# ZINC RECYCLING
## Stocks + Flows

As a material, zinc follows a complex life cycle from ore extraction, through refinement and use in society, to eventual collection and recycling of products at the end of life. This life cycle can be characterized by collecting information at various stages of production, manufacturing, use, and waste management. Information on these "stocks and flows" of material can be used to calculate recycling rates, identify recycling gaps, and impact opportunities for increasing zinc circularity.

## Material Flow Analysis

A tool called Material Flow Analysis (MFA) is used to characterize the zinc life cycle, which is based on the mass balance principle. In MFA, a material life cycle is described by identifying; the main stages (processes) of a material, the main flows connecting these processes, the stocks in which material accumulates over time, and its release from these stocks. These processes are interconnected through the generation and use of scrap in different forms and at different life stages. Flows are quantified by using a variety of data sources, estimates, and mass balance. Five main processes characterize the life cycle for zinc (Figure 1): mining & smelting (production), first use production, fabrication & manufacturing (products), use (service), and management and recycling of scrap and waste (end of life).

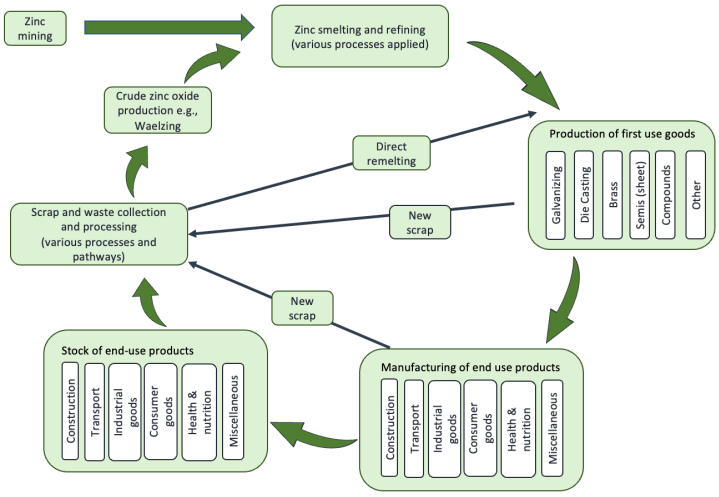


Figure 1: Anthropogenic cycle of zinc (Fraunhofer ISI 2022)

## The Dynamic Model of Zinc Global Stocks + Flows

The broad variety of zinc uses and zinc recycling pathways require a wealth of data to credibly describe the global zinc cycle. Zinc production, use, and recycling are closely interconnected with the material cycles of steel, brass, and lead, which adds to the complexity. The dynamic nature of the zinc cycle not only requires current input data, but also on historical flows to account for the durability of zinc which can offer a functional lifetime of 100 years for some applications. The International Zinc Association (IZA) partnered with Fraunhofer ISI Institute, Karlsruhe, Germany to develop a comprehensive dynamic model describing global zinc stocks and flows.

## Zinc Circularity

The zinc global stocks and flows model helps quantifying the current zinc circularity:

- In 2019, 247 Mt of zinc were bound in the use phase, the so-called anthropogenic stock, about twenty times the amount of zinc that was mined in the same year (Figure 2). At the end of useful life, zinc will become available for recycling from this urban mine.

- Over the past decade (2010 – 2019), zinc recycling doubled while zinc mining remained at a constant level (Figure 3).
- Recycling indicators such as the Recycling Input Rate (RIR) or the End-of-Life Recycling Rate (EoL RR) have improved significantly (Figure 3).
- Enforcement of regulations in favor of circularity result in increased zinc recycling over the last several decades, e.g., from steel mill dusts (EAF; Figure 4).

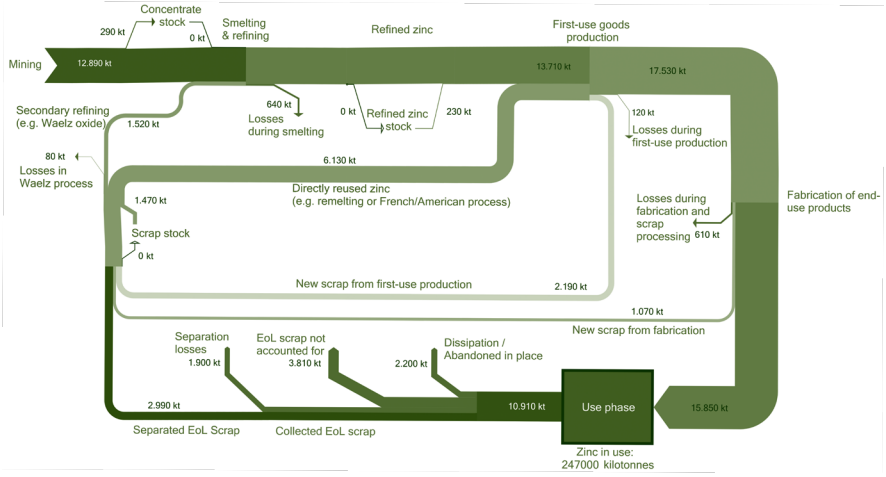


Figure 2: Global Zinc stocks and flows in 2019 (Fraunhofer ISI 2022).

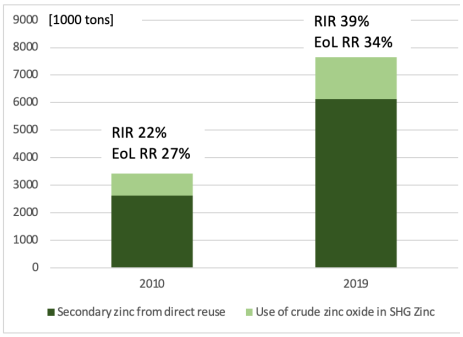


Figure 3: Zinc recycling doubled between 2010 and 2019 while zinc miine production remained constant at 12-13 Mt (Fraunhofer ISI 2022).
RIP: Recycling Input Rate, EoI, RR: End-of-Life Recycling Rate

## The Global Recycling Challenge

The difference between what is recycled today and the potential for recycling is called the “Recycling Challenge” (Figure 5). To support industries to pursue their recycling potential, the OECD in their “Global Material Resources Outlook to 2060” concluded that metal production from mined and recycled sources are needed to meet future demand. Zinc is no exception and the stocks and flows analysis helps identify impact opportunities to increase zinc circularity. Even though zinc is increasingly produced from recycled sources, mining is and will be needed to meet demand. Step changes in zinc circularity could be realized through innovations in collecting and sorting of old scrap and increased recycling of low zinc containing steel mill dusts.

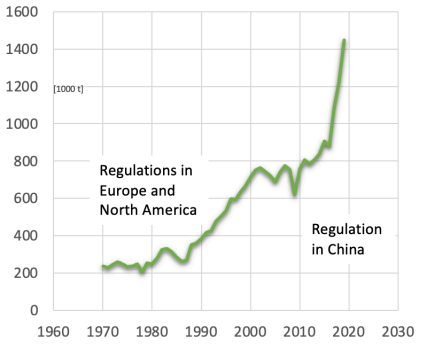


Figure 4: Zinc recycling from steel mill (EAF) dust increases with regulations being enforced (based on ILZSG statistics).

## Outlook

The International Zinc Association regularly updates the global zinc stocks and flows model. In addition to the global model, regional models are also being developed to define material flow, circularity, and recycling opportunities within Europe, North America, Latin America, China, the rest of Asia including India, and the rest of the world. At the same time, the models are used as starting point for estimating future zinc demand and recycling scenarios. In conclusion, the global and regional “stocks and flows” models will provide more specific analyses over the years that can be used to meet the “Recycling Challenge” for the zinc sector.

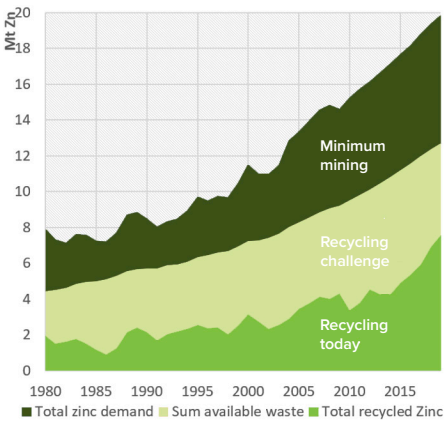


Figure 5: While Zinc recycling increases, there is still room for improvement e.g., better collecting and sorting schemes (Fraunhofer ISI 2022).

## Available Recycling Factsheets

Stocks + Flows
Demand + Supply
Material Supply
Closing the Loop

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