ENVIRONMENTAL AND ECONOMIC ANALYSIS TO EVALUATE THE VALORIZATION PROCESS OF METALLURGICAL WASTE AND BY-PRODUCTS

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Energy and resource efficiency are today key elements for the European industry. More specifically, the metallurgical industry is energy and resource-intensive, mostly located in big centralized plants, and it is today responsable for a large number of carbon emissions. While a big plant allows for stability in productivity, it also makes the process less adaptable towards innovative units/systems developed for more efficient use of energy and resources. Therefore, the future decarbonization targets might not be met without the development of new flexible and innovative technologies and strategies.

In this context, the goal of the H2020 project CIRMET (innovative and efficient solution, based on modular, versatile, and smart process units for energy and resource flexibility in highly energy-intensive processes) is to develop and validate an innovative and flexible circular solution for energy and resource efficiency in a metallurgical plant, that can also be replicable to other sectors of the process industry. The proposed circular model, represented in Figure 1, is composed of three units: (1) a metallurgical furnace for the recovery of valuable metals from industrial metallurgical residues and by-products, (2) a unit for heat recovery from the furnace's exhaust gases, and (3) a digital platform for the optimization of the whole process. The substitution of metallurgical coke (based on fossil carbon) with biobased material (Biochar) is also investigated, aiming at future carbon neutral emissions for energy intensive industries.

This study presents a combination of a Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) to investigate the environmental and economic performances of the proposed circular model. The LCA and LCC analyses are based on data from a real demonstrator at a pilot scale. Data were collected on-site during a testing campaign, in which residues from non-ferrous metals production were treated for the recovery of metals (zinc oxide, secondary copper), mechanical energy from waste heat, and the inert fraction from the residues. The results of the LCA and LCC highlight the environmental and economic potential benefits of the proposed technologies, identified as the metals recovery and the avoided landfilling of the residues. The substitution of metallurgical coke with biobased material can also lead to a significant reduction of fossil carbon emissions. The LCC has also revealed the potential for positive economic profit, as the revenues overcame the costs (both OPEX and CAPEX) in the long term. On the other hand, the high energy consumption in the furnace represents the main environmental challenge and economic drawback of the circular model. The consistency of the environmental and economic analysis has been tested through an uncertainty analysis run by Monte Carlo simulation.

As the proposed technology is still under development, these results must not be considered as a conclusive answer. However, they are an iterative exercise to provide useful insights already at the early stage of technological development, allowing for a more efficient design towards increased environmental and economic sustainability.

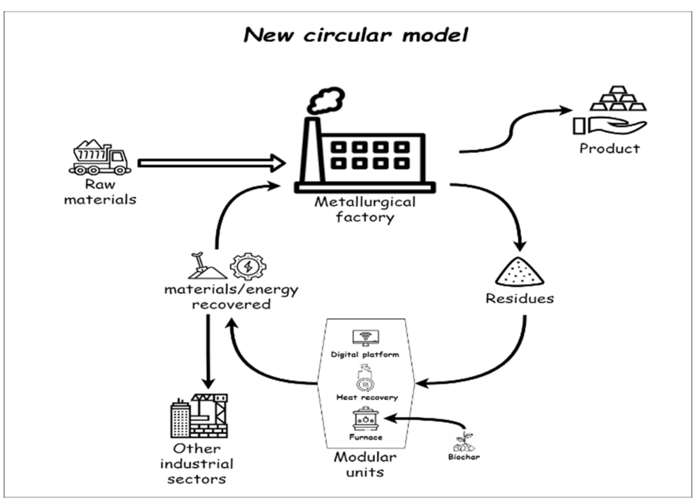

Figure 1 – The new proposed circular model for metallurgical industry