Process concept for the integration of shredder residue in the recycling of Waste Electrical and Electronic Equipment

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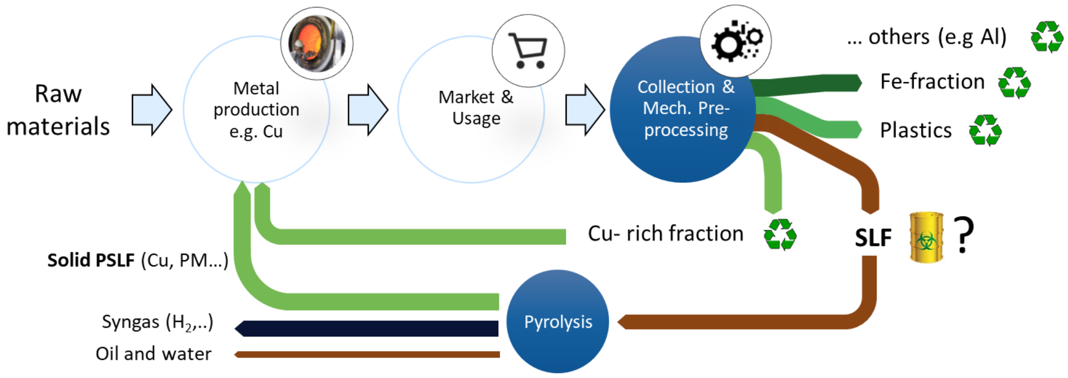
The generation of Waste from Electrical and Electronic Equipment (WEEE) has rapidly surged in the past decade, becoming a prominent global waste stream. In 2019, WEEE production reached 53.6 million metric tons (Mt), a remarkable increase of 9.2 Mt since 2014. This upward trajectory is set to persist, with an estimated WEEE generation of 74.7 Mt projected by 2030 due to an annual EEE consumption increase of 2.5 Mt[1]. This calls for efficient and sustainable WEEE recycling solutions.
Post-collection, WEEE undergoes pre-treatment, involving the removal of hazardous substances. Subsequently, meticulous manual separation of metallic components follows, preventing unnecessary losses in shredding. These components are directed to specialized recycling facilities. For the unsorted and metal blended fractions, a further pivotal step involves material crushing, facilitating component liberation. After successful liberation, a sorting process based on magnetism, conductivity, and density segregates materials into fractions like steel (Fe-fraction), copper, aluminum, plastics, and more [2,3].
Within WEEE recycling, Shredder Light Fraction (SLF) waste emerges from mechanical pre-processing ad specifically from density separators, constituting approximately 4.2% of the total output. SLF is a complex waste with a high concentration of different types of organics (textiles, plastics, wood, etc.), primary metals, including copper, tin, lead, zinc, silver, and gold [4]. Despite these valuable metals, direct use in conventional metallurgical processes presents challenges such as handling halogens from flame retardants, heterogeneous composition, and complex morphology for metallurgical aggregates [5]. Conversely, pursuing non-metallurgical alternatives risks metal losses. The research is thereby driven towards strategies enabling the reintegration of these metals into the value chain, thus fostering the circular economy of metals.
Such an innovative solution involves autothermic smelting of printed circuit boards followed by slag reduction utilizing pyrolyzed SLF as a reducing agent. Pyrolytic materials offer a distinct reduction path, making them well-suited for the process, even in comparison with traditional metallurgical reducing agents. The efficacy of the process was validated at a demo-scale using a 240L Top-blown-rotary converter at the IME Institute of RWTH Aachen University. The findings of this study present a multifaceted solution to challenges in WEEE recycling [6].

Figure 1. Closing the loop transforming waste into usable material



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