Mehlhart Consulting

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

Recycled content targets for steel in European automotive industry

Ad hoc Support Study for the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)

The Study was conducted as part of the AutoRess (Resource efficient and circular electric cars) research project

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Authors

Jürgen Sutter
Oeko-Institut e.V.

Georg Mehlhart
Mehlhart Consulting

Contact
info@oeko.de
www.oeko.de

Head Office Freiburg
P. O. Box 17 71
79017 Freiburg

Street address
Merzhauser Straße 173
79100 Freiburg
Phone +49 761 45295-0

Office Berlin
Borkumstraße 2
13189 Berlin
Phone +49 30 405085-0

Office Darmstadt
Rheinstraße 95
64295 Darmstadt
Phone +49 6151 8191-0

Further information to AutoRess and publications (e.g. final report, factsheets) are available at the German Environment Agency (Umweltbundesamt) website: https://www.umweltbundesamt.de/themen/verkehr/ressourcenschonung-im-verkehr

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1 Introduction

On 13 July 2023, the European Commission presented a proposal for a regulation on requirements for the circular design of vehicles and the disposal of end-of-life vehicles[1] revising the current Directive 2000/53/EC on end-of-life vehicles (ELVs)[2] and its corresponding Directive 2005/64/EC on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability (3R type-approval)[3]. The joint review aims at modernising the current legislative framework, which was initially established in 2000, and builds on the three key objectives:

1. improve circularity in the design, production, and end-of-life treatment of vehicles.
2. increase traceability of vehicles that are not reported when reaching the end of their life ("missing vehicles") and regulate the export of used cars which are not roadworthy or which are highly polluting vehicles.
3. extend the regulatory scope of the ELV Directive to new vehicle categories, especially motorbikes, lorries and buses.

The regulation would repeal and replace both the 3R type-approval and ELV Directives.

The European Commission has decided not to set any targets for the proportion of recycled steel in the current proposal for the ELV Regulation, as the impact assessment indicates that there are still too many uncertainties to set targets.

Instead, according to article 6 of the proposal the Commission is empowered to adopt delegated acts to supplement this Regulation by establishing a minimum share of steel recycled from post-consumer steel waste to be present and incorporated into vehicle types to be type-approved in accordance with this Regulation and Regulation (EU) 2018/858. The minimum share of recycled steel shall be based on a feasibility study, to be carried out by the Commission.

The feasibility study shall look in particular at the following aspects:

- the current and forecasted availability of steel recycled from post-consumer sources of steel waste,
- the current share of post-consumer waste in various steel semi-products and intermediates used in vehicles,
- the potential uptake of post-consumer recycled steel by manufacturers in vehicles to be type-approved in the future,
- the relative demand of the automotive sector in comparison to the demand for post-consumer steel waste of other sectors,

[1] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on requirements for the circular design of vehicles and for the disposal of end-of-life vehicles, amending Regulations (EU) 2018/858 and (EU) 2019/1020 and repealing Directives 2000/53/EC and 2005/64/EC, see https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=celex%3A52023PC0451

[2] Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles, see https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32000L0053

[3] Directive 2005/64/EC of the European Parliament and of the Council of 26 October 2005 on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability and amending Council Directive 70/156/EEC, see https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32005L0064

- economic viability, technical and scientific progress, including changes in the availability of recycling technologies concerning steel recycling rates,
- the contribution of a minimum share of recycled content of steel in vehicles to the Union's open strategic autonomy, climate and environmental objectives,
- the need to prevent disproportionate negative impacts on the affordability of vehicles, and
- the influence on the overall costs and competitiveness of the automotive sector.

According to the proposal the Commission may also adopt an implementing act establishing the methodology for the calculation and verification of the share of steel recycled from post-consumer steel waste present in and incorporated into vehicle types.

The proposal is currently considered by the European Parliament and the Council in the ordinary legislative procedure.

The current Hungarian Council Presidency has presented a recycled content target of 20% in a proposal for further negotiations. This target is based on a measure that was calculated and evaluated as part of the European Commission's Impact Assessment Report (based on a supporting study by the Oeko-Institut[4]).

Against the background of the current negotiations, the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection has asked the Oeko-Institut for an ad hoc support with scientific contributions. The following questions have been commissioned by the ministry:

- How much recycled steel is already used in vehicles? Status quo for long and flat steel in the automotive industry.
- How much recycled steel can be used in vehicles (now or after the transition to electric vehicles)? What would have to be changed for this?
- How much closed-loop/PCR is possible (now and after the transition to e-vehicles)?
- How should the 20% steel recycled content target within 7 years demanded by the Hungarian Council Presidency be assessed? Is it already feasible now or rather ambitious?
- How will the steel industry's ambitions and investments in 'green steel' influence the demand for secondary steel?
- What should a definition of steel look like?
- If a recycled content target for steel should be introduced, to what extent would Annex VII Part G need to be adapted?

[4] Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles, see https://op.europa.eu/en/publication-detail/-/publication/2fa7e161-2083-11ee-94cb-01aa75ed71a1/language-en

2 Overview on scrap usage in the automotive industry in EU

The primary steel production route using blast oxygen furnaces can be used for producing both long and flat steel products. The share of scrap used in this case is usually supplied at plant level, the pre-consumer scrap (high-quality scrap).

The secondary steel production using an electric arc furnace (EAF) is mostly used for long products, for which no high-quality scrap is required, so that post-consumer scrap (low-quality scrap) can be used.

While up to 100% scrap can be used in electric arc furnaces[5], the possible proportion of total steel scrap in blast furnaces is significantly lower.

ArcelorMittal Europe, for example, uses two main routes for the production of long products:

- the BF-BOF route (Blast Furnace-Basic Oxygen Furnace), which uses iron ore and coal for steel production - scrap usage rates vary between 10% and 20%
- the EAF route (Electric Arc Furnace), in which the steel scrap is melted using electric energy - scrap usage rate is up to 100%. The recycled content varies between 40% and 95% (including DRI-EAF plants)

No steel scrap is currently used in blast furnaces for the production of flat products.

Table 2-1 shows the share of scrap usage in steel and iron products used in the production of passenger cars in the EU, which is considered in this study.

Table 2-1 Share of scrap usage in production of steel and iron products

	Flat steel	Long steel	Cast iron
In-house scrap	2%	8.7%	11%
Post-industrial scrap	19%	13.6%	
Post-consumer scrap	0%	32.6%	43%

Source: Own table based on ArcelorMittal Europe Long Products (2022) for long products and Daehn 2019 for flat steel and cast iron

Renault stated in 2023 that, among the materials used in the plants in the Europe and North Africa Regions, the estimated portion of recycled steel materials ranges from 17% for flat steel to more than 90% for steel bars and cast iron. However, no information was provided how much of this comes from pre-consumer scrap and how much from post-consumer scrap.[6]

It can be assumed that the proportion of recycled content from post-consumer scrap in long steel used in the European automotive industry is somewhere between the approximately one third

[5] See for example the declaration on recycled content by the Swedish steel producer Ovako: https://www.ovako.com/49f36c/globalassets/downloads/sustainability/statement-recycled-content-ovako-20210621.pdf

[6] https://www.renaultgroup.com/wp-content/uploads/2023/03/renault_2022-urd_20230327_en.pdf

stated by ArcelorMittal and the approximately 90% stated by Renault. For the calculation, we use a lower limit and an upper limit to determine a currently feasible recycled content rate.

3 Possible rate for recycled content in steel products for the automotive industry in the EU

Many automakers have revealed the percentage of secondary steel used in their vehicles. BMW reported an average of 25% secondary steel content, with plans to increase this to 50% by 2030. Renault Group estimated that the secondary steel content in its vehicles ranged from 17% for flat steel to over 90% for steel bars and cast iron in 2022. Stellantis mentioned using up to 30% recycled steel, including both pre- and post-consumer scrap. Volvo used 15% recycled steel in its vehicles in 2022, aiming to increase this to 25% by 2025 (Bui et.al, 2024). However, in all this published information, no distinction is made between usage of pre-consumer scrap and post-consumer scrap.

There are many research projects, aimed at increasing the use of recycled post-consumer steel in vehicles.

In 2021, ThyssenKrupp and TSR started work in the research project **REDER** with the aim of developing an advanced shredder technology that produces a steel fraction ready to be used in the flat steel production[7]. In the meantime, the new TSR shredder plant in Duisburg is operative. The plant is expected to process up to 450 000 tons of different input materials annually – such as end-of-life vehicles, mixed scrap, or large household appliances[8]. The output of TSR40 is 300 000 tons

According to TSR, the TSR40 product from in the new steel scrap preparation process achieves a high purity (Cu < 0.08%, Cr < 0.25%, Mn < 0.4%, Mo < 0.02, Ni < 0.07%), which is also suitable for primary steel production in the blast furnace and converter and can therefore also be used for the production of high-quality flat steel.[9] In mid-2024, Remondis opened a second TSR40 plant in Amsterdam. It is currently building two more TSR40 facilities in Hamburg and Magdeburg, which are slated to start up in 2025 and 2026, respectively.[10]

In March 2023, OEM Audi reported on the **MaterialLoop** research project, which aims to achieve a recycling uptake rate of 12% for deep-drawing steel. The research project is being implemented at running industrial sites, together with TSR for sorting and Voestalpine adding the scrap in the converter of the blast furnace. Studies carried out as part of the project show that the proportion of steel recycled from vehicles in the coil could be increased even further in the future[11].

In April 2023, BMW reported about the research project **Car2Car**. The project will focus on several materials, including aluminium, steel, glass, copper, and plastic. According to BMW, “innovative dismantling and automated sorting methods should allow for far lag quantities of the resources to be

[7] https://www.thyssenkrupp-steel.com/de/newsroom/pressemitteilungen/steel-und-tsr-testen-innovatives-verfahren-zum-einsatz-von-hochwertigem-schrott-im-hochofen.html
[8] https://www.euwid-recycling.de/news/wirtschaft/schrottrecycler-tsr-nimmt-in-duisburg-neue-aufbereitungsanlage-in-betrieb-280423/
[9] https://arn.nl/wp-content/uploads/pdf_presentation-hks-arn-relatiedag-2-oktober-2024.pdf
[10] https://www.euwid-recycling.com/news/business/metals-recycler-tsr-and-papenburg-considering-offer-to-acquire-steelmaker-salzgitter-ag/
[11] https://www.audi-mediacenter.com/de/pressemitteilungen/aus-alt-mach-neu-projekt-materialloop-testet-kreislaufwirtschaftspotenziale-von-altfahrzeugen-15205

recovered from ELVs to be made suitable for use in the production of new cars than has been the case to date." In addition to several universities and trade groups, the Car2Car consortium partners include BMW, Scholz Recycling GmbH, Steinert UniSort GmbH, Thyssenkrupp Steel Europe AG, Salzgitter Mannesmann Forschung GmbH, Aurubis AG, Novelis Deutschland GmbH, Oetinger Aluminium GmbH, and Pilkington Automotive Deutschland GmbH.

4 Closed loop recycling

To assess how much closed-loop recycling for steel in the automotive industry is possible the model developed by Oeko-Institut as part of the impact assessment study for the European Commission was used for a specific calculation.

The model covers a period from 2025 to 2040. As a starting point for comparison – mainly for developing, checking and adapting modelled vehicle mass flows – we use time series from ACEA that go back to the year 2009 for all applications except for ICEVs which have been modelled back to 1990. The future perspective is based on data from the Euro 7 impact assessment[12].

For each individual life cycle stage, the mass flows are differentiated into the relevant engine types of ELVs. The following engine types are addressed in the model:

- Internal combustion engines (ICEs),
- Battery electric vehicles (BEVs),
- Hybrid electric vehicles (HEVs), and
- Plug-in-Hybrid electric vehicles (PHEVs).

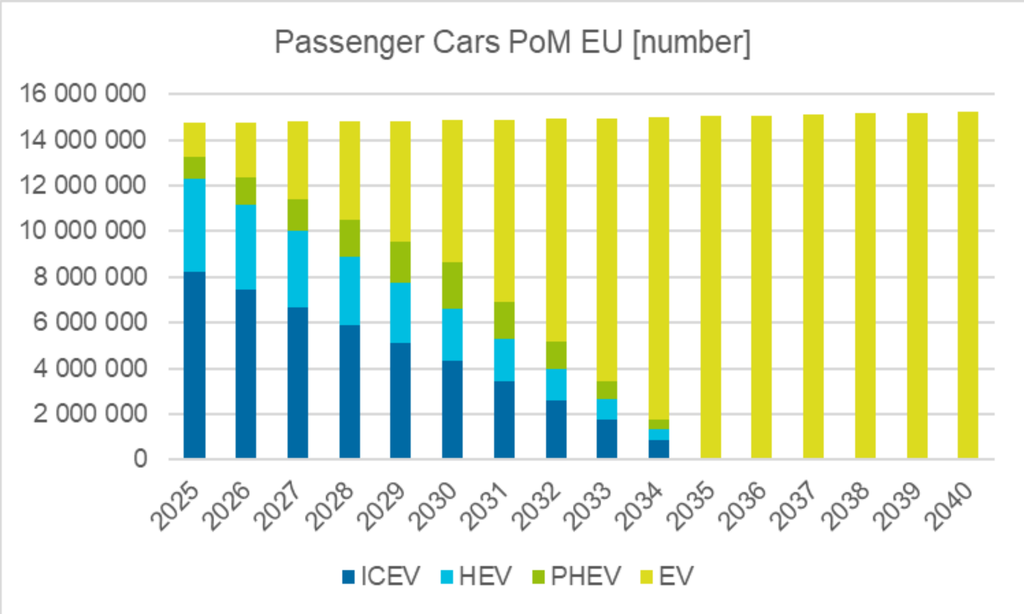
Figure 4-1 shows the development of the passenger cars PoM in the EU from 2025 to 2040. As a de facto ban on internal combustion engines will come into force for new registrations in the EU from 2035, the modelling of drive types based on the data from the Euro 7 Impact Assessment shows a massive shift towards electric drives.

To model the material composition of passenger cars, data from JRC-RMIS[13] on the composition of passenger cars was used, supplemented by data from the GREET model (Argonne 2021). The percentage composition was calculated down to the average weight of the vehicles.

[12] Aeris Europe: Euro 7 Impact Assessment: The outlook for air quality compliance in the EU and the role of the road transport sector. 2021. Online available under https://aeriseurope.com/papers-and-articles/euro-7-impact-assessment-the-outlook-for-air-quality-compliance-in-the-eu-and-the-role-of-the-road-transport-sector/

[13] https://rmis.jrc.ec.europa.eu/apps/veh/#/p/viewer

Figure 4-1: Number of passenger cars PoM in the EU by engine type



Source: Own illustration, based on data from Euro 7 IA

Table 4-1 shows the average weights for passenger cars and ELVs, which are used in the model.

Table 4-1 Average weights of passenger cars PoM and ELVs in the EU for the years 2025, 2030 and 2035

Vehicle	Average weight in 2025 [kg]	Average weight in 2030 [kg]	Average weight in 2035 [kg]
Passenger car PoM	1 549	1 588	1 628
End-of-life vehicle	1 197	1 258	1 322

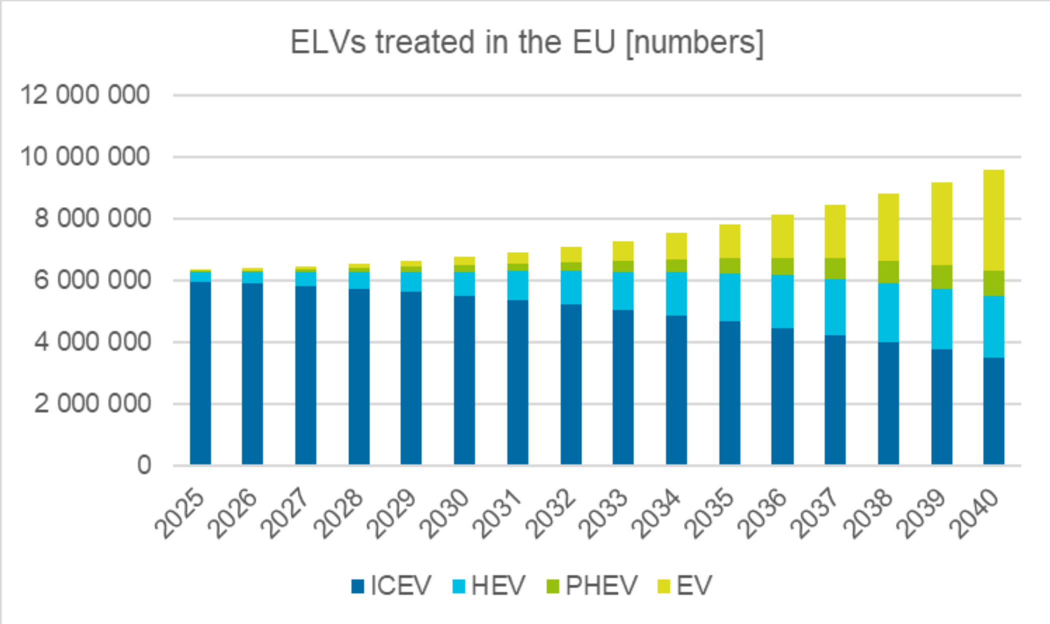
Source: Own table, based on desktop research[14]

To describe the probability of a vehicle reaching its end-of-life, a Weibull distribution has been used. For modelling the EoL of ICEs it is assumed that 50% of the vehicles that are placed on market in the European Union are also treated at end-of-life in the EU in accordance with regulations. For HEVs, PEVs and EVs it is assumed that 90% of the vehicles are processed in recycling plants in the EU.

Figure 4-2 shows the development of decommissioned ELVs in the EU, which are processed in ATFs from 2025 to 2040. The shift towards electric cars due to the ban on internal combustion engines from 20235 is evident here with a significant time delay.

[14] See here: https://www.steelonthenet.com/files/automotive.html

Figure 4-2: Number of decommissioned ELVs to be processed in ATFs in the EU



Source: Own illustration, based on model

In modelling, a distinction is made between flat and long steel as well as cast iron. According to ArcelorMittal "165 kg of long products can be found in a passenger car."[15] In a previous publication in 2018[16], ArcelorMittal mentions a share of 44% of flat products, and 12% of long products, and 44% other materials. As a second source, a survey by Steelonthenet[17] revealed an average total weight of 1440 kg per passenger car. The steel content was 830 kg (58%). In this assessment, flat steel products amount to 667 kg (46%) and long products to 163 kg (11%). Battery electric vehicles neither have a crank shaft nor a piston. Therefore, the assumption is that fewer long products are needed for BEV. According to personal communication from ArcelorMittal[18], the share of long steel in BEV is estimated at about 100 kg/BEV, compared to 165 kg/ICE-vehicle. For this study, we assume that the share of long steel for BEV will be 40% less compared to ICE vehicles.

[15] https://germany.arcelormittal.com/Innovation/Loesungen-aus-Stahl/Autos/Langstahlprodukte-in-ihrem-Fahzeug

[16] Jan Bollen, ArcelorMittal (2018): New steels driving the circular economy, innovative solutions for future mobility, presentation at the International Automotive Recycling Conference, Vienna, 2018-03-14

[17] https://www.steelonthenet.com/files/automotive.html

[18] E-Mail of Jan Bollen (ArcelorMittal), 2023-04-27

Table 4-2 shows the shares of steel and iron product in passenger cars PoM in the EU, which are used in the model. These shares are also used for the calculation of the ELVs.

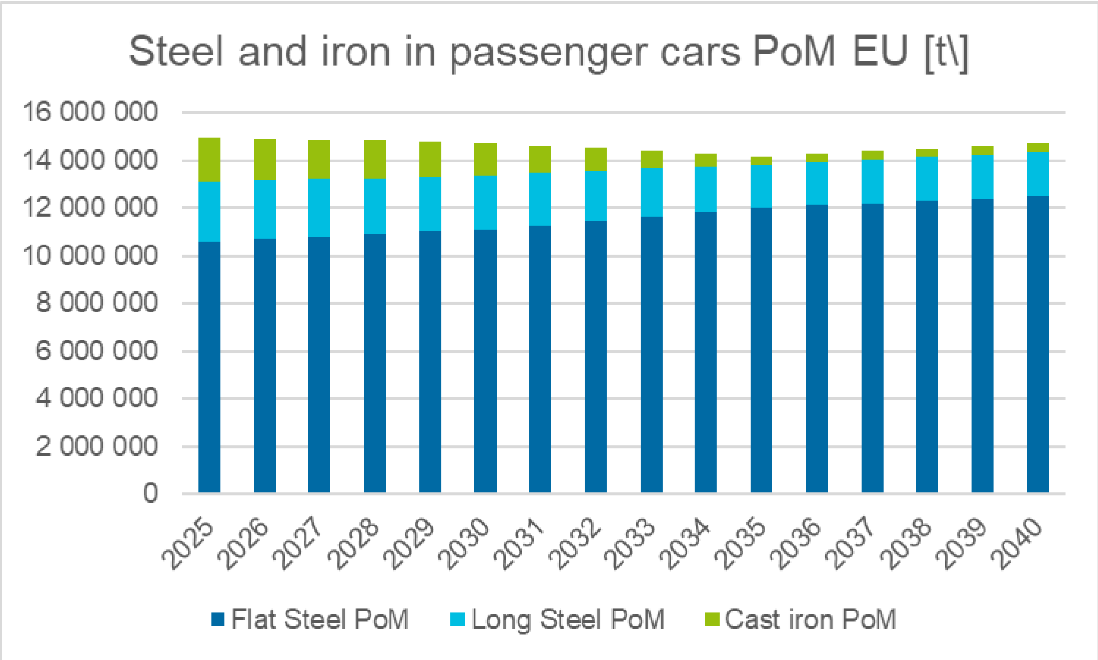
Table 4-2 Share of steel and iron products in passenger cars PoM in the EU

Material	ICEV	HEV	PHEV	EV
Steel	57.4%	58.0%	54.6%	56.5%
Flat steel	46.0%	46.5%	43.8%	49.1%
Long products	11.4%	11.5%	10.8%	7.4%
Cast Iron	8.9%	8.8%	8.5%	1.4%

Source: Support Study Oeko (2022), expressed in %; additional assumptions for flat steel and long products

Figure 4-3 shows the amounts of flat steel, long steel and cast iron used in passenger cars PoM in the EU from 2025 to 2040.

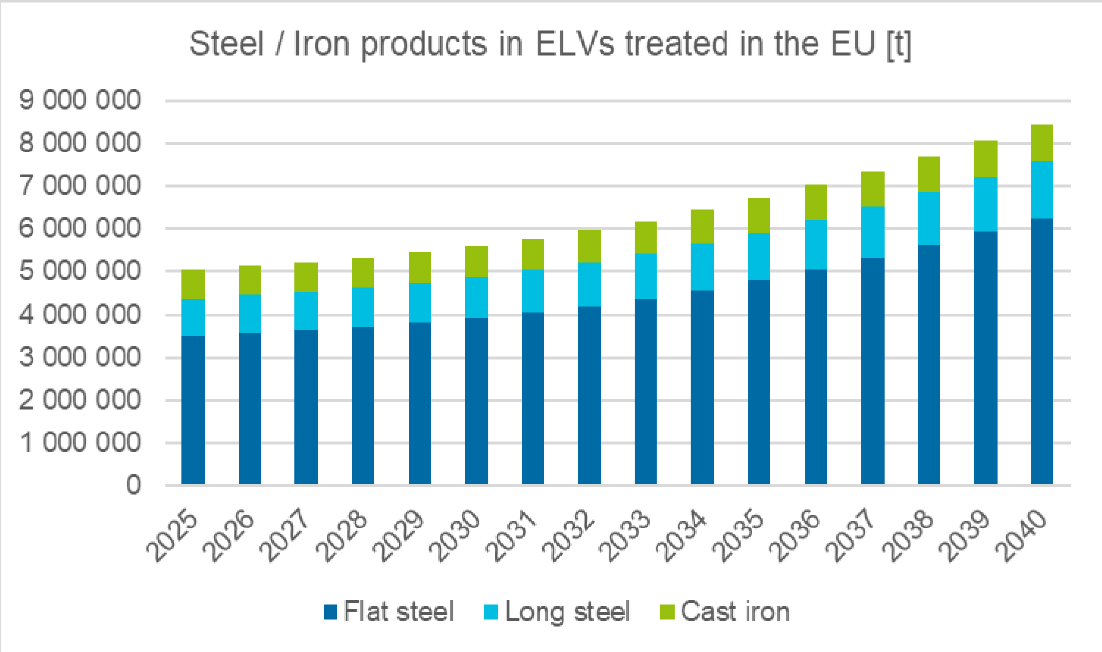
Figure 4-3: Total amounts of flat steel, long steel and cast iron contained in passenger cars PoM in the EU



Source: Own illustration, based on model

Figure 4-4 shows the amounts of flat steel, long steel and cast iron contained in ELVs processed in recycling plants in the EU from 2025 to 2040. Due to the larger number of vehicles treated in ATFs and the shift towards electric cars, the quantity of flat steel from the ELVs will increase by around 80% between 2040 and 2025, the quantity of long steel by around 50% and the quantity of cast iron by around 25%.

Figure 4-4: Total amounts of flat steel, long steel and cast iron contained in ELVs treated in the EU



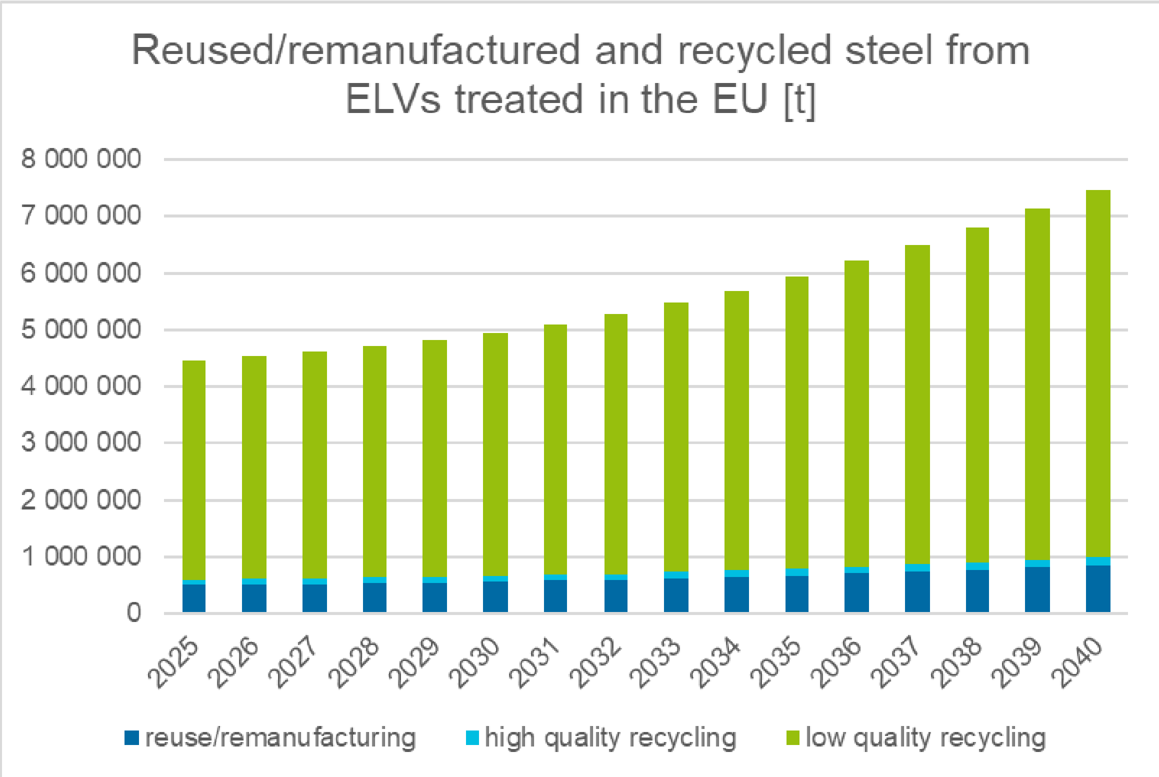
Source: Own illustration, based on model

Like the ELV impact assessment supporting study, we calculated an end-of-life scenario where some components are reused or remanufactured, as well as some material is dismantled before the shredder and can thus be recycled at a higher quality. In the case of steel, this means that no further copper contamination is added to the dismantled steel parts through shredding. For this calculation we considered that 10% of steel is reused/remanufactured, 2% is dismantled before shredding and 88% is shredded and then recycled. For the shredding process, an efficiency of 99% is assumed for the separation of steel and iron. For the subsequent steel recycling in the electric arc furnace, a recycling efficiency of 88% is assumed.

Figure 4-5 shows the quantities of reused/remanufactured and recycled steel from ELVs treated in the EU für the years from 2025 to 2040. A distinction is made here between high-quality recycling and low-quality recycling. In the case of steel parts that are removed from the shredder and recycled directly, it is assumed that the steel is of a higher quality than steel that first passes through the shredder process.

The total quantity of the steel and iron fraction from European shredder operations corresponds to around 30% of the total demand for steel and iron in passenger cars PoM in 2025. Due to the increasing recycling volumes in the model, this share increases to around 34% by 2030 and to around 42% by 2035. This is the volume that is *potentially* available for closed-loop recycling, provided that, firstly, 90% of the EoL for electric cars takes place in the EU in the future, and secondly, that it is possible in the future to process this steel fraction from the shredder in such a way that it can also be used for high-quality applications such as flat steel.

Figure 4-5: Total amounts of flat steel, long steel and cast iron contained in ELVs treated in the EU



Source: Own illustration, based on model

5 20% RC target proposed by Hungarian Council Presidency

Based on the Impact Assessment, the Hungarian Council Presidency proposed that in case of steel, a 20% recycled content target would be feasible in 7 years.

According to the current status quo of the production of flat steel, long steel and cast iron (see Table 2-1), it can be assumed that the lower limit of recycled material from post-consumer scrap is around 32% for long steel and around 43% for cast iron, while no post-consumer scrap is used in flat steel production. From the proportions of flat steel, long steel and cast iron, a current share of recycled content material based on the total quantity of steel and iron and a recycled content share in the total quantity of steel used in new passenger cars can be calculated.

As a recycled content rate of 90% is already feasible today to produce long steel and cast iron, already today an overall rate of 26% RC in relation to the total quantity of steel and iron in new vehicles could be feasible based on the proportion of long steel and cast iron in the vehicles. However, this potential recycled content rate would fall significantly over the years due to the shift towards electric vehicles (potential RC rate 2030: 22%, 2035: 14%), as electric vehicles have a much lower proportion of long steel and cast iron. This means that this RC rate could only be achieved in the long term by increasing the proportion of recycled steel in flat steel production. This depends above all on how quickly capacities of recycled steel can be built up to such a high quality that they are suitable to produce flat steel.

If the quality of processed recycled steel products, such as TSR40, proves to be of such high quality in the longer term and in larger capacities that they can be used for flat steel production, a recycled content quota of 20% from post-consumer scrap in relation to the total quantities of steel and iron in new passenger cars would also be feasible in the long term.

However, this recycled content rate of 20% can only be realized in relation to the total quantities of steel and iron in passenger cars PoM and if open loop recycling is permitted.

Table 5-1 shows achievable recycled content targets for steel and iron products based on total steel and iron in passenger cars PoM in the EU, if open loop recycling is permitted to achieve the targets.

Table 5-1 Achievable recycled content targets for steel and iron products in passenger cars PoM in the EU based on post-consumer scraps

Material	2025	2030	2035
Current status quo	11%	9%	5%
Technically feasible with current technologies	26%	22%	14%
Ambitious with future technologies	28%	28%	25%

Source: Own illustration, based on model

Table 5-2 shows achievable recycled content targets for steel products based on total steel in passenger cars PoM in the EU, if open loop recycling is permitted to achieve the targets.

Table 5-2 Achievable recycled content targets for steel products in passenger cars PoM in the EU based on post-consumer scraps

Material	2025	2030	2035
Current status quo	6%	5%	4%
Technically feasible with current technologies	17%	15%	12%
Ambitious with future technologies	20%	22%	23%

Source: Own illustration, based on model

If only steel is considered when calculating the recycled content rate and not both steel and iron, the potentially achievable RC rate is reduced accordingly. Based on the current RC shares in long steel, a total RC rate for steel of around 6% can be calculated for 2025, falling to around 5% by 2030 and to around 4% by 2035. If the already feasible RC share of 90% in long steel is assumed, this results in a potential RC rate of 17% for 2025 (2030: 15%, 2035: 12%). If the recycled content rate refers only to steel, a 20% rate is therefore only achievable if corresponding high-quality recycling materials are also available for flat steel production. In view of the current development in steel recycling, a ramp-up of such high-quality steel scrap processing from open loop recycling in the required quantity in the EU is ambitious, but quite conceivable within 7 years.

These calculations are based on the assumption that only post-consumer scraps can be included in the recycled content rate. If, on the other hand, post-industrial scraps (see Table 2-1) can also be included, as the recommendation of the Hungarian Council Presidency suggests, then the achievable RC rates are higher, see Table 5-3 for total quantities of steel and iron and Table 5-4 for steel.

Table 5-3 Achievable recycled content targets for steel and iron products in passenger cars PoM in the EU based on post-industrial scraps and post-consumer scraps

Material	2025	2030	2035
Current status quo	31%	29%	26%
Technically feasible with current technologies	41%	38%	31%
Ambitious with future technologies	43%	44%	43%

Source: Own illustration, based on model

Table 5-4 Achievable recycled content targets for steel products in passenger cars PoM in the EU based on post-industrial scraps and post-consumer scraps

Material	2025	2030	2035
Current status quo	27%	27%	25%
Technically feasible with current technologies	34%	33%	30%
Ambitious with future technologies	37%	39%	41%

Source: Own illustration, based on model

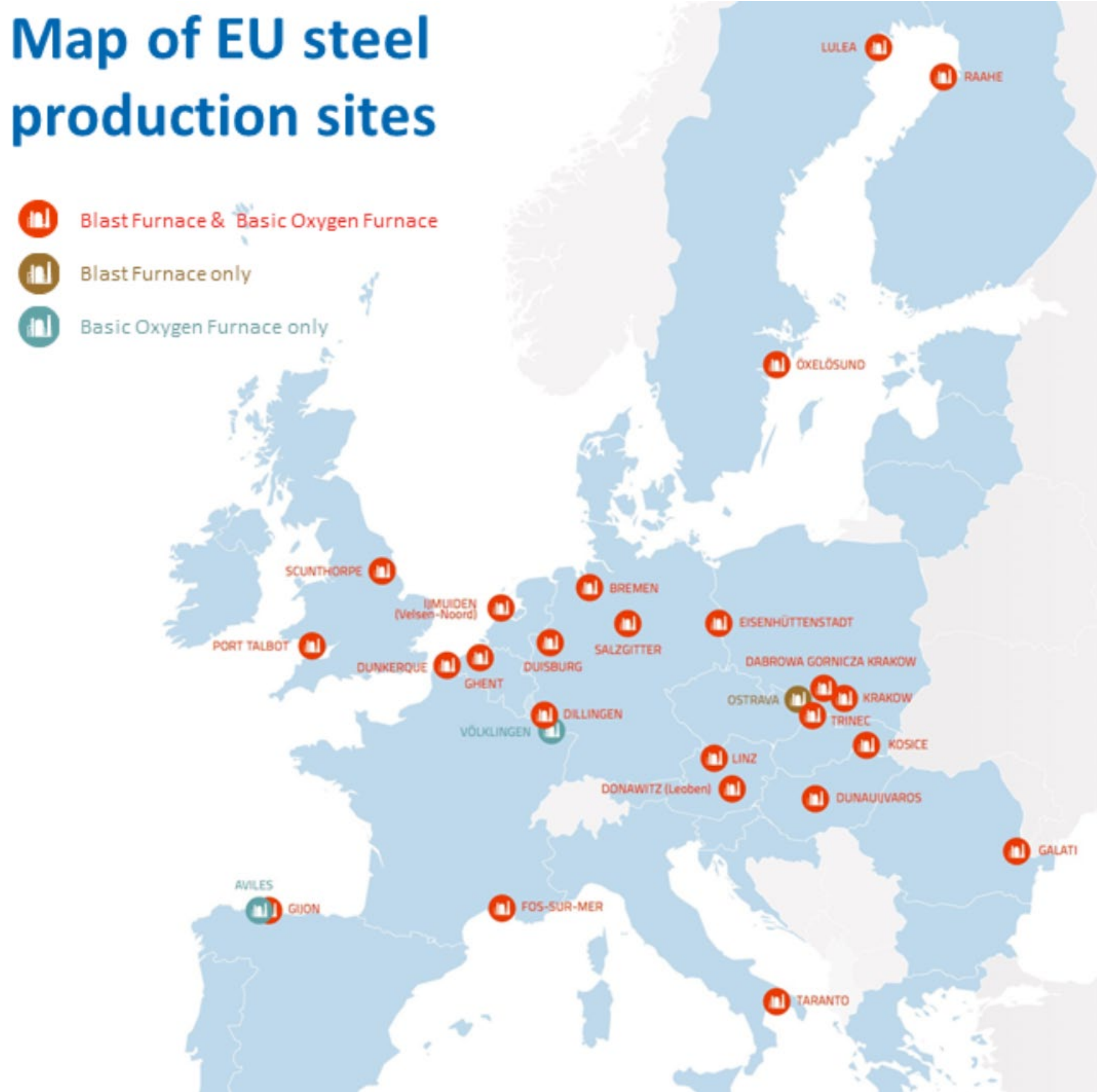
6 Green steel

The European and German steel industry today relies 100% on the blast furnace and oxygen blowing process (BF-BOF) for primary steel production, as shown in Figure 6-1. The electric arc furnace (EAF) process is used in Europe for secondary steel production. The European transition strategy for decarbonisation for of the steel sector aims to replace the existing BO-BOF rout by direct reduced iron (DRI) installations and subsequent EAF. This transition is supported by governmental aid as displayed in Figure 6-2. As an example, ThyssenKrupp Steel has commissioned the engineering, delivery and construction of a hydrogen-powered direct reduction plant with a capacity of 2.5 million tons per year and two connected innovative melters and associated ancillary units at the Duisburg site with a contract volume of 1.8 billion Euro[19]. A subsidy for the construction of 550 million is granted by governmental aid and subsequent aid of up to 1.45 billion Euro is granted for the purchase of H_2.[20]

[19] https://www.thyssenkrupp.com/de/newsroom/pressemeldungen/pressedetailseite/thyssenkrupp-steel-vergibt-milliardenauftrag-fur-direktreduktionsanlage-an-sms-group--start-eines-der-weltweit-grossten-industriellen-dekarbonisierungsprojekte-163183 (accessed 02 Dec 2024)

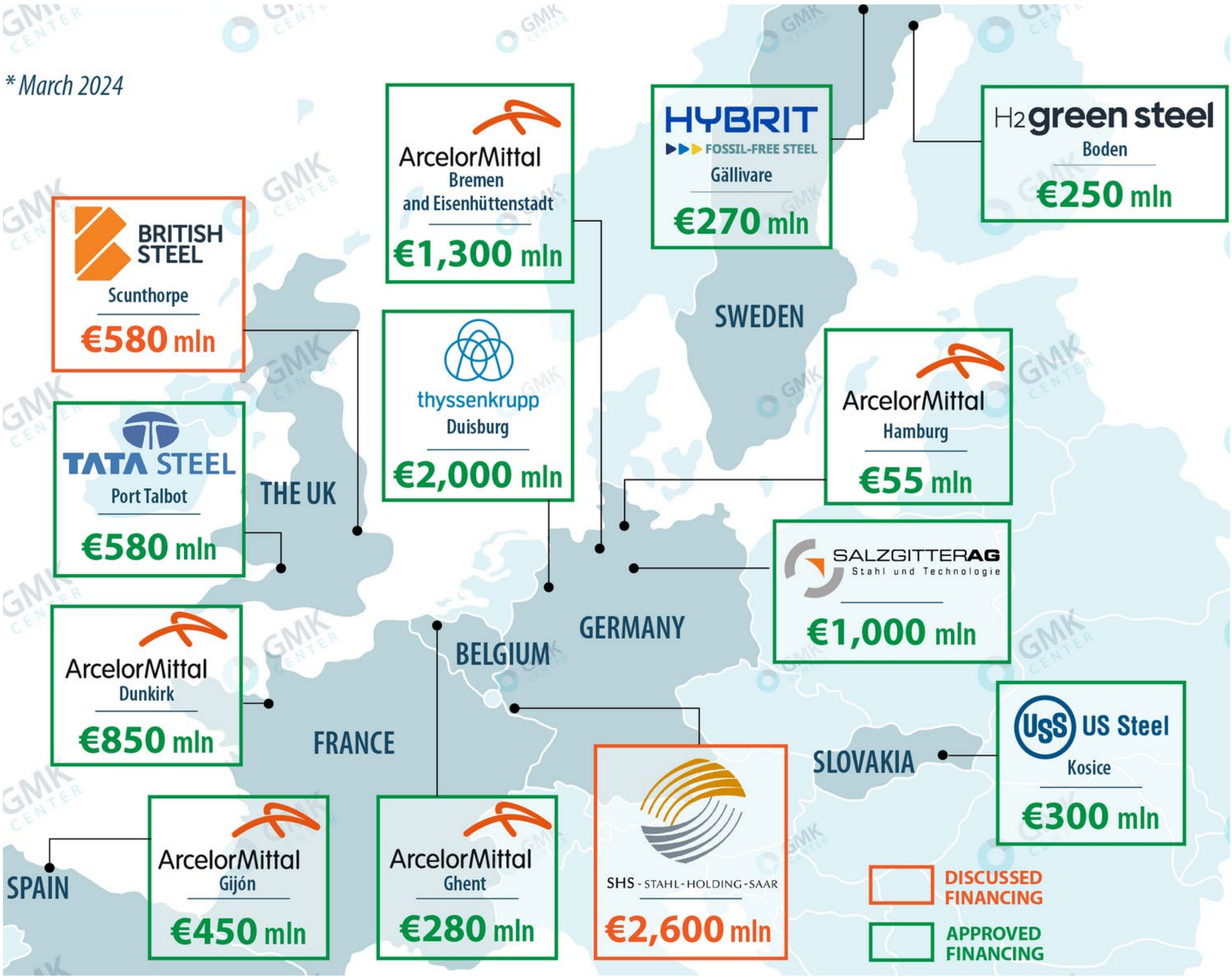
[20] https://www.tagesschau.de/wirtschaft/unternehmen/gruener-stahl-thyssenkrupp-100.html

Figure 6-1: Upstream production sites using the Blast Furnace and Basic Oxygen Furnace (BF-BOF) process for primary steel production in Europe.



Source: Eurofer, https://www.eurofer.eu/about-steel/learn-about-steel/where-is-steel-made-in-europe accessed 2024 Dec 02

Figure 6-2: Governmental aid for green steel transition for steelmakers in Europe as published in the period January 2023 to March 2024



Source: GMK centre, https://gmk.center/en/infographic/european-countries-granted-e10-5-bln-for-decarbonization-of-the-steel-sector-in-2023-2024/ 02 Dec 02

Compared to the investment and the cost for the operation of a DRI-H_2 plant, the investment cost for advanced shredder technology, targeting the separation of post-consumer flat steel, are - as published by Remondis - about 35 million Euro only for a plant with a capacity of around 300 000 t/a output of high quality steel scrap for the flat steel production with a copper content of less than 0.08%[21]. For more details of this TSR shredder see chapter 3.

We expect a high demand for such high-quality scrap, which can be used in the flat steel production as it immediately reduces the fossil fuel demand and the related carbon emissions. This assumption is supported by the announced investments of TSR for additional advanced shredder plants: "Remondis opened a second TSR40 plant in Amsterdam. It is currently building two more TSR40 facilities in Hamburg and Magdeburg, which are slated to start up in 2025 and 2026, respectively" (see chapter 3).

[21] https://www.reviews-magazin.de/fileadmin/user_upload/reviews_magazin/epaper-01_2022/index.html#22 Page 23, accessed 2 Dec 2024

A further pull factor for the demand of this high-quality scrap is that some of the car manufacturers aim to reduce their carbon footprint for materials used. For instance, it is known that Mercedes Benz signed a letter of intent with this regard with TSR. Mercedes has set itself the goal of increasing the proportion of secondary raw materials for its car fleet to an average of 40 percent by 2030.

To arrive at an outcome (or various scenarios), a more comprehensive economic assessment of the interrelationship between green steel production and high-quality scrap demand may be required. Aspect for consideration might be:

- scrap prices,
- the impacts of the prices for CO_2 emission allowances,
- import export balance,
- availability of scrap input with the needed quality,
- the impact of subsidies
- the market impacts on supply and demand if capacities of the steel production would be transferred to other global regions and the import of consumer products (like vehicles) from these regions are not covered by the European Carbon Border Adjustment Mechanism (CBMA).

7 Definition of steel

Post-consumer steel scrap: steel scrap from products which have been placed on the market.

Post industrial steel scrap: this term does not include the term “waste” and is therefore not preferred for the definition of a recycled content rate.

Manufacturing waste from steel processing: if a recycled content rate shall include industrial waste (like it is the case for the Batteries Regulation) the term “waste” shall be included in the term. However, this term might also include “internal recycling” of a steelworks, depending organisational borders at the plant and national interpretation. So possibly waste from steelworks might be excluded explicitly.

Steel scrap qualities: The EUROPEAN STEEL SCRAP SPECIFICATION provides a list of specification for different post-consumer and manufacturing waste from steel processing[22]. Regards the important contamination with copper, hampering the use of scrap for flat steel production, the specification declares “*that all grades shall be free of visible metallic copper which means free of copper – wound electric motors, sheets and copper coated materials, bearing shells, winding, and radiator cores. All grades shall be free of all but negligible amounts of wire, insulated wire and cable tubing and other copper, brass items mixed with, attached to, or coating ferrous scrap. All grades shall be free of material with high dissolved copper content such as rebars and merchant bars which will be grouped in the high residual grades.*” The copper limit for shredder scrap of the quality E40 0.25% and for tin 0.02%. It might be meaningful to establish a further quality specification with lower copper contents.

[22] https://www.bvse.de/images/pdf/schott-elektro-kfz/schrottsorten_en.pdf

8 Annex VII Part G

According to our knowledge the council discussed the Anne VII including Part G during the presidency of Belgium and changes were propose by the Belgium Presidency.

This partial Presidency compromise text proposes for Annex VII, Part G, item 2a:

The copper content of the main steel fraction shall not exceed 0.1% on a weight basis

We propose to consider the 'main' steel fraction as the largest portion by mass.

According to a discussion with Heiner Guschall (Sicon GmbH)[23] a total copper concentration of 0.12% - 0.14% is achievable with End-of-live vehicles and mixing with other wastes is required to achieve 0.1% or less. As mentioned in chapter 3 of this report, TSR offers scrap from ELVs, mixed scrap and large household appliances, with a copper content of less than 0.08% copper.

While it might need a certain transition time for the shredders across the EU we consider the target of not exceeding 0.1% copper as achievable.

The conditions in the partial Presidency compromise text for Annex VII, Part G, item 1 are of high relevance too.

[23] personal communication (18 November 2024)

List of References

Argonne National Laboratory. GREET Model: The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model. 2021. GREET2: vehicle manufacturing cycle model of vehicle technologies. Available online: https://greet.es.anl.gov

Bui, A. N.; Negri, M.; Ordonez, Y.; Bieker, G.; Isenstadt, A. (2024): Which automakers are shifting to green steel?, An analysis of steel supply chains and future commitments to fossil-free steel. The International Council on Clean Transportation, 2024. Online available at https://theicct.org/wp-content/uploads/2024/09/ICCT-Green-Steel-Supply.pdf, last accessed on 18 Nov 2024.

Daehn, K. E. (2019): Copper contamination in end-of-life steel recycling, developing a new strategy from million-tonnes to milligrams. University of Cambridge (ed.).

Daehn, K. E. Cabrere Serenho, A.; Allwood, J. M. (2017a): How Will Copper Contamination Constrain Future Global Steel Recycling? Environmental Science & Technology: 51, Pages 6599-6606.

Daehn, K.E. Cabrere Serenho, A.; Allwood, J. M. (2017b): How will copper contamination constrain future steel recycling? - Supplementary Information.

Nakamura, S., Kondo, Y., Matsubae, K., Nakajima, K., Tasaki, T., & Nagasaka, T. (2012). Quality- and dilution losses in the recycling of ferrous materials from end-of-life passenger cars: Input-output analysis under explicit consideration of scrap quality. Environmental Science & Technology, 46(17), 9266–9273. https://doi.org/10.1021/es3013529