TransitionAsia

ACCELERATING EAST ASIAN CORPORATE CLIMATE ACTION

SCRAP STEEL EXPLAINER

A guide on scrap steel types, their limitations and related market dynamics

August 2023

INTRODUCTION

Steel is the most recycled material in the world, as it can be infinitely recycled without loss of quality. Over 650 Mt is recycled annually, including pre- and post-consumer scrap. Recycling this large amount of steel accounts for significant energy and raw material savings: on average 1,370 kg of iron ore, 780 kg of coal and 270 kg of limestone are saved for every tonne of scrap steel made into new steel[1].

Increasing the ratio of scrap in steel production will be vital to reduce the reliance on raw materials and reduce emissions in line with a 1.5°C pathway.

TYPES OF SCRAP

Although scrap steel is used in both blast furnace (BF) and direct reduced integrated (DRI) processes, it is predominantly used in stand-alone electric arc furnace (EAF) facilities. Scrap steel can be broken down into three main groups each with different price points and qualities: Home/Return Scrap, Industrial/Prompt Scrap and Obsolete/Post-consumer Scrap. In analysing company commitments, it is also important to understand the difference between recycled steel and scrap steel.

HOME/RETURN SCRAP

Home scrap is steel waste that is created inside of a steel mill through the production process (leftover pieces, trimmings, etc.). Home scrap products are generally recycled within the mill immediately.

PROMPT/INDUSTRIAL SCRAP

Prompt Scrap is generated in the downstream manufacturing process. Industrial scrap is linked with the consumption of finished steel products. Most industrial scrap is typically recovered back to the steel mill within a year and are generally organised through long-term contracts due to their high value and ease in recycling.

OBSOLETE/POST-CONSUMER SCRAP

Obsolete scrap is collected at the end-of-life of a product containing steel. The volume of obsolete scrap is historically based on life cycles and recovery linked to localised and/or sector recycling. Once collected, obsolete scrap steel is crushed, shredded and sheared. The scrap is then separated via a magnet to further separate scrap from products that could contaminate the steel. The scrap steel is then added to a basic oxygen furnace (BOF) with pig-iron (the input used to create steel) from a BF for temperature control or loaded into an EAF.

1 Factsheet - Steel and Raw Materials, World Steel Association, worldsteel.org/wp-content/uploads/Fact-sheet-raw-materials-2023.pdf. Accessed 18 Aug. 2023.

SCRAP IN ELECTRIC ARC FURNACES

An EAF can be charged with 100% recycled material and is the preferred method of recycling steel worldwide. Grid-based emissions from the use of electricity are the main source of emissions from using an EAF but they can be drastically reduced through the use of renewable electricity.

HOME AND PROMPT SCRAP IN EAFS

In much of the world, EAF-based steel is associated with lower quality steel that cannot be used in certain products like parts of automobiles. This is due to several factors such as the BF-BOF method being globally dominant and obsolete scrap being used for producing lower quality steel due to the inclusion of tramp elements. However, in countries where cheap natural gas or the lack of coking coal (fuel used in a BF to create steel) has led to the DRI method becoming dominant, EAF-based steel fills the quality needs of domestic consumers. This is the case in the United States, the Middle East and legacy plants in India. Here, home and prompt scrap is used exclusively or mixed with DRI to produce high quality scrap-based or scrap-mixed with primary steel, untainted by tramp elements.

While the inputs for EAFs play a significant role, the technology itself is crucial in determining the steel's quality. Large steel plant providers, like Danieli in Italy, have suggested that EAFs can be effectively utilised for most high-quality steel grades. To ensure the production of high-quality steel, it is essential to have secondary metallurgy production facilities that complement EAF production since the output from EAFs differs from that of BOFs.

Where legacy EAF mills have been using the technology for years to produce high-grade steel products, steel conglomerates whose operations have traditionally been led by BF-BOF steel are entering the space. High profile examples now include Nippon Steel and JFE Steel in Japan, developing EAF and secondary processing facilities to charge scrap steel for electrical steel, a high-grade steel product suited to electrical vehicles.

OBSOLETE SCRAP IN EAFS

Obsolete scrap use in EAFs is largely associated with steel products in which a lower grade of product is permissible. Notably, the construction industry benefits from these types of products, for example, the world's largest scrap steel purchasing country, Turkey, is simultaneously the world's largest reinforcement bar (rebar) steel producer.

LIMITS OF SCRAP

HOME AND PROMPT SCRAP - AVAILABILITY CONSTRAINTS

Home and prompt scrap volumes are intrinsically linked to virgin steel consumption and the efficiency of secondary steel processing facilities. During periods of high steel production, levels of home and prompt scrap increase and vice versa during periods of low steel production. 40 percent of scrap steel is home and prompt scrap, a number that is set to decrease through increased efficiencies of secondary steel processing and the increase in global steel stock driving obsolete scrap levels. High value is attributed to this type of scrap as it is clean and demonstrates steel's ability to be almost infinitely recycled. Although preferable as a product to obsolete scrap, it is lower in availability.

OBSOLETE SCRAP - TECHNOLOGICAL CONSTRAINTS

While slag formation (a by-product of steelmaking) can eliminate most impurities, there are technological constraints when it comes to dealing with obsolete scrap. Despite undergoing screening and separation processes, obsolete scrap might still retain traces of other metals at extremely low concentrations due to factors like surface treatments. When these impurities can't be extracted from the molten metal, they are referred to as 'tramp elements'. Among these, copper and tin pose significant challenges, as even small amounts of these metals in steel lead to surface cracking during hot rolling and forming. Consequently, the presence of these elements curtails the quality and performance of recycled steel output. This limitation is why a substantial portion of obsolete scrap is directed towards producing lower-grade steel products like rebar for the construction sector.

OBSOLETE SCRAP - COST CONSTRAINTS

The availability of obsolete scrap is influenced by two key factors: the potential quantity that can be collected from the system and the rates at which companies can efficiently gather and process this scrap. The process of recycling obsolete scrap involves significant expenses, primarily related to labour and the energy required for processing. Additionally, businesses face substantial costs related to the transportation of obsolete scrap from consumers to collection and processing sites, and eventually to steel mills. The accumulation of these costs sets a baseline for the minimum price of obsolete scrap that the recycling sector must achieve to remain viable.

Compared to alternative materials, obsolete scrap remains less appealing, and its market price continues to be linked to the costs of iron ore and coking coal. To make obsolete scrap a driving force for influencing the prices of raw materials used in steel production, there must be a strong demand for obsolete scrap relative to its supply. Furthermore, the overall recycling expenses must be competitive with the prices of iron ore and coking coal.

Even in countries like the United States, which possess a surplus of obsolete scrap and a well-structured scrap recycling industry, the pricing of obsolete scrap has consistently followed a logic based on substituting it for the costs of producing hot metal.

FUTURE OF SCRAP MARKETS

Scrap steel is the basis for around 20% of total crude steel production, of which around 60% is obsolete scrap. Due to increasing efficiencies within steel production and finishing processes it is widely expected that this share of obsolete scrap will continue to increase towards 2050 with some estimates hovering around a 75% theoretical share. Although beneficial from a circularity perspective, unless significant countermeasures are introduced to decrease the concentration of tramp elements below 0.25% this steel will continue to be considered low quality by industry[2]. This stems from a continuance of little sorting and low dilution and will likely lead to quality requirements not being met, increasing reliance on primary steel production; stifling increases in scrap rates.

2 Dworak, S., Rechberger, H. and Fellner, J., 2022. How will tramp elements affect future steel recycling in Europe?–A dynamic material flow model for steel in the EU-28 for the period 1910 to 2050. Resources, Conservation and Recycling, 179, p.106072.

INCREASING SCRAP RATES THROUGH DILUTION

There are several specific methods for purification and removal of tramp elements from scrap, including diluting the impurities of scrap steel with DRI to improve the quality. American steel mills in particular use DRI as a means to reduce the overall amount of tramp elements or other impurities where obsolete scrap has been used. Although pig iron can also be used within EAFs, it is not easily transported and BFs have no clear technological pathway to near-zero emission production.

SORTING AND REMOVING OF TRAMP ELEMENTS

A small number of pilot recycling plants specialising in treating contaminated scrap steel are underway but these technologies are unlikely to be available at scale by 2050. Beyond this, there are simpler ways to increase the rates and applications of recycled steel. Increasing the processing of end-of-life scrap and designing with less copper or easier disassembly at end of life are simple ways in which to boost technological and capacity issues that the scrap markets face today.

SCRAP STEEL DEMAND

Steel-intensive industries are providing clear demand side signals to the steel sector, requiring decarbonised steel products. Hybrid EAFs for less carbon-intensive DRI mixed with high-grade scrap has provided the American automotive industry with steel for years. Offtake frame agreements for green steel such as the high profile agreements signed between SSAB and Volvo and Ford Europe and Tata signal a shift away from BF-BOF crude steel production.

With DRI being particularly well-suited to transportation in the form of hot-briquetted iron (HBI); steel companies should use this opportunity to invest in high quality EAFs and secondary processing facilities to ensure high-grade steel products are produced. Mills can also seek to develop green steel offtake partnerships such as those between Volvo and SSAB to de-risk their new investments. Similarly, progressive companies within sectors that have the margins to be early movers (automotive and shipping, for example) should seek to develop supply chains with mills that can provide low carbon, high quality steel.

With carbon borders under development in Europe, and the United States considering implementing the same, net exporters of steel are now pressured to ensure steel products are not subjected to tariffs designed to limit carbon leakage and encourage low carbon steel policies overseas. Scrap steel complemented by hydrogen-based DRI where necessary is proving itself to be the most effective way to meet these regulations and decarbonise the iron and steel industry.

DATA AND DISCLAIMER

This analysis is for informational purposes only and does not constitute investment advice, and should not be relied upon to make any investment decision. The briefing represents the authors' views and interpretations of publicly available information that is self-reported by the companies assessed. References are provided for company reporting but the authors did not seek to validate the public self-reported information provided by those companies. Therefore, the authors cannot guarantee the factual accuracy of all information presented in this briefing. The authors and Transition Asia expressly assume no liability for information used or published by third parties with reference to this report.

ABOUT TRANSITION ASIA

Founded in 2021, Transition Asia is a Hong Kong-based non-profit think tank that focuses on driving 1.5°C-aligned corporate climate action in East Asia through in-depth sectoral and policy analysis, investor insights, and strategic engagement. Transition Asia works with corporate, finance, and policy stakeholders across the globe to achieve transformative change for a net-zero, resilient future. Visit our website www.transitionasia.org or reach us at contactus@transitionasia.org to learn more.