EuRIC Circular Metals Strategy

Executive summary

Reaching climate neutrality by 2050 will require drastic changes throughout all value chains, in particular for energy-intensive industries such as metal production. Thanks to their intrinsic properties and market value, discarded metals have been recycled for decades and used to produce new ferrous and non-ferrous metals again and again.

Metal recycling is a must to achieve the climate and circular economy targets set by the European Green Deal[1] and the new Circular Economy Action Plan[2]. Compared to primary production, steel, aluminium or copper recycling save respectively 58%, 92% and 65% of CO^2 emissions and spare primary raw materials often extracted outside Europe.

Yet, substantial bottlenecks hamper metal recycling in Europe.

- **The first one has to do with the fact that Europe's industry remains mostly linear with only 12% of the materials it uses coming from recycling**. As a result, in Europe, the supply of metal scrap from recycling meeting industry specifications often exceeds the demand and remain under-utilised in metal production.
- The second one relates to the absence of mechanisms rewarding the substantial environmental benefits stemming from the recycling and use of metal scrap to substitute ores and concentrates (often extracted outside Europe). **As a result, commodity prices still fail to internalise metal recycling's massive environmental benefits**.
- **The third one is rooted in European waste legislation which hinders more circularity.** Metal scrap is a valuable commodity, having a positive value and environmental footprint, which should not be classified as waste. Current end-of-waste criteria are either not used by downstream users of metal scrap or are too restrictive. In addition, a number of procedures pertaining to cross-border shipments or permitting remain far too burdensome to incentivize circular metal value chains.

This strategy paper, which complements EuRIC Metal Recycling Brochure, aims at providing a comprehensive picture of both the state of play of metal recycling and what needs to be done to increase the circular use of metals in Europe and globally. In particular, it emphasizes the utmost need to:

- **Set up framework conditions and incentives, entirely absent up until now in Europe legislation, to reward the environmental benefits of metal recycling and level the playing field with virgin materials.** Such measures are essential to boost the use of scrap in metal production, to keep investing throughout the value chain in innovative recycling processes as well as to scale up in Europe secondary metal production, which all together directly contributes to climate neutrality and the circular economy.
- **Simplify legislation applicable to circular metal value chains** with as first priorities the creation of a status of "secondary raw materials" in the European waste legislation, without prejudice to existing end-of-waste criteria, and streamlined waste shipment procedures that support the circular use of metal scrap in production.
- **Guarantee free, fair and sustainable trade by refraining to set any trade restrictions** which would substantially disrupt metal recycling in Europe and by requiring that primary materials imported from non-EU countries have to comply with human health, environmental and human rights standards that are broadly equivalent to the ones established in Community legislation.

In that respect, it is worth recalling that metal scrap is a commodity priced and traded globally in accordance with industry specifications. For a number of recycled materials, such as steel scrap, supply structurally exceeds European demand. Export restrictions would trigger a collapse of the current collection and recycling infrastructure for which unhampered access to end-markets in Europe and beyond is essential to cover fixed costs and remain competitive.

[1] The European Green Deal, COM (2019) 640 Final.
[2] A new Circular Economy Action Plan For a cleaner and more competitive Europe, COM/2020/98 final.

1. Table of Contents

2. Metal recycling: A must to achieve the ambition of the European Green Deal

Key messages:

- Recycling saves a large share of the CO_2 emissions when compared with primary material production;
- Recycling and circular economy are necessary for the metal production sector to reach the targets set by the Paris agreement and the Green Deal;
- Regarding steel, long term studies show that scrap supply can fit the requirements for most steel qualities, and cover most of the steel demand.

Metals including steel, copper and aluminium are critical to achieve the objectives set by the European Green Deal and the new Circular Economy Action Plan. Those metals are used in virtually all applications needed to make of Europe the first-climate neutral continent by 2050, to achieve the digital transformation, or to fulfill the objectives of the Renovation wave[3]. However, given the nature of the manufacturing processes, metal production still represents today a substantial share of global industrial CO_2 emissions. Steelmaking for instance accounts for 25% of these emissions.

Metals are intrinsically circular: given their properties they can, in theory, be recycled again and again. Metal recycling brings substantial climate benefits thanks to proven avoided CO_2 stemming from the use of secondary raw materials[4]. This paper focuses on steel and aluminum scrap, but also on copper scrap which are among the most produced based metals globally.

Recycling and circular economy are necessary for the metal production sector to achieve carbon neutrality CO_2 Emissions reductions related to decarbonized energy input and energy efficiency may not be sufficient for the ferrous and non-ferrous metals producers to stay below the 2°C average temperature increase compared to pre-industrial ages by 2100, as set by the Paris agreement. The total CO_2 emissions from the aluminum and steel manufacturing industries, even after implementing technologies still at development stages (e.g. Carbon Capture and Storage – CCS – or fully decarbonized electricity supply), might be superior to the industry's "carbon budget"[5] for 2100 (Material Economics, 2018). This is also true for copper[6] for which, 'near-perfect' recycling is necessary to keep copper-related GHG emissions under the sector-specific threshold set to reach the 2°C target, along energy efficiency improvements and lifestyle changes. In this case, secondary copper flows will approach the expected demand. **Circular economy in general, and recycling in particular, is an utmost necessity to reach those targets in addition to energy efficiency and decarbonization measures**.

In the case of steelmaking, other solutions for decarbonizing metal production, such as Direct Reduced Iron (DRI), could come at a very high cost in current conditions. In the case of DRI, in particular with a green hydrogen infeed[7], it is unlikely that much progress will be made regarding the scale up of those technologies until 2030 (Arcelor Mittal, 2020). The investment needed has been estimated between 40-200 Bn€, the high end of range leveraging green hydrogen infrastructure. While those technologies are obviously part of the solution, their widespread use in the steelmaking industry will not be possible before a decade, which is an issue to meet the Paris agreement targets.

Reducing CO_2 emissions substantially is thus essential as the longer we await, the higher the yearly GHG emissions reduction rate will have to be in the future. Regarding steel, it is also worth noting that **the development of DRI steelmaking is compatible with a higher scrap intake**. DRI is ultimately melted in Electric Arc furnaces (EAF), which is also the route used for steelmaking from scrap[8], with up to 100% of steel scrap intake as an infeed material – see steelmaking routes on Figure 1. Besides, regardless of the steel production route, BOF and EAF, scrap is needed for the melting process.

[3] A Renovation Wave for Europe -greening our buildings, creating jobs, improving lives, COM(2020) 662 final.
[4] Compared to primary production, steel, aluminum and copper recycling save respectively 58%, 92% and 65% of CO^2 emissions (FEDEREC, 2017).
[5] Total GHG that can be emitted to keep global warming below 2°C.
[6] Ciacci et al (2020)
[7] „Green hydrogen": hydrogen produced by water electrolysis with renewable energies. "Blue hydrogen": hydrogen produced by steam reforming of natural gas.
[8] While steel scrap is generally directed toward EAF to produce crude steel, it is also used as a coolant in Basic Oxygen Furnaces (BOF) processes, up to 20-30% of the infeed material (Wörtler et al., 2013).

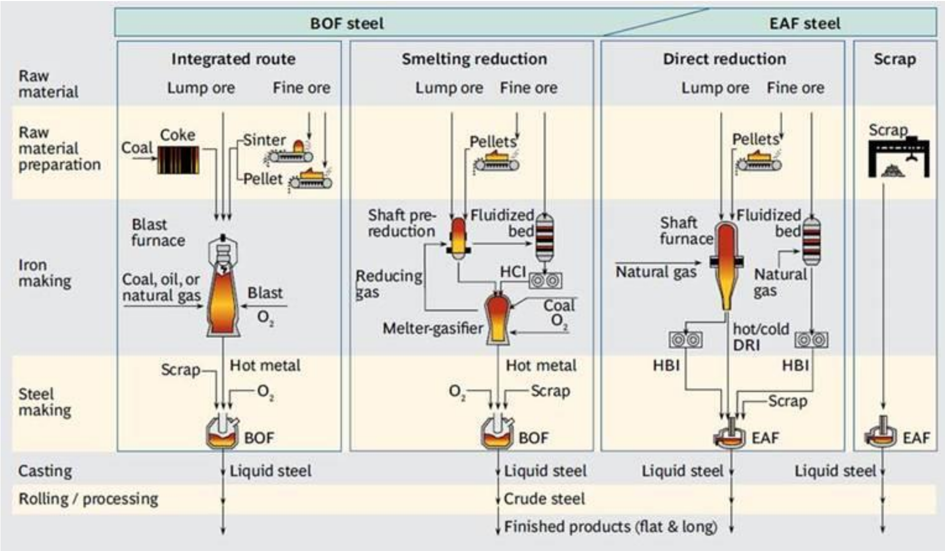

Figure 1 : Overview of iron and steelmaking processes (Wörtler et al, 2013)

Ultimately, metal production pathways having the least environmental footprint, as measured by Life Cycle Analysis (LCA), should be favored.

Increasing the use of metal scrap is crucial and technically possible

At global level, steel scrap collection could cover 70% of global steel production, and recycled steel could match quality specifications for 80% of steel demand (Joly et al., 2020).

At EU level, available scrap could cover 85% of the steel demand by 2050 (Material Economics, 2018). This is not the trend currently observed in the EU, where intake of steel scrap is at best constant, around 55% of crude steel production (see Table 1), mostly because Europe's steel capacity still largely relies on iron ore and EU policies fails in many aspects to incentivize the use of steel scrap despite the massive environmental benefits it brings. Countries such as Turkey or, in the EU and to a lesser extent, Italy have shifted decades ago towards secondary steelmaking relying on processed scrap as main infeed source, proving that such a shift is feasible.

A report just published by Wood Mackenzie in November 2020 confirms that "*scrap metals (…) remain underutilised compared to its overall availability*" and stresses that "*from an environmental perspective, secondary aluminium production has a carbon footprint five to 25 times lower than primary metal production. For steel, the largest industrial emitter, emissions can be around 30% lower compared to today, despite growing demand*"[9].

Table 1 : Crude steel production and steel scrap use in the EU-28(BIR, 2020)

	2016	2017	2018	2019
	Mt	*Mt*	*Mt*	*Mt*
Crude steel production	162	168,5	167,7	159,4
	%	*%*	*%*	*%*
Share EAF of crude steel	*39,5*	*40,4*	*41,5*	*40,4*
	Mt	*Mt*	*Mt*	*Mt*
Total steel scrap use	93,6	93,8	90,9	87,5
	%	*%*	*%*	*%*
Ratio steel scrap / crude steel	**54,6**	**55,5**	**55,9**	**54,8**

[9] Scrap metals to remain underutilised despite availability and rising demand - Using aluminium and steel scrap could reduce emissions by up to 600 Mt each annually, 26 November 2020, Wood Mckenzie.

Regarding copper, the refined production of secondary copper in the EU has even slightly decreased[10] since the end of the 1990s (Ciacci et al., 2017) in line with the decline of copper demand in the EU. For aluminium, the share of secondary aluminium on the total European production increased between 1990 and 2015, from 16% to 27% (BIR, 2017). **Besides, despite the relatively good end-of-life recycling rates of steel, copper and aluminium, European demand for scrap is insufficient to cover the scrap supply generated within the EU (Record, 2019)** – see figures on Table 2. Scrap use is then highly dependent on demand in the importing country, for instance the EAF steelmaking capacity in Turkey, or the high copper and aluminium scrap demand in China.

Table 2 : Domestic use of Cu, Al and steel scrap (Passarini et al, 2018). Data from a: 2015, b: 2014, c: 2013

	Copper scrap[b]	Aluminium scrap[c]
Unit	*Mt*	*Mt*
Scrap collected at end of life for recycling	1,6	3
Domestic use	0,7	2,2
Unit	*%*	*%*
Ratio of domestic use on collected scrap	**46**	**74**

However, examples show that it is possible to increase the demand for secondary raw materials in metal production. While it remained constant in the last years in the EU (Table 1), **the share of EAF in steelmaking in the US has been increasing since at least 20 years** – see Figure 2. In 2019, the share of EAF in US' crude steel production was 67,8% (BIR, 2020). Similarly**, the share of steel scrap in crude steel production in the US is significantly higher than in the EU,** around 70% since 2015 (BIR, 2020).

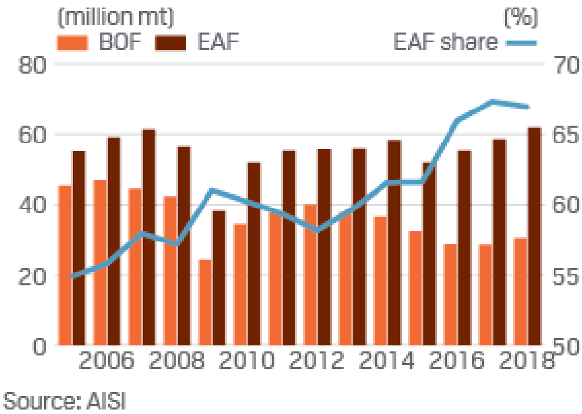

Figure 2 : US Electric-arc furnace steelmaking share (Tolomeo, 2019)

The US example shows that using scrap to produce high-quality steel grades is technically feasible. As one of the most important steelmakers in the US, NUCOR produces several qualities of steel, including high-quality flat steels, using steel scrap (NUCOR, 2019). As a comparison, flat steels, used e.g. in cars, are produced at 91% by BOF plants in the EU. **The US example demonstrates that in practice under certain conditions the EAF route can reach similar levels of quality as the BOF route.**

[10] It peaked at about 1000 kt/year at the end of the 1990s then decreased and remained stable around 800 kt/year.

3. Intelligent material flow management can enable closed loop recycling of metal scrap, but current economic and policy framework conditions do not always meet technical possibilities

Key messages:

- It is not possible to recover as much metals as technically possible under current economic conditions;
- The use of breakthrough sorting and recycling technologies comes at a cost which needs to be reflected in prices by internalizing the environmental benefits they generate;
- Framework conditions enabling to reward circular metals value chains and scale up circular capacities in Europe are needed.

If properly sorted and processed, metal can be indefinitely recycled without downgrading

Reducing downgrading, i.e. conserving the function and composition of metals from secondary raw materials compared to their previous lifecycle ("closed loop recycling"), enable to keep metals in use for a longer period of time, and is likely to increase the use of recycled metal.

Each application requires a certain material recipe, consisting of the targeted metal (Fe, Cu, Al) to which some alloying elements are added in different proportions. European recyclers thanks to their experience and state of the art techniques, sort and process metal scrap to meet industry specifications or end-of-waste criteria[2].

Under current economic conditions, the intake of recycled materials by metal producers remains limited by the possible end-uses of metals.

Those conditions do not always enable the recovery of metal at a grade similar to the usage in the previous lifecycle of the material, because the removal of some alloying elements is challenging, under technically and economically viable conditions. **As a result, metal demand for specific applications does not equate metal supply from recycling**. "Closed loop recycling" is for instance not always possible for steel from scrap. Ferritic stainless steel has for instance a specific composition that cannot always be fulfilled by inputs stemming solely from recycling using best available techniques. Hence the complementarity with carbon steel, another route for the intakes of steel scrap. Similarly, treatment processes can increase the amount of copper in steel, above tolerance threshold required for a lot of steel products, making the recycled steel unfit for any usage other than rebar – construction steel[11].

Impurities, also known as "tramp elements", very much depend on the type of recycled metal. With some exceptions (Cu, Co…), impurities are easily removed from steel in EAF or BOF processes, while alloying elements are very difficult to remove from aluminium. The Figure 3 illustrates those differences by showing which elements stay in the metal phase and which elements go in the slag phase during re-melting of Copper[12], aluminium & steel.

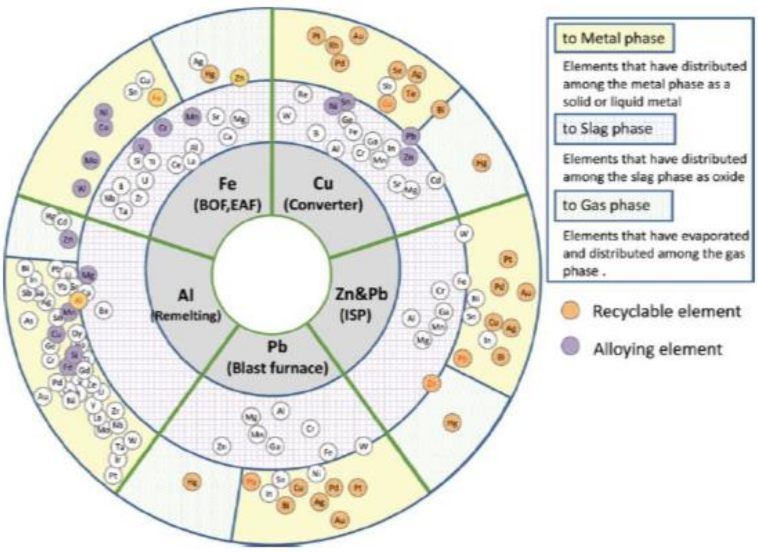

Figure 3 : Element radar chart for the metallurgical process of base metals (Nakajima et al, 2010)

[11] The maximum copper of content of rebar steel is 0,4 w%. the average level in scrap within the OECD is 0,2 – 0,25 w%. Most other uses require a Cu content below 0,12 w% (Material Economics, 2018)

[12] Regarding Cu, low quality secondary copper can also go through a process of electrolytic refining, which enables to remove most impurities.

New technologies could improve sorting and processing thus increasing the amount of metals recycled in near-closed loops. **However, alloy-to-alloy sorting[13] and pre-shredding separation of steel and copper, e.g. in end-of-life vehicles, will come at a cost for the recycling industry which is not rewarded currently in market prices as long as the latter consistently fail to internalise the environmental benefits from recycling resulting from the use of secondary materials in the production of steel, copper and aluminium.**

An increase in dismantling time of a complex product to localize and dismantle specific scrap qualities is costly, and not necessarily covered by the benefits of scrap selling. The following figures illustrates, using the example of plastics, the relationship between increased material recovery, dismantling time and marginal cost of dismantling (see Figure 4 and Figure 5).

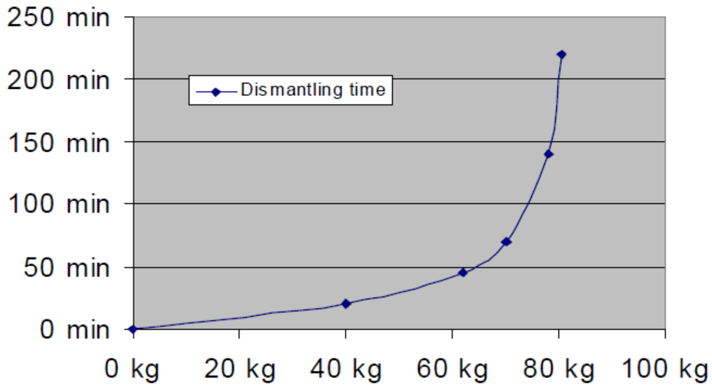

Figure 4 : Dismantling time for an end-of-life vehicle (total plastics 160kg), (GHK, 2006)

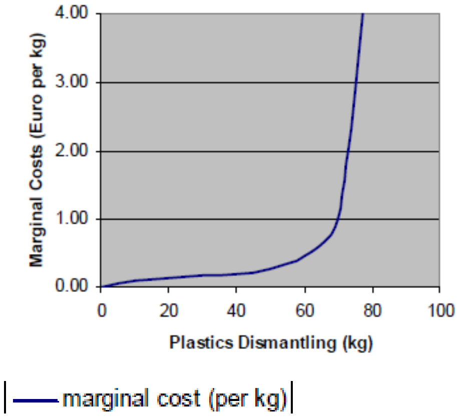

Figure 5 : Marginal costs of plastics dismantling in an end-of-life vehicle (GHK,2006)

For instance, in the case of Cu impurities in steel, **efforts to avoid or remove Cu in steel scrap are not covered by a higher scrap price paid by the steel mill since it is possible to blend steel scrap with steel from primary raw materials** in order to lower the Cu content, and produce the desired steel qualities. **Therefore, a further increase in scrap availability and quality through technological or organizational improvements comes at a cost that has to be evenly shared along the value chain. Recyclers are ready to make the effort but cannot bear these costs alone without being certain that market conditions will reward further investments that benefit directly the circular economy and climate-neutrality. Ultimately, there is both an environmental and economic rationale to boost markets for secondary raw materials to increase scrap availability – see part 5.**

[13] E.g. Using laser-induced breakdown spectroscopy (LIBS).

4. Metal scrap sector supports the path to a sustainable European and global circular economy

Key messages:

- Metals (secondary and primary) are commodities priced globally;
- Metal recycling rates in the EU are not disconnected from global metal prices;
- Imbalances between supply and demand in different world regions makes the global trade of metals essential;
- Restricting metal scrap exports would damage the EU recycling industry;
- The recycling industry needs a free and fair trade of secondary raw materials, a level-playing field with virgin raw materials and a protection of downstream users of scrap from uneven extra-EU competition.

Metal scrap is a valuable commodity creating a global scale circular economy

Metal scrap is major commodity priced on metal exchange markets, such as the LME for steel scrap, and traded globally alike primary raw materials. Metal scrap prices are not disconnected from primary raw materials prices, although those are often mined outside Europe and subsequently imported, while secondary raw materials are produced locally. As a result, metal scrap is a widely traded commodity at global scale, especially in comparison to other waste streams Figure 6. Also given its intrinsic value and physical properties, metal scrap will be used to produce metals again and not be littered.

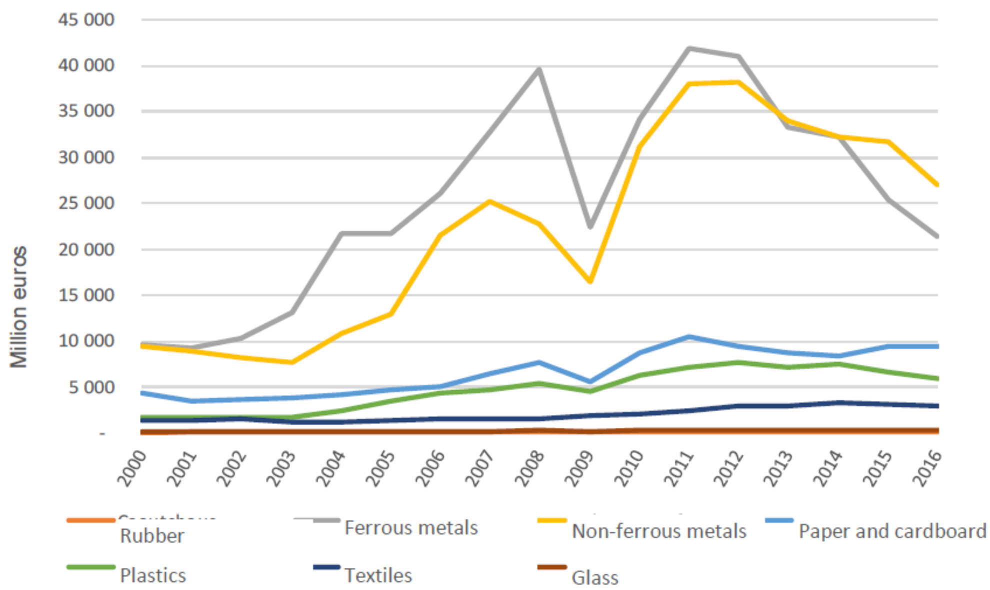

Figure 6 : Historical trends in international trade in recoverable waste and secondary raw materials in M€ by flow (RECORD, 2019)

Scrap supply in Europe is driven by the large quantities of end-of-life products containing metals, from the ones used daily (packaging products) to the most complex ones (WEEE or ELVs) recovered every year. Yet given the downward trend of industry and deindustrialization in Europe, metal demand remains driven by other parts of the world, in particular Asia benefiting from more dynamic building sectors or more recently installed capacities designed for secondary raw materials.

The EU-28 is the world largest steel scrap exporter in the world, with around 22 million tons in 2019 (BIR, 2020). Yet, the apparent domestic supply of steel scrap accounting for the steel scrap used in Europe as well as imports and exports of steel scrap remains significantly positive which demonstrates that there is no secondary raw materials shortage in Europe. Europe also exports copper and aluminium scrap – see Table 3.

Table 3 : EU wide use and exports of steel, copper and aluminium scrap. a) Data from BIR (2020) for the year 2019. b) data from BIR (2016) for the year 2015. c) copper scrap use, within the EU corresponds to the secondary scrap production added to the usage of direct scrap (BIR, 2016)

	Steel scrap[a]	Copper scrap[bc]	Aluminium scrap[b]
	Mt	*Mt*	*Mt*
Scrap use within the Eu	87,5	2,1	2,9
Exports out of the EU	21,8	1	0,9
	%	*%*	*%*
Ratio of exports on EU scrap use	**25**	**48**	**31**

Figure 7 : Imbalances in stainless steel scrap supply and demand at world scale (credits: G. Pariser)

While restricting waste exports in general have been called upon to limit adverse environmental impacts, the global trade of metal scrap meeting industry specifications clearly does not pose problems encountered for other streams and is actually a must for a well-functioning secondary raw materials market.

First, there's an oversupply of scrap in the EU when compared with the domestic demand, especially in times of economic slowdown. Thus, export restrictions will simply artificially lower the value of metal scrap which in turn will negatively impact well-functioning circular value chains and ultimately the ability of recycling companies to invest and scale up capacities. The demand in non-EU countries hints at the necessity of a free scrap trade under current market conditions – see Figure 7 . A case study on metals circularity conducted by Graedel et al (2019), from the Yale School of Environment, concludes *"that a circular materials economy is difficult to impossible to achieve at the level of a single country. Australia has been used as an example, but no country anywhere has a complete collection of the technologies that would be needed in order to achieve circularity**. It is apparent that a circular economy must be conceived at the global level**".* As metals production and use market is global, a similar conclusion could be reached for the EU.

Moreover, the export of metal scrap to facilities operating in accordance with international environmental management standards does not reduce significantly the environmental benefits of scrap use: carbon dioxide emissions and material use are avoided for instance, wherever the scrap is used. As climate change is a global issue, it is better to use metal scrap in circular value chains than to lose or landfill it.

Free and fair trade of metal scrap is instrumental to a well-functioning European secondary raw materials' market

Proper treatment of waste is instrumental to maximize material recovery and minimize adverse environmental impacts from "artisanal" facilities which lack the ability to implement any measures to protect workers' health and safety and the enforcement. This is why EuRIC advocates for stricter enforcement of obligations set by the Waste Shipment Regulation combined with simplified procedure for waste shipments among permitted recycling facilities. For instance, non-depolluted ELVs, unprocessed WEEE shall not be exported to facilities which lack the infrastructure to guarantee proper treatment, not only because they enable the recovery of large volumes of metal scrap but also since it is key to ensure that recycling takes place in facilities complying with sound environmental standards.

Yet, metal scrap recovered from end-of-life products, be them ELVs, WEEE or household waste is a raw material, not a valueless waste, meeting industry specifications and which often has a much higher purity than primary raw materials mostly imported from non-European countries.

The lack of domestic demand and the inherently global market of raw materials needed to produce metals render free and fair trade of of metal scrap from recycling essential. Trade restrictions will substantially jeopardize the economically viable conditions enabling the collection, sorting and recycling of waste containing metals.

The structural oversupply of scrap within the EU, compared to the current demand, will result in artificially depressed scrap prices, which won't only damage recyclers' revenues in the short term but their ability to invest on the medium to long term to scale up capacities and further innovate to maximize recovery rates.

Ultimately, export restrictions will be detrimental to society. If recycled materials have no end-market, society will have to pay for their collection, handling and disposal as currently the case for other materials with a much lower intrinsic value. It can also lead to the destruction of local jobs since the recycling is made of a network of small and medium sized operators scattered across the entire European territory. The recycling industry structure usually correspond to a pyramid-shaped organization, whereby a large network of SMEs collect and sort waste at local scale and then convey it secondary material to fewer but larger recycling operators for further processing - Figure 8.

The negative effect of exports ban on scrap collection levels is illustrated by several case. For instance, in Ukraine, a higher scrap export duty was introduced in May 2018 to foster suppliers to allocate more ferrous scrap to the domestic market. As a result, domestic supply of scrap was still below steelmakers demand, but more importantly scrap collection levels decreased because of the fall in domestic prices (ArgusMedia, 2019).

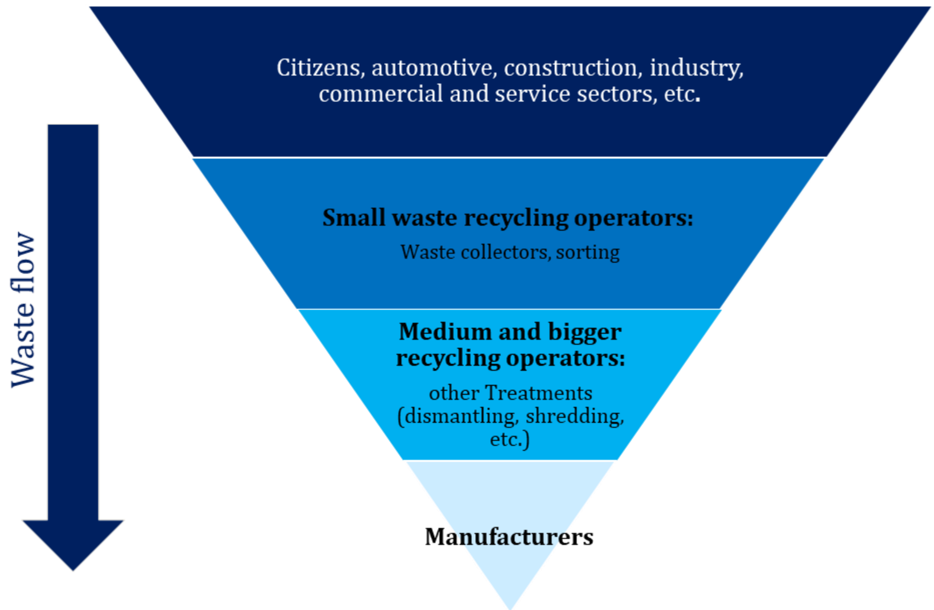

Figure 8 : structure of the recycling value chain

A holistic approach needed to foster circular metal value chains

A win-win solution for the entire European metal value chain should rely on three main pillars:

- **Ensuring free and fair trade of metal scrap in order to ensure that supply, demand and prices remain driven as much as possible by commodity markets which are global.**

- **Level the playing field with virgin raw materials in terms of regulatory conditions surrounding their trade.** In that respect, it is much easier to import primary raw materials from non-EU countries which compete with secondary raw materials in commodity markets but have far more substantial negative environmental impacts than to export in Europe or outside secondary raw materials despite the fact that raw materials mined in non-EU countries come with a much higher footprint, in terms of environmental and sometimes human rights' protection. Fostering a circular economy requires to remedy such regulatory distortions. It is thus essential to ensure that, at least, primary raw materials imported in Europe are extracted and processed into ores and concentrates in accordance with human health and environmental protection standards that are broadly equivalent to standards and regulations established in Community legislation.

- Strengthen Europe's metal value chain by better protecting Europe's steel and non-ferrous metals producers suffering from lasting uneven international competition through a more ambitious use of trade defense instruments whenever necessary. In order to scale up Europe's production capacity in a sustainable manner, EuRIC strongly supports incentives to reward the use of scrap and thus internalize CO_2 savings. In that respect, a carbon border adjustment mechanism could play an important role. In addition to protecting against carbon leakage, this mechanism must also promote directly the use of low-carbon technologies and secondary raw materials.

5. A functioning circular economy requires a well-functioning market for secondary metals

Key messages:

- A specific status for secondary raw materials different from waste is needed;
- Permitting procedures for recycling plants have to be speeded up;
- Cross-border movements of metal scrap have to be simplified;
- Interface between waste and chemicals legislations has to be improved.

Reducing administrative burdens is, together with free and fair trade of metal scrap as well as incentives to reward recycling's environmental benefits, essential to increase the use of scrap metals in the production of metals and level the playing field with virgin raw materials.

This is all the more relevant as **scrap is produced within the EU, with strict regulations applying, while ores from which steel, aluminium or copper are produced are mostly not mined in the EU** (EC, 2017):

- Aluminium: 85% of EU bauxite ore supply is imported, Guinea representing 62% of the total EU supply
- Iron ore: 74% of EU iron ore supply is imported, Brazil representing 36% of the total EU supply;
- Copper: 82% of EU copper supply is imported, with copper mining countries such as Chile and Peru representing a large share of EU copper supply, respectively 21% and 20%.

Legal uncertainty remains a major obstacle to a well-functioning metal recycling market in Europe. Priorities for Europe's metals recycling industry encompass:

- **Guarantee a proper status for metal scrap meeting industry specifications which shall no longer be classified as waste.** Secondary raw materials, which are the backbone for circular value chains, are subject under European legislation to a status which is far more burdensome than the one applicable to primary raw materials, often extracted outside Europe. As outlined in the top 5 Priorities of the Recycling Industry for the Period 2019 -2024, it is essential to lay down a new status of "secondary raw materials" in the European waste legislation to move away from the stark dichotomy between "waste" and "products" status for processed waste meeting industry specifications or quality standards, without prejudice to existing end-of-waste criteria.
- Fasten permitting procedures for recycling facilities playing an essential role in the transition towards a circular economy;
- Speed up procedures for cross-border movements of secondary raw materials, in particular metal scrap, to ensure that supply meets demand within Europe's internal market and beyond;
- Improve the interface between waste, products and chemicals legislation through a risk-based approach to support metals' circular value chains;

While the permitting process under the Industrial Emission Directive (IED[14]) enables metals production within the EU according to high environmental standards, its implementation at Member States level can hamper the treatment of metals scrap. Member States can decide to set permit conditions which are even stricter than the strictest AELs provided in BAT Conclusions, as for instance regarding the air emissions limits that the Walloon Region is currently proposing for shredders operating in Wallonia. **A level playing field is needed for industrial installations in Europe, with similar permitting conditions and no substantial deviations from agreed BAT Conclusions**.

[14] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

6. Incentives to boost markets for secondary raw materials using a lifecycle approach

Key messages:
- Metal recycling environmental benefits substantially contributes to EU's climate and circular economy targets but fail to be rewarded in market prices;
- Incentives to reward the use of metal scrap in manufacturing and internalize in prices their environmental benefits are essential to boost investments in circular value chains, level the playing field with virgin materials and scale up secondary metal production in Europe.

Metal recycling brings substantial environmental benefits. As outlined in EuRIC Metal Recycling Factsheet (2020), aluminium recycling saves the equivalent of 92% of CO2 emissions while ferrous metals recycling saves the equivalent of 58% of CO2 emissions when compared with primary production using ores and concentrates. To give an order of magnitude, in 2018, 157 million tonnes of CO2 were saved in the EU by recycling 94 million tonnes of scrap, an equivalent amount to all automobiles circulating in France, Great Britain and Belgium.

Achieving the ambitious targets set by the European Green Deal, the new Circular Economy Action Plan and the New Industrial Strategy requires policy framework conditions currently missing in Europe. Both primary and secondary metals production already receive policy support, although incentives in favor of the former can be deterrent to the developments of secondary materials markets, as shown by recent OECD reports (OECD, 2019).

One of the key barriers to promote investments in innovative recycling processes and scale up circular metal value chains in Europe remain the lack of internalization of recycling environmental benefits measures by LCAs, in terms of GHG emission and energy savings. Secondary materials prices, despite their positive environmental footprint and a completely different cost-structure, are correlated to primary material prices.

Regarding steel for instance, CO_2 prices meant to internalize negative externalities linked to GHG emissions, are currently too low and thus fail to incentivize the use of EAFs – see Figure 9. The carbon price under the EU European Trading system (ETS) at the beginning of 2020 was around 25€/t (Glachant and Mini,2020).

Wood Mckenzie (2020) estimates that a US$110/tonne carbon price to limit global warming to 2 degrees will *undoubtedly lead to an acceleration of scrap processing in carbon-intensive industries* and puts forward that *using all available scrap could bring down aluminium and steelmaking emissions by up to 600 Mt a year each. If a universal carbon tax rises to US$110/tonne, each relevant industry could save US$66 billion a year*.

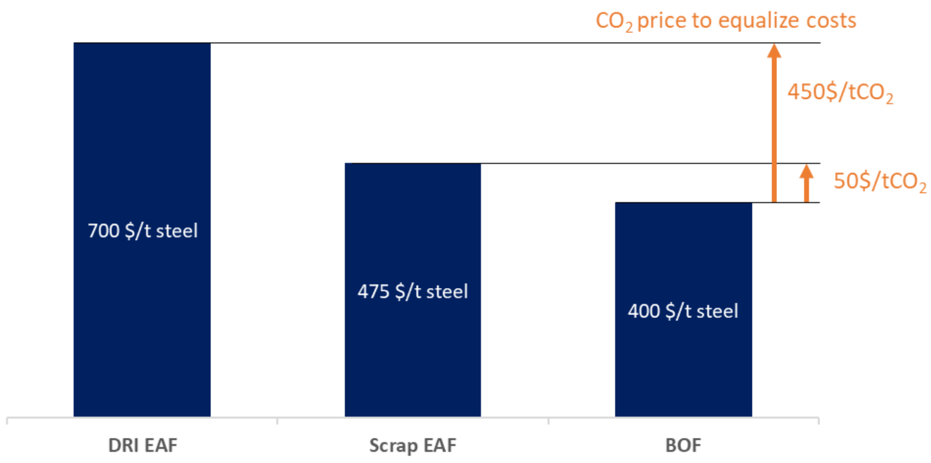

Figure 9 : world average costs for steel production by route in 2018 (Joly et al., 2020).

To put the steel production costs presented in Figure 9 into perspective, pricing attempts of steel scrap positive externalities, or "scrap bonus", have shown that it amounts to 213 €/t of carbon steel scrap and between 158 and 502 €/t of stainless-steel scrap (Pothen et al., 2020). This "scrap bonus" represent a significant share of the steel production costs mentioned in Figure 9.

In addition to the scrap bonus, we can also assume that a virgin material policy incentive still exists, given that that in most cases, the environmental standards applied in primary metals production outside of the EU are not as strict than those in force for secondary metals production within the EU, making scrap less competitive due to those uneven conditions. The strengthening of EU climate policy will make this situation even more likely in the future unless action is taken to level the playing field between primary and secondary materials.

Achieving the objectives set by the European Green Deal and the new Circular Economy Action Plan requires framework conditions and incentive mechanisms to decorrelate primary and secondary material prices based on metal scrap positive externalities. Those mechanisms would ultimately enable to pull the demand for recycled metals thus lowering the carbon footprint of metal production and ultimately boost investments into new sorting, processing and production technologies.

Such mechanisms are already in force in the supply side, and for specific waste streams, for instance EPR fees modulation, which modifies the value of the fee depending on the recyclability and recycled content of the products falling under its scope. The current EU Guidelines on State aid for environmental protection and energy 2014-2020 (2014/C 200/01) allow state aid for addressing market failure to internalize externalities, in particular regarding material efficiency.

A list of mechanisms, based on papers drafted by or for EuRIC and EuRICs' members (e.g. Pothen et al. (2020), FEDEREC (2017), Hogg et Sherrington (2012), **is presented in the table below**. While all of them relate directly to the internalization of externalities, to tackle the current market failures it will be important to implement one or a set of framework conditions which incentivize circular metal value chains.

Indicative list of incentives to boost circularity of the metals value chains

	Addressed in this note	Sources
1. Mandatory recycled content	✓	FEDEREC (2020); EuRIC (2019)
2. Label and standards	✓	Pothen el al. (2020)
3. Credits for End Use of Recycled Metals	✓	Pothen el al. (2020) Hogg & Sherrington (2012)
4. Credits for End Use of Recycled Metals linked to the EU-ETS	✓	Hogg & Sherrington (2012)
5. Carbon border adjustment	✓	Pothen el al. (2020); Hogg & Sherrington (2012)
6. Circular VAT	✓	EuRIC (2019);
7. Scrap subsidies	✓	Pothen el al. (2020); FEDEREC (2020)
8. R&D subsidies	✓	Pothen el al. (2020);

Mandatory recycled content

Imposing a mandatory recycled content will immediately stimulate demand for recycled materials and thus stimulate investment in R&D and in scaling up capacities of production facilities relying on secondary incorporate recycled materials. It will also lead to economies of scale.

A mandatory recycled content could be set at 90% for EAF production in Europe. This threshold corresponds to the share of scrap that has to be reached in the EAF process in order for steelmaking to be contribute to climate change mitigation as laid down in the Draft Delegated Act under the Taxonomy Regulation ((EU) 2020/852) on climate mitigation. Regarding BOF steel, a mandatory recycled content at 25% of infeed material could be set, as it matches what is technically possible for this production route.

Recycled content could include non-ferrous metals such as aluminium used for instance in packaging.

Binding recycled content target set by the Single-Use Plastics Directive has already proved that it is a powerful tool to de-correlate prices of recycled materials from commodity prices and thus reward the environmental benefits of circular value chains relying on their use[15].

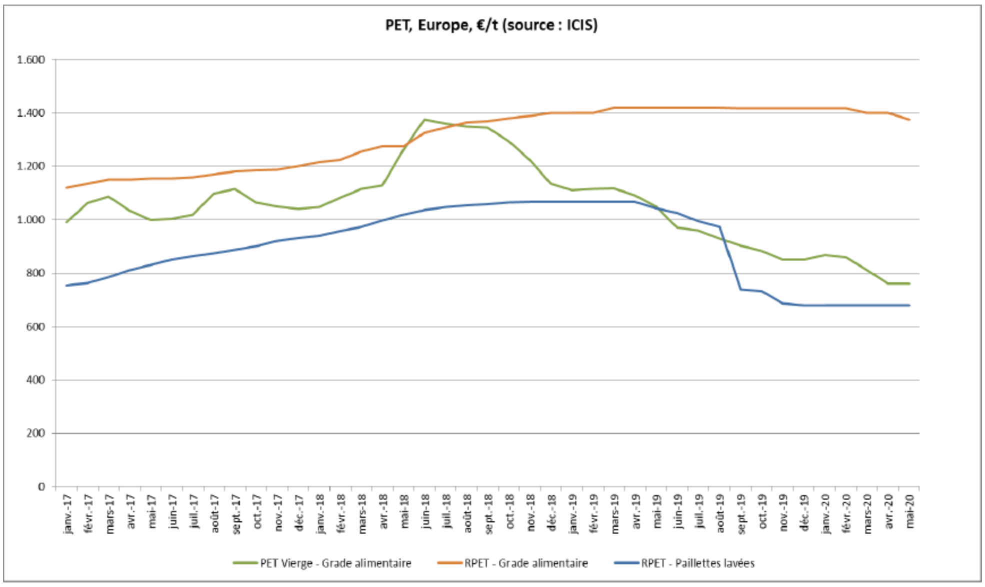

Figure 10 : Flowchart on the impacts of COVID-19 on RPET prices with the exception of food-grade RPET. Source: ICIS, the Independent Commodities Intelligence Service. Indicative FR → EN translation: PET Vierge – Grade alimentaire (FR) → Food-grade virgin PET (EN) ; RPET – Grade alimentaire (FR) → Food-grade R-PET (EN) ; RPET – Paillettes lavées (FR) → Washed R-PET flakes (EN)

Label and standards

Label and standards, provided they are not channeling biased environmental claims, are important to empower consumers' sustainable choices. "Labels that document the proportion of recycled materials in a product indicate that the manufacturer uses raw materials circularly" (Pothen et al., 2020). Appropriate calculation standards, default values and weighting factors can ensure that properly documented use of scrap metals can be reported, and used to pull the demand for recycled materials.

Regarding recycled content, some schemes such as the LEED certification[16] for sustainable building requires a proof for recycled content. NUCOR provided figures on the recycled content of its products to that end (NUCOR, 2019). Labels can also help to indicate which product is design for recycling, allowing an eased recovery of metals.

Credits for End Use of Recycled Metals – Tradable recycling certificates

Such a scheme can be defined as *"tradable allowance system permitting the use of a certain amount of primary material on presentation of evidence that a certain amount of secondary material has been used 'somewhere else'. Those who use a higher proportion of secondary materials would generate credits to then sell on to the end users of primary material*" (Hogg & Sherrington, 2012). This will lead to an increase in scrap demand.

Depending on the very design of such a scheme, tradable recycling certificates could either complement or substitute binding recycled content targets whereby a minimum proportion of recycled materials in a product is set (Pothen et al., 2020).

Credit for End Use of Recycled Metals Linked to the EU-ETS

This mechanism would link the principle of a credit for end us of recycled metals to the existing system of EU ETS. The difference would be that instead of rewarding recycling, this incentivizes recycling by integrating recycling-related CO_2 avoided emissions into the allowance of EU ETS emission quotas allocated to the steel or aluminium

[15] EuRIC Press Release - Decisive actions needed to support plastics recycling in Europe, 17 June 2020.
[16] https://www.usgbc.org/leed

industry. Hogg and Sherrington (2012) identify several conditions for having a tradable credit system based on the CO_2 externalities of scrap, including two ideas mentioned above:

- A border tax adjustment, whose goal is to avoid that the system of recycling credit divert metal production outside of the trading system boundaries;
- A minimum price for carbon trading allowances, i.e. a minimum carbon price that would justify the level of tariffs.

As the authors put it, "*preliminary consideration of a possible policy mechanism suggests that it could operate as follows:*

1. *Taking the existing allowances issued to a metal sector, both primary and secondary (e.g. the steel sector) the overall amount of allowances is reduced*
1. *to align with actual emissions;*
2. *Account is then taken of the relative benefit of secondary production over primary on a tonne CO2/tonne basis;*
3. *The tonnage of collection for recycling, (of steel in this instance) that takes place in the EU, that is ultimately recycled, is established, and the associated CO2 savings (over primary) are deducted from the sector's overall allocation;*
4. *The sector's (lowered) cap will be further reduced year on year;*
5. *Credits will be issued for each tonne of CO2 saved through steel recycling;*
6. *Credits will be issued upon proof of recycling (either within the EU or overseas);*
7. *In order to make up the shortfall in allowances for the sector, primary (and secondary) producers will either have to further reduce their own emissions or obtain credits from the recyclers*".

Carbon border adjustment

The inception impact assessment released by the European Commission on 21.07.2020 indicates that "*Carbon leakage occurs when production is transferred from the EU to other countries with lower ambition for emission reduction, or when EU products are replaced by more carbon-intensive imports*". In this context, a carbon border adjustment mechanism would ensure that the **price of imports reflect more accurately their carbon content**, and avoid carbon leakage. Ideally, the carbon border adjustment would be a custom right, calculated as follows

$$Custom\ right = Carbon\ price \times carbon\ content\ of\ imported\ products$$

Without harming the World Trade Organisation (WTO) rules, this carbon border adjustment mechanism would address the unfair competition linked to the implementation of the EU's Emissions Trading System ("EU ETS"). Until now, and have been covered by the free allowance of emission quotas in energy intensive sectors, especially when those are highly exposed to international competition, and GHG reduction costs represent a large share of their Gross value added. Steel and aluminium manufacturing sectors match both criteria – see Figure 11. The carbon border adjustment could replace this free allowance system, and set a level playing field between EU products and imported products not subject to strict environmental rules.

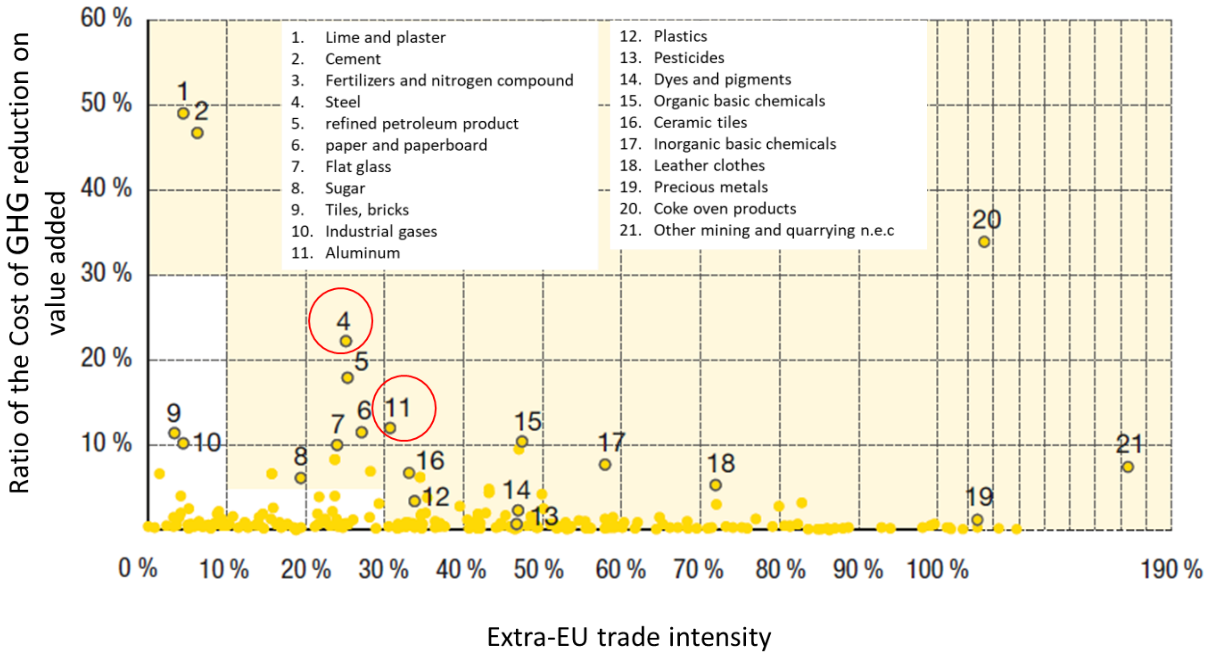

Figure 11 : Cost of direct and indirect GHG emissions vs extra-EU exchanges intensity of industrial sectors under the EU-ETS system (Glachant & Mini, 2020)

Circular VAT

A "circular" Value-added Tax (VAT) would aim at reflecting in VAT tax levels the circularity of a product, including for instance the share of recycled material presents in the product. A VAT promoting circular activities has been suggested by the Commission in the New Circular Economy Action Plan. It would be a powerful tool both to reward in prices the benefits of products made of recycled materials and to boost consumers' sustainable choices.

A proof of concept study supported by ADEME has been conducted in France on a "circular" VAT, called MODEXT project - Environmental externality monetization for a circular Value Added Tax (Gérand et al., 2018). It assessed the feasibility of monetizing the environmental externalities of a product or service life cycle, including GHG emissions, in order to modulate VAT rates. The study compared for instance a VAT rates between a product containing recycled material and the same product containing none, on the basis of the monetized externalities difference between a reference product and an eco-designed product – see example in Table 4 for a pan containing recycled material.

Table 4 : Result of monetization assessment performed in the MODEXT project

Product	Ecodesign strategy	Observed market price		Externalities of reference product		Externalities difference reference product vs eco-designed product	
		Incl. tax	Excl. tax	€2018	% of price excl. tax	€2018	% of price excl. tax
Pan (*Tefal Natura*)	Use of recycled material	20	16,7	13	78%	2	12%

Scrap subsidies

Subsidies are defined here as conditional transfers of money from governments to enterprises. In the present cases it could be conditioned by the intake of recycled material by scrap downstream users. Pothen et al. (2020) suggest that the subsidies amount corresponds to the scrap bonus they calculated.

R&D subsidies

One of the conclusions in the part above is that an increase in metal scrap intake could imply in some cases better sorting and processing technologies. The report on the implementation of the Circular Economy Action Plan claims that "*Over the 2016-2020 period, the Commission has stepped up efforts in both directions totalling more than €10 billion in public funding to the transition*" (EC, 2019):

- €1.4 billion from H2020 funding
- €7.1 billion from the Cohesion Policy
- €2.1 billion European Fund for Strategic Investments and Innovfin

Other funds not primarily directed at recycling, but rather at climate change mitigation could provide support to the increase of scrap metal intake. The NER 300 program[17] for instance, which is funded by the EU ETS and aims at funding innovative low carbon technologies, with a focus on renewable energy technologies or CCS technologies.

Some other EU level initiatives such as the Clean Steel Partnership[18] could be an opportunity to fund R&I in recycling processes. EU strategic orientations towards sustainability and climate change mitigation unlock various budgetary tools likely to fund circular and decarbonized technologies.

[17] https://ec.europa.eu/clima/policies/innovation-fund/ner300_en
[18] https://www.estep.eu/open-consultation-of-the-clean-steel-roadmap-2/

7. References

- Allwood, J.M., Cullen, J.M., (2012), Sustainable Materials with Both Eyes Open. UIT Cambridge Ltd., Cambridge, UK.
- Arcelor-Mittal (2020), Climate Action in Europe - Our carbon emissions reduction roadmap: 30% by 2030 and carbon neutral by 2050
- Argus Media (2019), Ukraine home-sourced scrap supply remains below demand, published 20 August 2019, retrieved from: https://www.argusmedia.com/en/news/1962182-ukraine-homesourced-scrap-supply-remains-below-demand
- BIR (2020), World Steel Recycling in figures 2015-2019, Steel scrap – a raw material for steelmaking, 11th edition, Bureau of International Recycling.
- L. Ciacci, T. Fishman, A. Elshkaki, T.E. Graedel, I. Vassura, F. Passarini (2020), Exploring future copper demand, recycling and associated greenhouse gas emissions in the EU-28, Global Environmental Change, Volume 63, 2020, 102093, ISSN 0959-3780, https://doi.org/10.1016/j.gloenvcha.2020.102093.
- Ciacci, L.; Vassura, I.; Passarini, F. Urban (2017), Mines of Copper: Size and Potential for Recycling in the EU. Resources 2017, 6, 6.
- EuRIC (2019), Top 5 priorities of the recycling Industry for the period 2019-2024. Brochure. Accessed at: https://www.euric-aisbl.eu/position-papers
- European Commission (2017) Study on the review of the list of Critical Raw Materials - Non-critical Raw Materials Factsheets;
- European Commission (2018), Assessment of the implementation of Directive 2000/53/EU on end-of-life vehicles (the ELV Directive) with emphasis on the end of life vehicles of unknown whereabouts - Under the Framework Contract: Assistance to the Commission on technical, socioeconomic and cost benefit assessments related to the implementation and further development of EU waste legislation, report prepared by Prepared by Oeko-Institut e.V., Institute for Applied Ecology;
- European Commission (2019), report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the implementation of the Circular Economy Action Plan, COM(2019) 190 final.
- FEDEREC (2017). Environmental Assessment of Recycling in France according to Life Cycle Analysis Methodology. Press Conference. Retrieved from *http://avnir.org/documentation/congres_avnir/2017/PPT/Recyclage_Federec_Congres_avniR_2017.pdf*
- FEDEREC (2020), Mesures de relance économique des entreprises du recyclage dans le contexte de crise sanitaire COVID-19
- Gérand Y., Le Pochat S., Dubosc A.,(2018), Modélisation des externalités environnementales pour une TVA circulaire (MODEXT) – Synthèse du rapport Ademe, 27p.
- GHK / BIOIS (2006), A study to examine the benefits of the End of Life Vehicles Directive and the costs and benefits of a revision of the 2015 targets for recycling, re-use and recovery under the ELV Directive, Final Report to DG Environment.
- Glachant M., Mini C. (2020), Quand le carbone coûtera cher – L’effet sur la compétitivité industrielle de la tarification du carbone, Paris, Presse des Mines.
- Graedel, T.E.; Reck, B.K.; Ciacci, L.; Passarini, F. (2019), On the Spatial Dimension of the Circular Economy. Resources, 8, 32.
- Hogg D., Sherrington C. (2012), Analysis of Tradable Recycling Credit Systems: Review of Existing Policies and Consideration of Potential Policy Mechanisms, report for EFR and EUROMETREC.
- Joly A., Ramos C., Aulanier H.-M. (2020), Stratégie d’entreprise dans (et pour) un monde décarboné – Etude de cas sur le secteur de l’acier : l’analyse par scénario éprouvée par Carbone 4
- Laplace Conseil (2013), Implication of the EU steel action plan and other EU initiatives for Steel scrap production and trade, report for EFR.
- Material Economics (2018), The Circular Economy – A powerful force for climate action – transformative innovation for prosperous and low-carbon industry, report.
- Nakajima. K., Takeda. O., Miki. T., Matsubae. K., Nakamura. S. & Nagasaka. T. (2010) Thermodynamic analysis of contamination by alloying elements in aluminium recycling. Environmental Science and Technology. 44. 5594-5600

- NUCOR (2019), 2019 Recycled Content of Nucor Steel Mill Products, Letter to NUCOR customers;
- OCDE (2019), Business Models for the Circular Economy : Opportunities and Challenges for Policy, Éditions OCDE, Paris, https://doi.org/10.1787/g2g9dd62-en.
- Passarini, F., Ciacci, L., Nuss, P., Manfredi, S. (2018). Material Flow Analysis of Aluminium, Copper and Iron in the EU 28. JRC Technical Reports. Retrieved from https://publications.jrc.ec.europa.eu/repository/bitstream/JRC111643/jrc111643_mfa_final_report_june2018.
- Pothen F., Growitsch C., Engelhardt J., Reif C., Brock L.V. (2020), External Costs and Fair Competition in the Global Value Chains of Steelmaking, Fraunhofer-Institute for Microstructure of Materials and Systems IMWS Center for Economics of Materials CEM in Halle (Saale), report for the German Steel Recycling Association - Bundesvereinigung Deutscher Stahlrecycling- und Entsorgungsunternehmen e.V. (BDSV).
- RECORD (2019), Echanges intra-européens et internationaux de déchets valorisables et de matières premières du recyclage. Panorama actuel et prospectif, 316 p, n°18-0253/1A
- Tolomeo N., Fitzgerald M., Eckelman J. (2019), US steel sector thrives as mills move up quality ladder, S&P Global Platts Insights, Accessed at: https://blogs.platts.com/2019/05/09/us-steel-mills-quality/
- Will we need to mine metals in the future? Wood Mackenzie, 26 November 2020.
- Wörtler M., Schuler F., Voigt N., Schmidt T., Dahlmann P., Lüngen H. B., Ghenda J.-T. (2013), Steel's contribution to a low-carbon Europe 2050 – Technical and economic analysis of the sector's CO_2 abatement potential, The Boston Consulting Group (BCG), Steel Institute VDEh

8. List of Figures

9. List of Tables