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EAF versus Smelter + BOF –A Comparative Assessment for Low-Carbon Steelmaking

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Transitioning from traditional integrated steelmaking using blast furnaces to direct reduction combined with electric arc furnaces is among the most promising strategies to reduce CO_2 emissions in iron and steel production. However, the availability of raw materials required for this route, such as high-grade iron ores, is limited. To overcome this constraint, alternative green production routes employing a two-step process with a Smelter followed by a BOF are gaining attention. The Smelter enables efficient melting and final reduction of low-grade DRI and allows recycling of iron oxide-rich by-products such as dusts, slags, and mill scale. Additionally, this two-step process offers several options to decouple ironmaking from steelmaking, enabling the energy-intensive ironmaking step to be located in regions with competitive access to green energy.

This paper presents a detailed comparison between the one-step EAF route and the two-step Smelter–BOF route. The analysis begins with input material flexibility: EAF offers high adaptability in charge mixes, while the Smelter provides superior tolerance for varying ore grades and by-product recycling. Metallurgical aspects and steel quality considerations are examined, including differences in refining practices in EAF versus BOF and their implications for secondary metallurgy. By-product management is another key differentiator: Smelter slag can be granulated for high value use in cement production, whereas EAF and BOF slags typically require separate treatment to avoid landfilling.

Finally, the paper compares operational expenditures, including CO_2-related costs, and capital expenditures for both brownfield and greenfield installations. The findings highlight trade-offs between raw material flexibility, process efficiency, and cost structure, providing insights into how these routes can complement each other in achieving large-scale decarbonization of iron and steelmaking.

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