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Electrification of High Temperature Heating Demand: A Techno-Economic Perspective on Decarbonized Steel Making

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The steel industry, known for its high carbon intensity, has primarily focused its decarbonization efforts in the ironmaking phase, which accounts for 70% of the sector's total emissions. However, the steelmaking and post-processing phases, responsible for the remaining emissions, have been largely overlooked until now. These phases contribute a significant percentage of emissions that must be addressed to achieve full decarbonization of the industry. This paper provides a comprehensive review of existing literature on steel industry decarbonization, followed by a comparative analysis of various electrification technologies and conventional methods, specifically targeting the mini-mill. The study evaluates the energy intensity and emissions reduction potential of electrification technologies such as hydrogen combustion and plasma heating torches. It also examines the effectiveness of these technologies for preheating scrap entering the electric arc furnace (EAF) and assesses the impact of different metal feeds (scrap, DRI, H2-DRI) on the EAF's energy balance. Additionally, the study investigates the potential of electrification technologies for the reheating furnace. Finally, the economic viability of electrifying mini-mill operations is evaluated, considering future trends like carbon pricing and energy costs. The findings suggest that electrification technologies present a viable strategy for decarbonizing the steel industry. However, their effectiveness is highly dependent on the emissions profile of the electricity used. Moreover, the economic viability of these technologies remains a significant challenge, highlighting the need for policy measures to support the transition towards a sustainable steel industry.

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