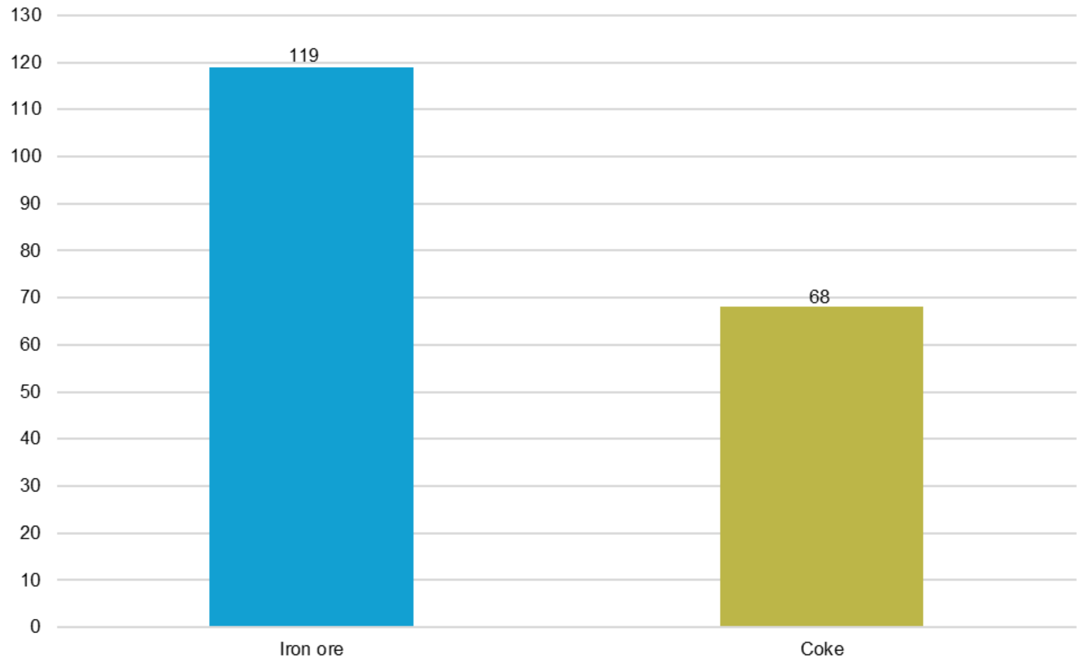
Source: Own representation and calculation. Stainless steel scrap here refers only to stainless steel in the narrower sense, which accounts for around 1% of total crude steel; the remaining stainless steel is treated as equivalent to carbon steel scrap in terms of CO_2 savings.

Overall, the use of 17 million tons of steel scrap (carbon steel scrap and stainless-steel scrap) in crude steel production in Germany in 2024 will result in cost savings of approximately €2.0 billion. In addition, there are savings in local environmental costs of €29 per ton of steel scrap (Fraunhofer IMWS 2019), resulting in an additional benefit of approximately €0.5 billion.

5.3 Raw material savings

The use of steel scrap in crude steel production also leads to savings in primary raw materials, primarily iron ore and coke. For every ton of crude steel produced using steel scrap, 1.3 tons of iron ore and 0.38 tons of coke are saved (Fraunhofer IMWS 2019). To determine the associated cost savings, these raw material savings are valued at the respective world market prices in mid-2025. These were approximately €92/ton for iron ore and approximately €180/ton for hard coal coke. The cost savings per ton of steel scrap calculated on this basis are shown in Figure 9.

Figure 9: Cost savings for iron ore and coke in € per ton of steel scrap



Source: Own depiction and calculations.

Based on the use of 17 million tons of steel scrap in 2024, this results in total cost savings for iron ore and coke of €3.2 billion. In addition, there are savings on other raw materials used in the production of stainless steel, which, as already mentioned, accounts for around 1% of total crude steel production, in particular nickel and chromium, resulting in additional savings of approximately €0.5 billion.

In the case of other alloyed steel, which is not strictly speaking classified as stainless steel (in 2024, this accounted for around 37% of total crude steel production), further primary raw materials are saved in addition to iron ore and coke, which are included in the quantitative benefit assessment. These include nickel and chromium, as well as alloy metals such as molybdenum, manganese, titanium, and tungsten. However, as the average content of these raw materials per ton of stainless steel cannot be determined exactly due to the large number of very different types of alloyed steel, these savings were not included in the cost analysis.

The decreasing dependence on raw material imports associated with the savings in primary raw materials is also not quantifiable, as there is no assessment standard for this, although it definitely has a positive effect. The benefits of raw material savings resulting from the use of steel scrap calculated here are therefore underestimated, although the exact extent of this underestimation cannot, of course, be precisely quantified.

5.4 Total cost savings through steel recycling

The various cost-saving components of using steel scrap in crude steel production are summarized in Table 3, and the total savings and savings per ton of steel scrap are shown (Table 4 contains the corresponding values for the EU for comparison).

Table 3: Cost savings through the use of steel scrap in Germany in 2024

Cost category	Estimated savings
Savings in iron ore and coke	*€3.2 billion*
Savings in nickel and chromium in stainless steel (approx. 1% of crude steel)	*€0.5 billion*
CO_2 savings	*€2.0 billion*
Savings in local environmental costs	*€0.5 billion*
Total cost savings	*€6.2 billion or €365/t steel scrap*

Source: Own calculations.

The total cost savings from the use of steel scrap in crude steel production amounted to €6.2 billion in 2024. This results in total savings of €365 per ton of steel scrap. The benefits of steel recycling in the form of cost savings are therefore not fully reflected in the market price, which averaged €322 per ton in 2024.

Table 4: Benefits of using steel scrap in the EU in 2024

Cost category	*Estimated savings*
Savings in iron ore and coke	*€14.4 billion*
Savings in nickel and chromium in stainless steel (approx. 1% of crude steel)	*€2.3 billion*
CO_2 savings	*€9.0 billion*
Savings in local environmental costs	*€2.3 billion*
Total benefit	*€28.0 billion*

Source: Own calculations.

Other components of the cost savings are difficult to quantify. These include savings in raw materials other than iron ore and coke in other stainless steels, greater independence from raw material imports, and positive marketing aspects regarding the marketing of scrap-based crude steel. This positive effect is offset by a potentially negative cost effect. The savings are reduced by electricity consumption associated with the use of steel scrap in electric furnaces (such as EAFs), which are expected to be further expanded in the coming years. This effect is also difficult to quantify. One reason for the presumed higher benefit of using steel scrap in relation to the price of steel scrap is that environmental costs are not fully internalized in the market prices of steel scrap.

Rising prices for CO_2 emission rights and raw materials, which are to be expected from the current perspective, will further increase future cost savings from steel recycling per ton of steel scrap.

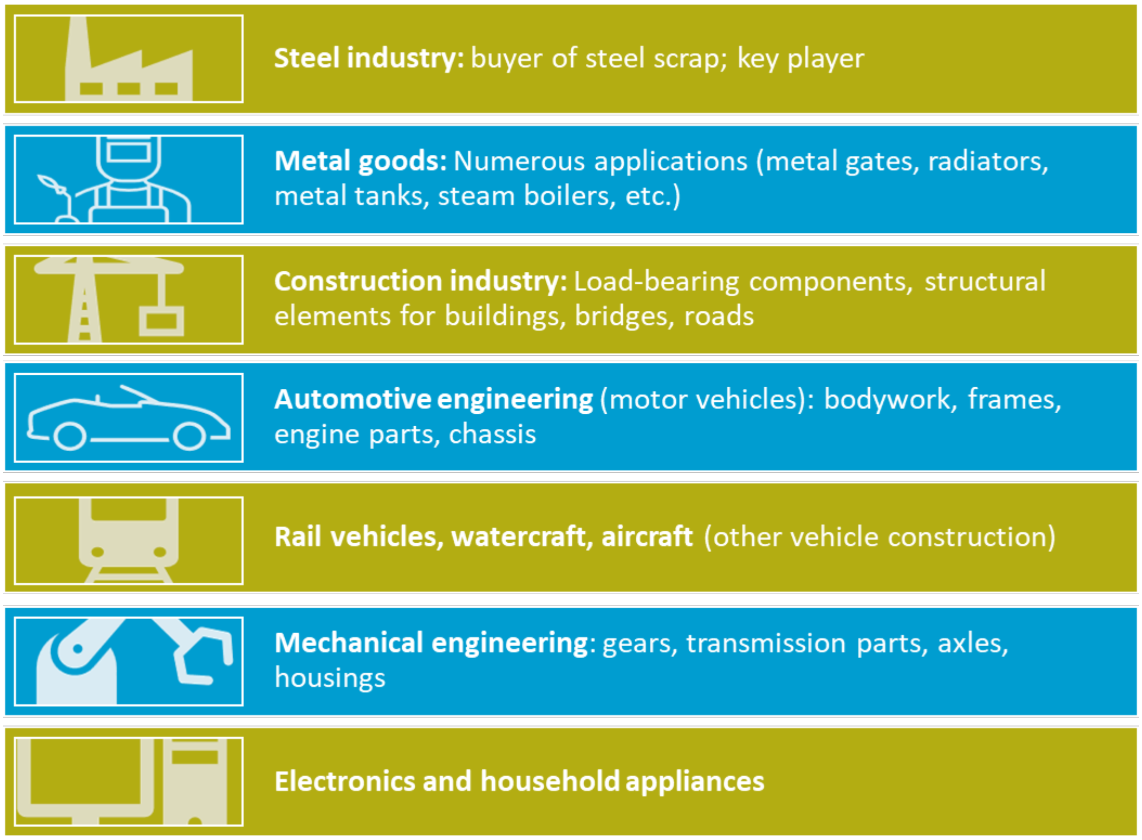
The total cost savings calculated in this section are allocated to the consumer industries in the following section.

6. Significance of steel recycling for the steel industry and its customer industries: Industry profiles

6.1 Selection and focus

Steel recycling primarily involves the use of steel scrap in the steel industry's production processes for crude steel and in foundries. Depending on the respective steel scrap content of the various steel products, the recycled steel scrap reaches the customer industries for steel products. In order to assess the importance of steel recycling for the various customer industries of steel products, industry profiles were created as part of the study. The focus is on the most important industries in which recycled steel scrap is used indirectly through the use of steel and foundry products.[10] Figure 10 shows the industries that were considered. The selection was based on the economic importance of the selected industries on the one hand and the special contribution of steel recycling to the development of these industries on the other.

Figure 10: Selected customer industries



Source: Own depiction.

6.2 Indirect use of steel scrap in customer industries

As a starting point for assessing the role of steel scrap for customer industries, model calculations were first carried out to estimate how much steel scrap is contained in the products manufactured by the most important customer industries.

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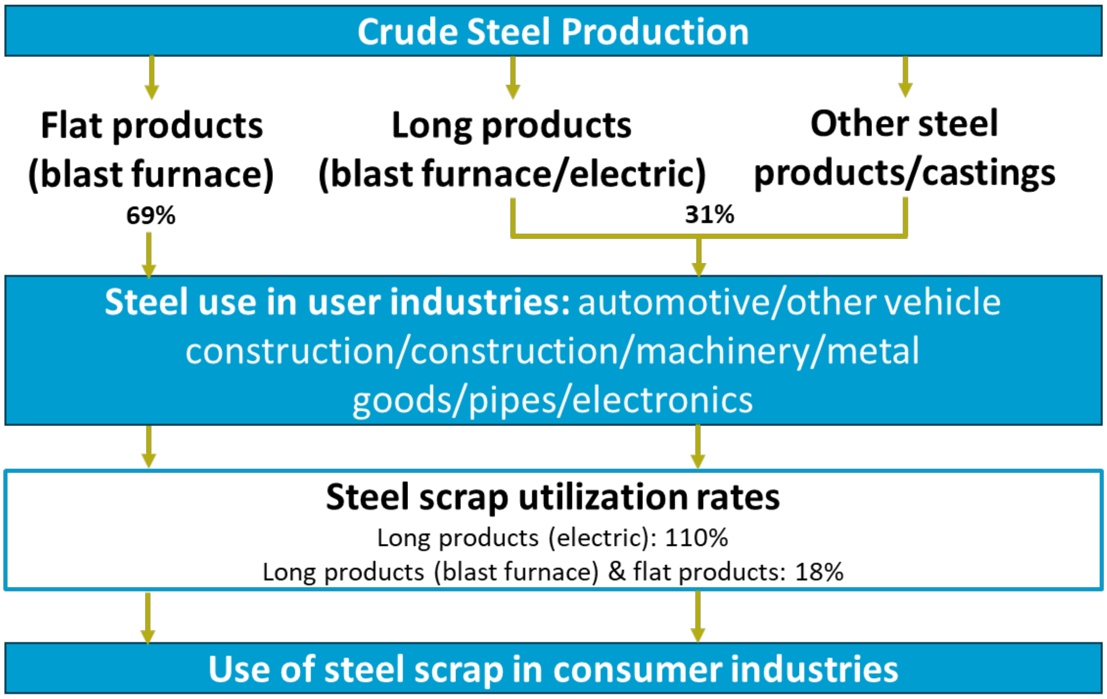
[10] *The classification of industries used in this study is shown in the appendix.*

Since no detailed information is available at the level of the customer industries, expert interviews were conducted, and the relevant literature was evaluated. This provided information on the requirements companies place on the properties and quality of the steel they demand and the extent to which long or flat steel is used.

These requirements have a decisive influence on whether companies use steel produced via the blast furnace route or as electric steel. The production process, in turn, determines the amount of steel scrap that can be used, so that the amount of steel scrap used in the products of the consumer industries can be inferred in this way. The use of steel scrap in the customer industries was determined in a multi-stage model calculation, which is shown schematically in Figure 11.

Figure 11: Use of steel scrap in consumer industries (calculation scheme)



Source: Own representation based on information from WV Stahl (2025).

This is based on the assumption[11] that around 69% of crude steel production in Germany is used for flat products and around 31% for long products and other steel products (including cast products)[12]. While only crude steel from blast furnaces is used for flat products, electric steel can also be used for long products. This distinction is important for the use of secondary steel, as the two production routes use different amounts of steel scrap: while between 15 and 20% can be used in the blast furnace route, crude steel in EAFs is produced exclusively from steel scrap[13]. In terms of process technology, undesirable by-products (impurities) and losses during combustion even result in steel scrap usage of more than 100%[14]. Together with the assessments of the experts

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[11] Crude steel production is calculated as domestic crude steel production minus steel exports plus imported crude steel.

[12] Other steel products mainly include products manufactured in steel casting or block casting, as well as special semi-finished products that are intended directly for castings, special processing, or as preliminary products for other industries. These products are usually manufactured for individual applications.

[13] Here, the utilization rate is actually up to 110% due to the residual materials contained in scrap.

[14] https://de.wikipedia.org/wiki/Lichtbogenofen, accessed on December 8, 2025.

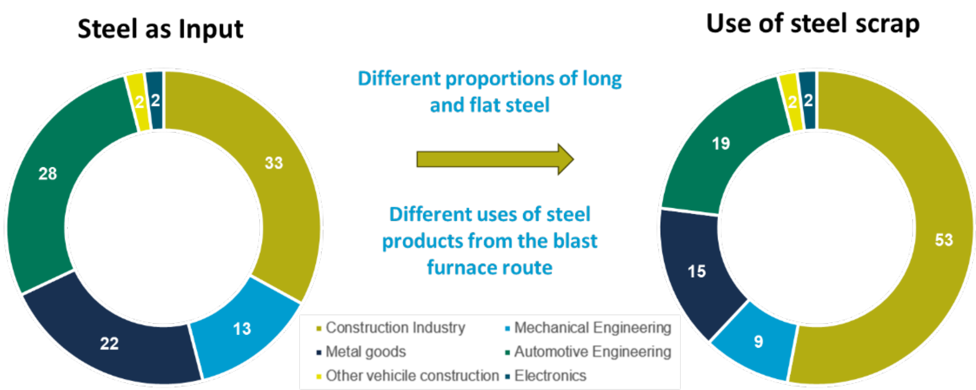
surveyed, it is possible to estimate the proportions of steel scrap that indirectly enter the products of the consumer industries.

To determine the importance of steel scrap for the customer industries, the amount of steel scrap used to produce steel for the various customer industries was calculated on the basis of steel consumption. The following key factors were considered:

- The various industries use long and flat steel to varying degrees.
- Flat steel is produced in Germany using the blast furnace route.
- A large proportion of long steel is produced from steel scrap using the electric furnace route.

This results in the distribution of steel scrap used for steel production in the various consumer industries of the steel industry shown in Figure 12.

Figure 12: Indirect use of steel in consumer industries in 2022



Source: Model calculations based on data from the German Steel Association, BDSV, company data, and information from expert interviews. Information on the quantity of long and flat steel was only available for 2022.

The results show that the indirect share of steel scrap used in the products of consumer industries can differ from the direct steel input. This is particularly evident in the construction industry, which uses one-third of the steel used in the industries surveyed, but in whose products more than 50% of the steel scrap is used indirectly. In contrast, 28% of steel in Germany goes to the automotive industry, but due to specific requirements, the products manufactured there currently contain only 19% of the indirectly used steel scrap.

6.3 Industry profile: Steel industry

The steel industry is a key supplier to important customer industries such as automotive, construction, and mechanical engineering. With a gross value added of €8.0 billion and 96,000 employees in 2023, the industry makes an important contribution to industrial production and employment in Germany (Table 5). The challenges posed by international competition are reflected in stagnating value added and slowly declining employment figures in recent years.

With a volume of 14.4 million tons and crude steel production of 35.4 million tons, steel scrap makes an important contribution to the supply of steel to the economy. Both crude steel production and domestic steel scrap volumes have declined much more sharply than employment in recent years. The average annual decline in steel scrap production between 2013 and 2023 was 2.4%.

Table 5: Industrial characteristics of the steel industry

	2023	Annual average growth 2013/23
Gross value added*	€8.0 billion	+0.2
Employment*	96 thousand	-0.5
Crude steel production in tons	35.4 million tons	-1.8
Steel scrap volume (domestic) in tons	14.4 million tons	-2.4

*Sources: Own calculations, Federal Statistical Office and WV Stahl. *Steel industry classification: WZ08-24.1, 24.3 and 24.52.*

There are two main methods of steel production: the blast furnace route, which produces oxygen steel, and the EAF (electric arc furnace) process (see World Steel Association 2017b). Steel recycling plays a central role in both processes:

- In the **blast furnace route,** between 15 and 20% steel scrap is used in Germany (value from interviews). The process is primarily based on smelting iron ore with coke to produce pig iron, which is then further processed. Steel scrap is used in the converter process to regulate the temperature and cool the melt during the conversion of pig iron to steel.
- The EAF route, on the other hand, uses only steel scrap as raw material (Schüler 2016). The EAF process is also used in the new direct reduction process.
- In addition to these two processes, steel scrap is also used in **steel foundries**. Of the 14.4 million tons of steel scrap used in production in 2023, 2.8 million tons (19.4%) were used by foundries.[15] The foundry industry thus also makes a key contribution to establishing sustainable material cycles in the use of steel scrap (Deike 2020).

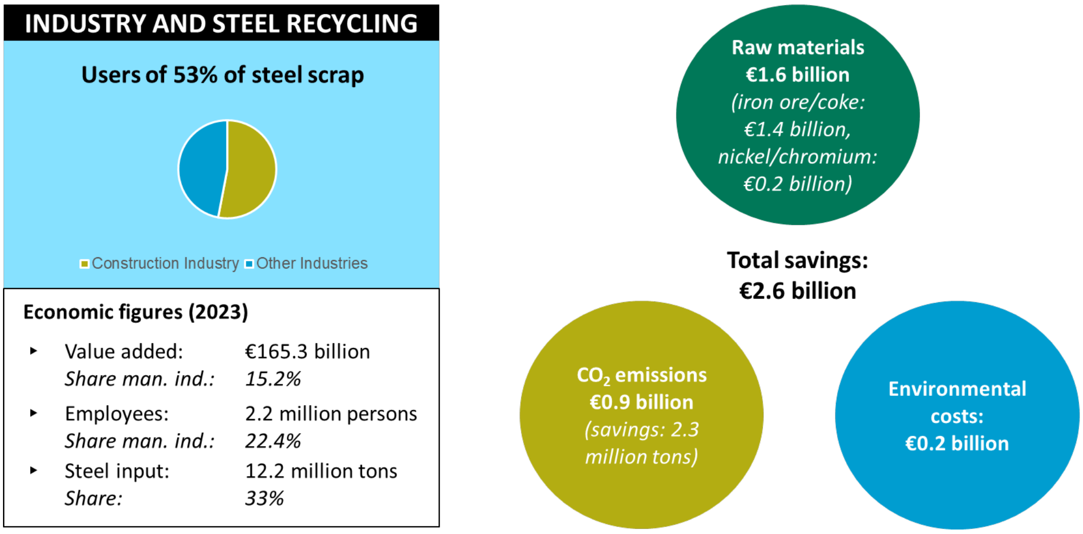
The blast furnace route dominates the German flat steel sector, while EAFs are predominantly used in the long steel sector. The share of electric steel in steel production was 29% in 2024 (WV Stahl 2025). Due to the increased use of the electric steel route, this share was 45% across the EU (EUROFER 2025).

6.4 Industry profile: Construction industry

The construction industry alone uses one-third of the steel used by all the consumer industries considered here. Steel scrap is a central component of steel use in the construction industry. Overall, the construction industry uses **more than half (53%) of the steel scrap used in the German steel industry** (Figure 13). This makes the construction industry, indirectly via the steel sector, by far the largest user of steel scrap.

[15] *Information from BDSV.*

Figure 13: Scrap use in the construction industry: utilization of steel scrap, economic significance, and cost savings



Source: Own calculations based on data from Destatis, BDSV, and results from expert interviews. The calculated cost savings result from the allocation of total cost savings (Section 5) according to the indirect use of steel scrap to the customer industries.

Depending on the field of application, there is demand for a wide variety of steel products and steel grades. For structural steel, high-quality, well-sorted steel scrap is required above all, as the quality and purity of the scrap are crucial for the production processes.

The economic importance of **the construction industry** in Germany is reflected in the fact that in 2023 it contributed **€165.3 billion**, or 15.2% of the total value added by the manufacturing sector and employed around **2.2 million people** (22.4%). The construction industry is a major consumer of steel products for the **steel industry**. A total of 12.2 million tons, or 33% of the steel that flows into the consumer industries under consideration, is used in the construction industry.

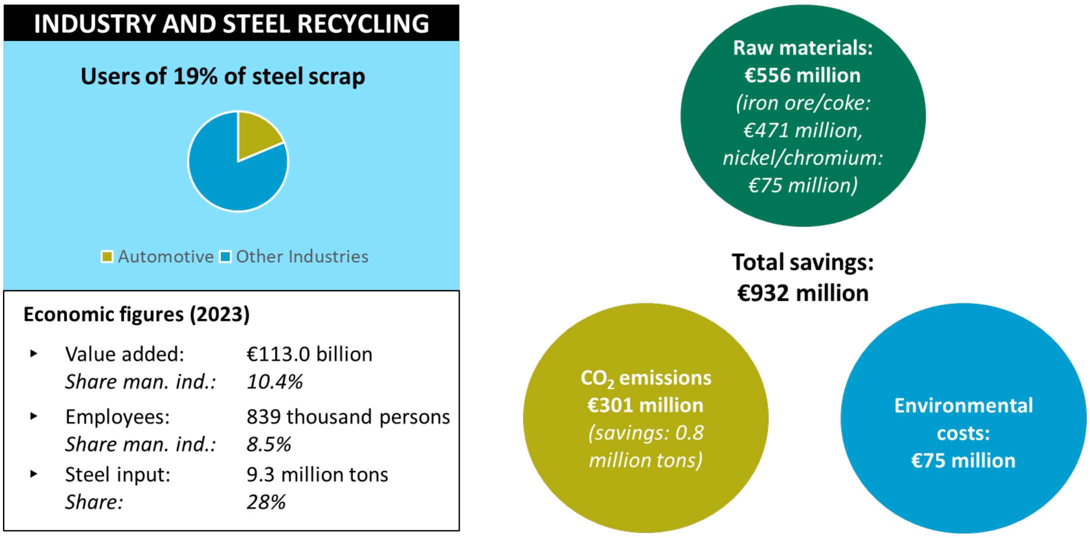
Steel recycling contributed significantly to cost savings (environmental and raw material costs) in the construction industry in 2023: the use of steel scrap resulted in total savings of €2.6 billion in 2023, with the largest share coming from raw material savings. The savings in raw materials include iron ore and coke (€1.4 billion) as well as nickel and chromium (€0.2 billion). In addition, CO_2 emissions in the construction industry were reduced by 2.3 million tons of CO_2, corresponding to a benefit of €0.9 billion.

The industry is pursuing the goal **of closing cycles, further increasing the recycling rate, and systematically reducing CO_2 emissions**. Steel recycling is therefore becoming increasingly important, and without a high recycling rate, climate targets for existing buildings cannot be achieved. A functioning material cycle is crucial in this context, in which construction-related steel scrap from workshop cutting, construction site surplus, and demolition material is completely fed back into the recycling industry and thus back into the steelworks.

6.5 Industry profile: automotive industry

The automotive industry in Germany indirectly uses approximately 19% of the steel scrap used (Figure 14), making it the industry that uses the largest amount of steel scrap after the construction industry.

Figure 14: Scrap use in the automotive industry: utilization of steel scrap, economic significance, and cost savings



Source: Own calculations based on data from Destatis, BDSV, and results from expert interviews. The calculated cost savings result from the allocation of total cost savings (Section 5) according to the indirect use of steel scrap to the customer industries.

The automotive industry is a steel-intensive key industry for Germany that uses high-quality steel. A large proportion of this is flat steel. Due to high quality requirements, the share of steel scrap in the steel input of the automotive industry is still rather low compared to other industries.

With added value of €113.0 billion in 2023 and 839,000 employees, the automotive industry in Germany is a key sector of the manufacturing industry. However, these figures only partially reflect the importance of the industry, as numerous employees in other sectors such as the electronics industry, mechanical engineering, the chemical industry, and the steel industry are dependent on the development of the automotive industry due to interdependencies in the supply chain.

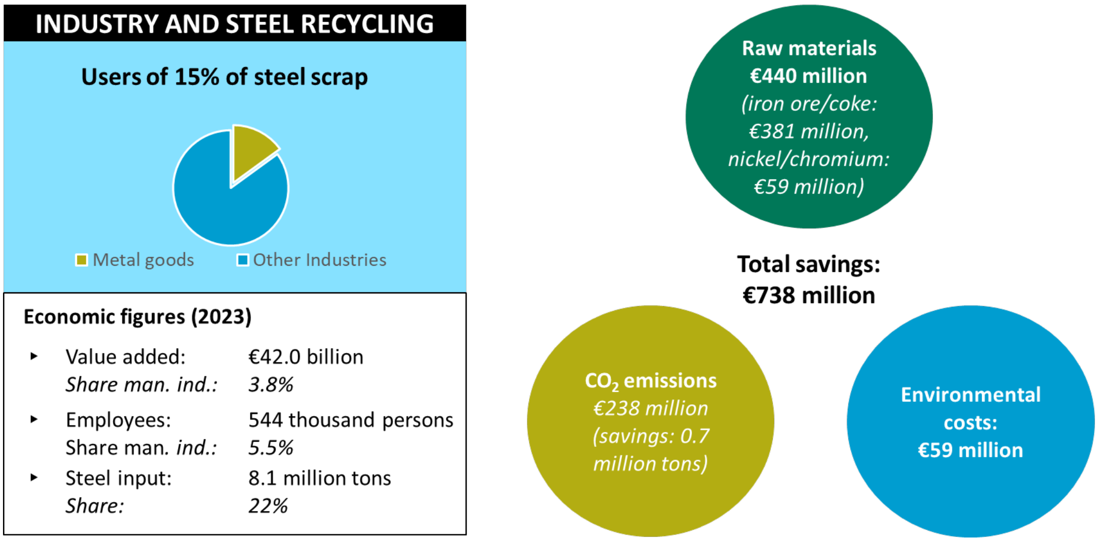
Steel recycling generates cost savings of €932 million in the automotive industry. It also reduces CO_2 emissions by 0.8 million tons, which corresponds to a benefit of €301 million. Steel recycling also leads to savings in environmental costs in the automotive manufacturing value chain amounting to €75 million.

High-quality recycling of steel scrap is one of the automotive industry's goals in the context of improved recycling along the value chain ("circular car"). This aspect is particularly important because high-quality steel (such as flat steel) is used in many automotive applications. At the same time**,** steel is already one of the **materials in cars that is recycled to a high degree**. Vehicle recycling can be significantly improved in terms of material separation (e.g., through separation by type). There are already companies in the EU that specialize in offering high-quality recycled steel, which is used in the automotive industry, for example. At the same time, improving the framework conditions under the new End-of-Life Vehicles Regulation, which is set to replace the previous End-of-Life Vehicles Directive, is highly relevant politically. This regulation will introduce a requirement to provide proof of compliance for every vehicle sale, and it also provides for measures to strengthen recycling, such as recycling and recovery quotas and strict export controls for vehicles from the EU.[16]

6.6 Industry profile: metal products

The metal products sector (summarized: metal goods and pipes) uses 15% of the steel scrap used through its demand for steel (Figure 15).

Figure 15: Scrap use in the manufacture of metal goods: utilization of steel scrap, economic significance, and cost savings



Source: Own calculations based on data from Destatis, BDSV, and results from expert interviews. The calculated cost savings result from the allocation of total cost savings (Section 5) according to the indirect use of steel scrap to the customer industries.

The industry primarily involves the further processing of metals (including steel) into finished products. Customers include a wide range of industries in which metal products are further processed, such as mechanical and plant engineering, the construction industry, and the wind power industry. Steel plays a central role as a raw material, in a wide variety of qualities depending on the field of application and the associated requirements. The manufacture of metal products is naturally very steel-intensive, with 22% of the steel used in the industries under review going into this field of application. In 2023, the manufacture of metal products generated added value of €42 billion and employed 544,000 people.

The metal products industry achieves cost savings of €738 million through steel recycling, consisting of raw material savings of €440 million, avoided CO_2 emissions amounting to €238 million through a reduction in CO_2 emissions of 0.7 million tons and avoided environmental costs amounting to €59 million.

Companies that produce metal products attach particular importance to improving the recyclability of products. In order to improve recycling, collection and sorting rates for end-of-life products should be set and illegal waste exports or exports to countries with low environmental

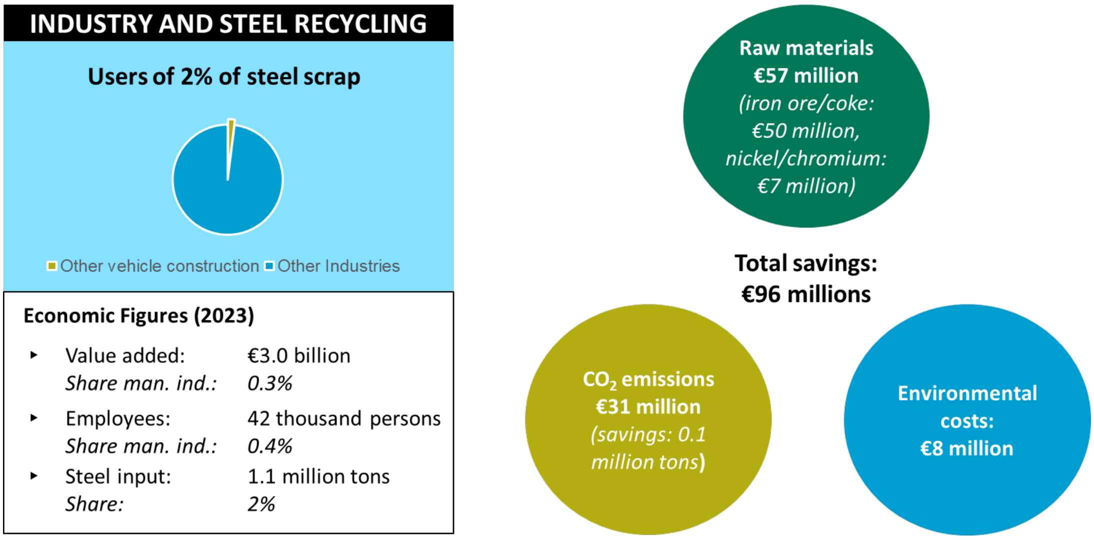
[16] *https://environment.ec.europa.eu/topics/waste-and-recycling/end-life-vehicles_en, accessed on December 8, 2025.*

standards should be reduced. The focus of the analysis is therefore strongly on improving **recycling along the entire value chain** (WV Stahl, WVMetalle n.d.).[17]

6.7 Industry profile: Other vehicle construction

Other vehicle construction, i.e., in particular the manufacture of rail and water vehicles, accounts for only a small proportion (2%) of indirectly used steel scrap (Figure 16). This has less to do with the supposedly low steel intensity of the industry than with the fact that it comprises a small part of the manufacturing sector in the selected definition.

Figure 16: Scrap use in other vehicle construction: use of steel scrap, economic significance, and cost savings



Source: Own calculations based on data from Destatis, BDSV, and results from expert interviews. The calculated cost savings result from the allocation of total cost savings (Section 5) according to the indirect use of steel scrap to the customer industries.

In the definition used here, other vehicle construction includes ship and boat building, rail vehicle construction, and the manufacture of motorcycles.[18] Value added of €3.0 billion is offset by a workforce of 42,000.

Steel recycling results in savings of €96 million for the industry. This consists of raw material savings of €57 million, cost savings from avoided CO_2 emissions of €31 million, and a reduction in environmental costs of €8 million. CO_2 emissions along the value chain are reduced by 0.1 million tons as a result of steel recycling.

The special contribution of steel recycling to circularity in this consumer industry becomes clear when you take a closer look at the individual areas: In the railway sector, sustainability is considered along the entire value chain with the aim of largely implementing circularity by 2040 (Deutsche Bahn 2022). The use of steel in rail construction associated with the railway industry is included in the statistics for the construction industry. Rail steel is a key raw material in this

[17] The interests of the customer industry, which is very heterogeneous in terms of customer structure, are primarily represented by WV Stahl.

[18] The distinction is made in accordance with EUROFER (2025). Aircraft construction, which is also classified as other vehicle construction in the WZ 2008 classification, is not included in this study. Steel products are hardly used here for weight reasons.

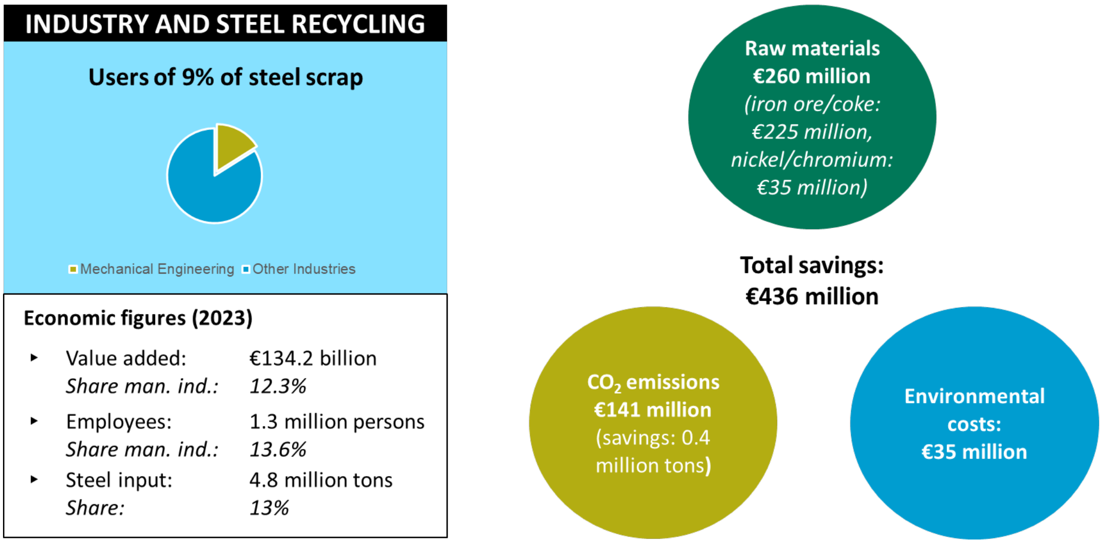
context. Deutsche Bahn plans to almost double the use of steel scrap in rail construction by 2030 compared to 2019 (Deutsche Bahn n.d.). In addition, most of the waste generated by the vehicle fleet – including steel scrap – is recycled.

Ship steel, the second most important steel product in this sector, is already being recycled at a high rate. In the field of ship recycling and the efficient reuse of materials such as steel, the circular economy concept offers further potential for implementing systematic and environmentally friendly recycling and advancing the circular economy (Hiertz, Schumacher 2021).

6.8 Industry profile: mechanical engineering

In the products of the mechanical engineering customer industry, 9% of steel scrap is used indirectly through the use of steel (Figure 17). Steels are a key raw material for mechanical engineering due to their specific product properties such as strength, corrosion and temperature resistance, hardness, and low wear.

Figure 17: Scrap use in mechanical engineering: Use of steel scrap, economic significance, and cost savings



Source: Own calculations based on data from Destatis, BDSV, and results from expert interviews. The calculated cost savings result from the allocation of total cost savings (Section 5) according to the indirect use of steel scrap to the customer industries.

Steel components are used in various mechanical engineering products. These include tool steels for molding tools, steels for machine components, use in the form of steel structures and welded assemblies (machine platforms, machine frames, assembly frames), or cast components made of cast steel. Different alloys allow steel to be adapted to the various specific requirements in a wide range of applications. With added value of €134 billion and 1.3 million employees, the industry is a backbone of the manufacturing sector in Germany.

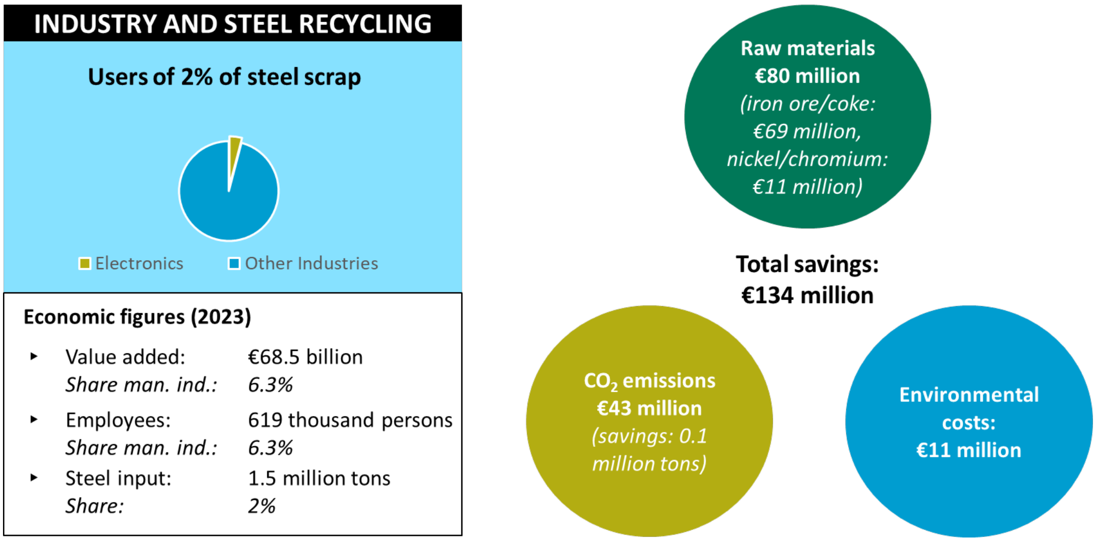
The use of steel scrap led to total savings of €436 million in 2023, with raw materials worth €260 million saved, CO_2 emission costs of €141 million (saving of 0.4 million tons of CO_2) and environmental costs of €35 million.

In addition to the advantages of steel as a material, the key contribution of steel recycling lies in its **contribution to recycling** in the application industry. Despite the heterogeneity of the industry in terms of fields of application, industry-specific characteristics can be identified. These include remanufacturing, i.e., repairing machines to restore their functionality and extend their service life.[19] A modular design makes it possible to increase the longevity of products. Recycling of old materials through targeted sorting and processing is the focus of steel recycling. This is of great importance in the industry given the specific material requirements. At the end of a machine's service life, the steel components are dismantled and separated from other materials such as plastics, non-ferrous metals, or electronic components. Sorting is often carried out manually or with the aid of automated systems to obtain the purest possible steel scrap fraction.

6.9 Industry profile: Electronics and household appliances

In the electronics and household appliances industry, steel scrap accounts for 2% of the total volume and is therefore of relatively little quantitative significance (Figure 18). Nevertheless, steel and steel scrap are central to the industry in terms of the benefits of the material and its role in recycling.

Figure 18: Scrap use in the manufacture of electronics and household appliances: use of steel scrap, economic significance, and cost savings



Source: Own calculations based on data from Destatis, BDSV, and results from expert interviews. The calculated cost savings result from the allocation of total cost savings (Section 5) according to the indirect use of steel scrap to the customer industries.

As a material, steel can play to its strengths in this consumer industry, particularly where it contributes to the structural integrity of household and electronic appliances. Due to its high strength and durability, it is used in refrigerators, washing machines, stoves, and dishwashers, for example. Stainless steel is often used for the outer shells and inner parts of kitchen appliances and microwave ovens because of its corrosion resistance; it is also very easy to recycle. Stainless steel is recycled to a high degree in this industry, as in other fields of application.[20]

[19] *https://www.produktion.de/technik/das-muessen-sie-ueber-kreislaufwirtschaft-im-maschinenbau-wissen/1679397, accessed on November 17, 2025.*

[20] *https://www.edelstahl-rostfrei.de/fileadmin/user_upload/ISER/downloads/Der_globaler_Lebenszyklus_nichtrostender_Staehle_-_Final.pdf (German Steel Association), accessed on November 17, 2025.*

In addition to numerous end products for households, the industry produces components for other sectors such as the automotive industry and mechanical engineering, as well as numerous service industries. With a value added of €68.5 billion and 619,000 employees, the industry is of great importance to the manufacturing sector in Germany.

In 2023, steel recycling led to cost savings of €134 million, comprising €80 million in raw material savings, €43 million in CO_2 emissions savings, and €11 million in avoided environmental costs. Along the value chain, 0.1 million tons of CO_2 were saved.

Like other metals, steel is specifically recovered and melted down for recycling in the household appliance and electronics industries. Steel, like other bulk metals, is already recycled to a high degree, meaning that the material cycle is already largely closed. At the same time, the largely single-type separation and delivery for recycling, which is a prerequisite for high-quality recycling, still poses a problem in some cases. This is particularly the case because products from this consumer industry (e.g., cell phones, tablets, or computers) contain a variety of different raw materials in varying quantities. One approach to a solution is design for recycling, in which dismantling and recycling are already taken into account during product development.

6.10 Overall assessment of the role of steel recycling for consumer industries

The **cross-industry significance of steel recycling** is particularly evident in its key role in the sustainable use of limited resources and the reduction of environmental costs through the closure of material cycles and the conservation of resources. The use of steel scrap as a recycled raw material in steel production contributes significantly to enabling the transition to a circular economy. Substituting primary raw materials not only reduces dependence on raw material imports, but it also increases security of supply for the entire value chain. At the same time, the use of steel scrap as a raw material leads to considerable energy and CO_2 savings and thus also to corresponding cost savings in the consumer industries.

The **relevance of steel recycling** extends beyond the steel industry and affects all industries in which steel is used as a material. This includes, in particular, the construction industry, the automotive industry, mechanical and plant engineering, electronics and metal processing, and numerous other branches of industry. There are considerable differences between these industries in terms of the indirect use of steel and steel scrap: while the quantitative importance of both steel and steel scrap is particularly high in the construction and automotive industries, qualitative aspects such as recycling-friendly product design and modular construction methods are more important in electronics and metal processing as well as in mechanical engineering. For example, early consideration of recyclability in product design can significantly increase the recovery and reuse of steel components. In mechanical engineering, on the other hand, modular structures enable efficient disassembly and reuse of components, which further increases material efficiency and recycling rates.

The **economic benefits** of steel recycling are noticeable in all the industries considered. In addition to direct cost savings through lower raw material and energy requirements, the use of recycled raw materials also has an impact on the entire value chain: total production costs can be reduced while at the same time increasing resilience to supply fluctuations on the international raw material markets.

In summary, it can be said that the **use of steel scrap makes a key contribution to the sustainability goals of all the industries considered**. Against the backdrop of increasing demands for climate protection and resource efficiency, the cross-industry recycling of steel is becoming increasingly important strategically, going beyond purely ecological aspects to also encompass economic and social dimensions. Although the industry-specific objectives and measures for establishing closed material cycles differ in their specific design, they are ultimately based on the common goal of establishing steel as a sustainable material of the future.

7. Barriers to development and economic policy implications

The development of steel recycling is hampered by various obstacles, which should be addressed in the form of targeted recommendations. In a survey of selected BDSV member companies conducted as part of this study, the following obstacles to further development were identified:

- Framework conditions in the form of regulatory and bureaucratic hurdles/political support/trade restrictions;
- Technological development (sorting, quality assurance);
- Competition with primary raw materials, energy costs.

In addition, the image of the industry and the partial lack of transport capacity were considered important. In contrast, financing options, skills shortages, and a lack of funding opportunities were only considered relevant by a small proportion of respondents.

With regard to the most important obstacles, the studies result in the following recommendations:

Firstly, **regulatory barriers** are a key problem for the future development of the industry. The existing approval procedures for production processes and facilities are often cumbersome and cost intensive. In addition, unrealistic limits are often set for potentially hazardous trace elements in steel and thus also in the corresponding steel scrap, which do not correspond to the actual requirements in practice. This leads to inefficient processes and tends to make it more difficult to use recycled material. The "toxicification" of metallic materials could also lead to stigmatization regarding their use, which could negate all the successes achieved in recycling due to the disappearance of the materials.

Regulations on economic activity are not inherently bad or anti-competitive. What matters is whether they create clear, comprehensible structures, ensure legal certainty, are practical, and do not lose sight of the costs involved. **Regulatory hurdles affect companies in the steel recycling industry primarily through increased costs, bureaucratic effort, and delays in investment and innovation.** This can hinder the development of recycling capacities, make steel recycling more cost-intensive, and, in the worst case, bring recycling to a standstill.

The main effects in detail are:

- **Financial and personnel burdens:** Bureaucratic regulations and complex approval procedures cost companies considerable resources, which severely restricts small and medium-sized enterprises in particular.
- **Hindering innovation:** Strict and lengthy regulatory requirements slow down the introduction of new technologies and products and make it difficult to invest in innovation.
- **Unequal burden:** Depending on how the rules are interpreted, companies can be burdened very differently depending on their location and hindered in their activities.
- **Uncertainties:** If it is unclear how certain rules are to be applied and which limits must be observed, uncertainties can arise and make business decision-making processes more difficult.
- **Scope:** Insofar as the rules only apply to German or European companies, they can represent an obstacle to global competition. German special regulations that go beyond European law

(known as gold-plating) are particularly challenging. This poses a problem for the competitiveness of German recycling companies, especially in border regions.[21]

A **practical example** shows the impact on steel recycling companies when there are no clear rules of procedure: Certain specialized machines for processing and recycling steel scrap can be used flexibly as portable "semi-mobile units". These machines often incorporate modern technologies. This makes them particularly important for the efficient processing of steel scrap. These systems must comply with the state of the art in terms of noise and pollutant emissions. However, there is uncertainty as to whether these systems require approval if they are put into operation for a trial period of up to six months, for example. Clarity could be provided in this case by requiring only advance notification of the competent authority for trial operation, but no permit. This would remove the uncertainty about the correct procedure and at the same time enable the temporary operation of innovative plants, especially for small and medium-sized enterprises, which could use and test them flexibly.

Solution: To overcome regulatory hurdles, it is recommended that bureaucratic processes should be made more efficient and practical by reviewing and simplifying regulations, especially where they do not generate economic added value. At the same time, it is necessary to adjust the limit values to realistic and technically justifiable standards. In addition, European law should be implemented on a 1:1 basis. Where this has not yet been done, regulation should be reduced to the European standard in order not to impair the competitiveness of German recycling companiesIn the area of automotive recycling, another problem is the **lack of enforcement of legal regulations**. Here, control over the whereabouts of end-of-life vehicles has been incomplete to date. As a result, many old vehicles disappear into an illegal recycling sector without proper documentation. The existing EU directives are implemented inconsistently and incompletely. In addition, numerous end-of-life vehicles are transported to countries with lower environmental standards.

Solution: One solution to the problem is to tighten regulations in this area. This includes digital tracking of end-of-life vehicles, enforcement of existing regulations, and more inspections. The responsibility of manufacturers should be increased and, at the same time, recognized recyclers in the system should be strengthened. A corresponding regulation has been proposed by the EU Commission.[22]

Another major obstacle is the **poor quality of steel scrap**. Due to its composition and impurities, some recycled scrap does not meet the high requirements for steel applications. At the same time, buyers are often unwilling to pay enough for sorted, high-quality recycled steel scrap, which discourages investment or the use of existing processes and methods to improve scrap quality. Since higher quality usually goes hand in hand with higher costs, it is logical that without appropriate compensation for the additional expenses, it is hardly possible to meet the expectations of buyers.

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[21] *This aspect is also highlighted in a joint press release issued by bvse (Federal Association for Secondary Raw Materials and Waste Disposal), BDSV (German Steel Scrap Association – Bundesverband Deutscher Stahlrecycling- und Entsorgungsunternehmen e.V.) and VDM (Association of German Metal Traders). bvse – Industrieemissionsrichtlinie: Recycling- und Metallwirtschaft warnt vor bürokratischem Gold-Plating, accessed on December.12, 2025.*

[22] *https://germany.representation.ec.europa.eu/news/kreislaufwirtschaft-eu-kommission-legt-eine-verordnung-fur-recycling-von-fahrzeugen-vor-2023-07-13_de (The future of the automotive industry: The automotive industry is facing a radical transformation), accessed on November 19, 2025.*

Solution: The framework conditions should be improved to promote high-quality scrap sorting and processing. This requires a systemic view of recycling, which takes into account, among other things, design for recycling and the establishment of collection and dismantling infrastructures. This includes the consistent implementation of disposal regulations, for example in automotive recycling,[23] the promotion of innovative technologies for scrap processing, and the elimination of market failures, for example through more effective internalization of environmental costs via higher CO_2 prices, which could provide a monetary incentive for increased scrap use with higher processing quality and could ensure fair competition between complementary primary and recycled raw materials overall.

High energy costs, particularly in the EU context, have a negative impact on the competitiveness of the steel recycling industry. They represent a significant cost disadvantage and limit competitiveness compared to regions with cheaper energy supplies. This aspect affects not only steel production itself, but also scrap processing (shredders, shears, sorting technology), which is also energy intensive.

Solution: It is therefore recommended that energy supply efficiency should be improved, and the energy transition should be designed more rationally. In the short term, this may also include temporarily reducing energy taxes to the EU minimum level in order to strengthen the competitive position of German recycling companies and their energy-intensive customers, the steel producers.

A potential problem is the **export bans on steel scrap** currently being discussed in the political arena, as these would have a welfare-reducing effect on the economy and society on the one hand, and on the other hand would not solve the problem of domestic scrap availability, which they are intended to address.

Solution: Market mechanisms are better suited than export bans for promoting steel recycling, as they provide incentives to improve high-quality scrap sorting and processing without causing the negative economic effects of export bans. Export bans often lead to a loss of prosperity because resources are not used where their benefits are greatest. They reduce the motivation to collect and sort scrap because the underlying cause — a lack of willingness to pay for high-quality processed steel scrap — is not addressed (Recycling Magazine 2025). At the same time, there is no fundamental problem regarding a prevailing shortage of available steel scrap that could be cited as justification for an export ban.

In summary, regulatory simplification, improvements in the quality of scrap material, and competitive energy costs are essential for the sustainable development of steel recycling. The combination of these measures helps to increase resource efficiency, promote environmental sustainability, and secure the long-term competitiveness of the steel recycling industry and its customer industries.

In this context, functioning market mechanisms operate through prices that control supply and demand. This creates an incentive for consumer industries to improve the collection and sorting of steel scrap and for recycling companies to increase quality and work more efficiently. An im-

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[23] *The illegal and improper disposal of end-of-life vehicles is still a problem in recycling, as was made clear during expert discussions, among other things.*
See also https://www.euwid-recycling.de/news/wirtschaft/illegale-altfahrzeugverwertung-verursacht-hohe-oekonomische-und-oekologische-kosten-091222/, accessed on December 10, 2025.

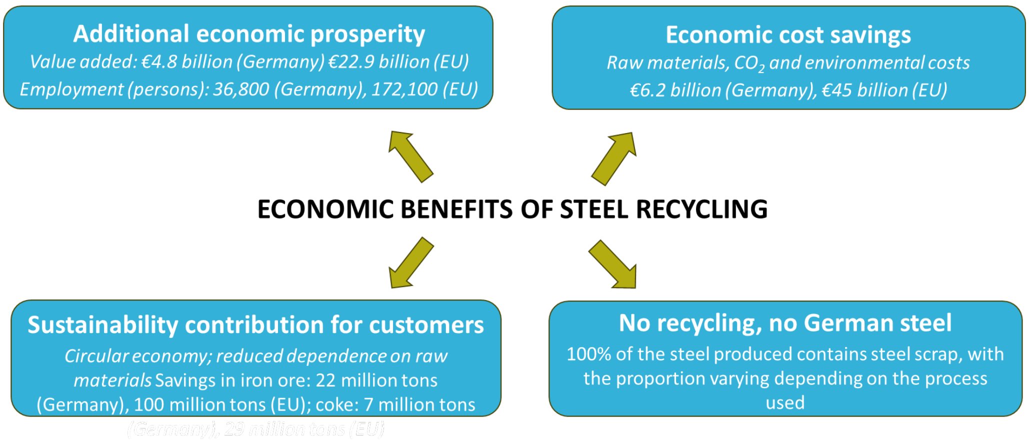
proved institutional framework that creates, for example, circular product design, improved dismantling processes for end-of-life products, and price adjustments that take environmental costs into account (e.g., through CO_2 pricing) thus promotes sustainable recycling.

8. Conclusion: What are the economic benefits of steel recycling?

Based on the scientific studies conducted, it is possible to answer the question of what dimensions the direct and indirect benefits of steel recycling encompass for our society and economy. Figure 19 shows the various dimensions of economic benefits based on this consideration:

These include (1) additional economic prosperity through value creation and employment in the industry itself or through interdependence with supplier industries, (2) economic cost savings in the form of raw material, CO_2 and environmental costs through steel recycling, (3) the substantial contribution of the industry to recycling and reduced raw material dependency in customer industries, and (4) the contribution made by the fact that German steel – regardless of whether it is produced using the blast furnace route or the EAF process – always contains steel scrap, which is an indispensable raw material input for steel production. In addition, without steel recycling, the disposal of steel that has reached the end of its life cycle in the corresponding products or is produced as waste material in production would have to be ensured in another form. These hypothetical disposal costs are also saved through steel recycling. The trend towards direct reduction processes will further increase the importance of steel scrap in the future.

Figure 19: Economic benefits of steel recycling



Source: Own depiction.

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10. Appendix

10.1 Input-output analysis as a methodological approach for measuring the contribution to prosperity

Input-output analysis is a methodological approach that takes into account both the direct and indirect effects of steel recycling. It is based on Wassily Leontief's demand-oriented model, which allows the effects of a given demand (e.g., for secondary steel) on overall economic production, value added, and employment to be examined (Oosterhaven 2022).

The data is based on the so-called input-output tables of official statistics. These are interdependence matrices that show the economic relationships between the sectors of an economy, the use of the goods produced in final demand, and the creation of gross value added in monetary terms. Input-output tables can be used to calculate both the direct effects of a production process on value added and employment and the indirect effects that arise at all upstream production stages.

The sectors or branches of industry shown in the input-output tables are structured according to the classification of economic activities[24] (2008 edition, abbreviated to WZ 2008). However, the definition of the steel recycling industry using WZ 2008 is too broad and is therefore approached from two sides in this study. In the input-output tables, steel recycling is part of the very broadly defined waste disposal industry (WZ08-37-39). In addition to wastewater disposal (WZ08-37) and the collection, treatment, and disposal of waste as well as recovery (WZ08-38), this also includes the removal of environmental pollution and other waste disposal (WZ08-39). Steel recycling is included here as part of "recovery of sorted materials" (WZ08-38.32). This is the smallest definable area for which data is available in official statistics. However, this industry also includes companies outside the steel recycling sector, such as plastic recycling companies.

This inevitably leads to inaccuracies in the results. However, these inaccuracies are limited in this case: Put simply, the steel recycling industry primarily "produces" sorted and processed steel scrap, which is supplied exclusively to the iron and steel industry[25] as a customer, both domestically and abroad. Since this supply relationship can also be clearly identified in the input-output data within the waste management industry as a whole, the starting point for the calculations – the steel industry's demand for steel scrap and recycled steel – can be clearly defined.

The present study is therefore based, as far as possible, on the group of companies with revenues from steel recycling. In this "narrow" industry definition, data from the BDSV on quantities and prices in connection with steel recycling can be used. The linking of results at this level and from the input-output analysis is based on appropriate assumptions, which are presented in the relevant sections.

In a step-by-step approach, an input-output analysis in an infinite loop calculates the overall economic production effect of an initial demand for goods (demand impulse), which results from the given interdependence structure of production processes in an economy (input structure). The structure of the intermediate inputs from other industries required for a specific production process (e.g., the recycling of steel scrap) and the resulting gross value added can be interpreted as production technology — in this case, the steel recycling industry. If the initial demand for

[24] At European level, the statistical classification of economic activities in the European Community NACE Rev. 2.0 is used. Since the German classification of economic activities (WZ) is derived from NACE, the structure of both classifications is identical (at least up to the 4-digit level).

[25] This includes the foundry industry.

goods is multiplied by this structure, the result is a vector of intermediate inputs that are required from other industries, but also from the industry itself, in order to produce the goods in demand. In addition, the gross value-added results from this production round. The results of this first production cycle are referred to as the direct effects of a demand impulse. In the next and all subsequent production cycles, the intermediate inputs required serves as a demand impulse in the respective intermediate input industries. This results in the indirect effects of an initial demand impulse. As an overall result, an input-output analysis provides monetary values for total economic production (intermediate consumption and value added) that is directly and indirectly triggered ("induced") by an initial demand for goods. With the help of the labor productivity of the industries in the economy, the direct and indirect effects on employment can be calculated from this.

Another result of an input-output analysis is multipliers for the main aggregates of production, value added, and employment. A multiplier reflects in aggregated form the macroeconomic effects of a stimulus per unit of demand. For a given aggregate, it represents the ratio of the direct effect to the total effect of a demand stimulus.

When it comes to the question of which are the key input industries for the steel recycling industry, the evaluation of the input-output tables reveals some differences between Germany and the EU-27. Both in Germany and at the European level (including Germany), the intrasectoral interdependence of the industry (i.e., intermediate consumption within the same industry) – measured as a share of total intermediate consumption – is strongest, accounting for 34% of all intermediate consumption in Germany and 23% in the EU. These intrasectoral intermediate inputs arise when companies in the steel recycling industry supply steel scrap to other companies in the industry. They result from the division of labor within industry, with some companies collecting steel scrap and others carrying out further processing steps.

Other important intermediate input industries for steel recycling in Germany are services provided by architectural and engineering firms as well as technical, physical, and chemical testing (14%), wholesale trade (9%), and construction (9%). In the European steel recycling industry, the most important intermediate industries include metals and metal products (11%), public administration services (9%), real estate and housing (4%), and construction (4%).

The varying proportions of input industries in the steel recycling industry in Germany and the EU reflect differences in the overall economic organization of steel recycling – the overall economic production technology of this industry. The higher level of intrasectoral integration may indicate that steel recycling in Germany takes place more within the recycling industry, while at the European level, a larger proportion of steel scrap is recycled or reused directly by steel producers.

10.2 Industry classification

Delimitation of customer industries	
Industry	**WZ08 classification**
Construction industry	41, 42, 43, 25.1, 25.2
Mechanical engineering	28, 27.1, 25.3
Metal goods	24.2, 25
Automotive	29
Other vehicle construction	30, 30.1, 30.2, 30.91
Electronics	26, 27, 27.51
Steel industry	24.1, 24.3, 24.52

Source: EUROFER (2025).