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RESEARCH NOTE

The Decarbonizarion Challenge & Path Toward Green Steel

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Steel is one of the core pillars of today's society and, as one of the most important engineering, construction, and consumer durable materials, has a large presence in our lives. However, the industry is facing pressure to reduce its carbon footprint and adapt for the economy of the future. The global steel industry is presented with a number of challenges to reduce its carbon footprint, and this is especially true in emerging markets, given the unique technology mix, political resistance, and impact on employment. Many of these steel producers, however, are actively investing to reduce their emissions and, with the right policies and assistance from developed countries and multilaterals, should make significant progress over the next decade.

The steel industry is currently one of the three biggest producers of carbon dioxide. Every ton of steel produced in 2019 emitted on average 1.85 tons of carbon dioxide, equating to about 8% of global carbon dioxide emissions.[1] Despite significant technological advancements in production methods, there are no viable substitutes for steel, in terms of durability and/or versatility. Therefore, transitional risks for the sector are high, and there's a race against time to find a solution. The fact that steel production, and, as a result, emissions, are concentrated in a few locations makes this industry an ideal candidate for decarbonization.

Steel is produced via two primary processes. The conventional method uses an integrated blast furnace (BF)/basic oxygen furnace (BOF), which operate with metallurgical coal as the chemical-reducing agent of iron ore. The alternative method is an Electric Arc Furnace (EAF), which uses electricity to repurpose steel scrap or direct reduced iron (DRI) as the primary raw material; EAF emission intensity can be as low as 40%-80% of that of a conventional integrated blast furnace.

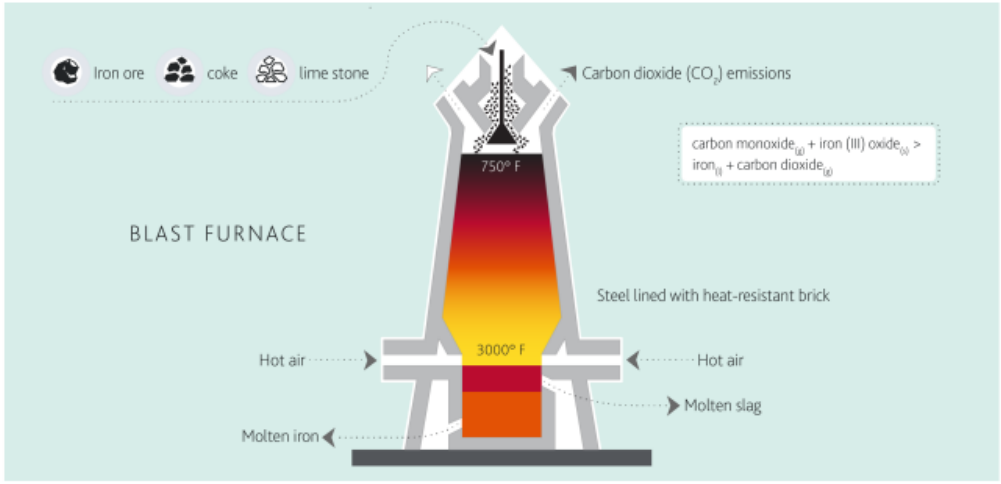
The United States has an advantage in the decarbonization challenge, due to the structural composition of the sector, with approximately 70% of the steel produced in EAF—compared to 40% in Europe and 30% in the rest of the world. The U.S. advantage is fortuitous rather than by design, explained by the high availability of scrap steel and affordable natural gas.

The Challenge

Unsurprisingly, most Emerging Markets operate more BFs rather than EAFs, for several reasons. In EM, steel is largely used for infrastructure or construction, rather than use in other industries. As EMs develop and rollout infrastructure projects, the steel used in these projects is locked in the structure for many years, resulting in a more limited stock of old steel available for scrap/recycling (i.e., a scrap reservoir). In the developed world, the average lifecycle of steel products is close to 20 years; for EMs, this is very likely going to be for longer. Furthermore, scrap recycling is a complex process often based on an informal network of waste/recycling collection, which is onerous and time consuming. Some processes, such as sheet steel,

1. World Steel Association. Last referenced on December 6, 2021. https://www.worldsteel.org/steel-by-topic/sustainability/sustainability-indicators.html.

Simplified illustration of the steel production using BOF method



Blast furnaces produce iron from iron ore. In a second step, a basic oxygen converter turns iron, with some additions of scrap, into steel.
Source: Moody's Investors Service research

require premium/high-quality scrap, making the transition even more challenging. Sourcing scrap has been a challenge for EM producers who have attempted to run EAF, resulting in defeat and disposed assets, given the lack of premium scrap in the market, as was the case in Russia.

The second reason EMs predominately operate a BF production process is the natural cost advantage EMs have in certain metals and minerals, such as coal and iron ore, which are inputs to this process. Brazil, for example, is one of the largest and lowest cash-cost producers in the world for high-quality iron ore. Other countries, such as Indonesia or Russia, are among the most-competitive coal and metallurgic coal producers globally.

From a national interest perspective, there is also the social impact/labor consideration, as the mining sector tends to be a large employer in these countries. Emerging Market governments need to balance the green transition with the political cost of losing jobs and training employees for the industries of the future.

The Path to Transition and Decarbonization Strategies

Globally, steel producers are developing strategies and running pilot plants to assess different production technologies to help decarbonize the industry. By using best practices in existing BF/BOF, such as higher ore grades or fuel optimization, emissions intensity can be reduced by up to 30%. However, in order to fully decarbonize the sector, and given the foreseeable lack of scrap, especially in Emerging Markets, the industry is working on non-mutually exclusive technologies such as establishing or switching to green hydrogen-based (H_2) steel production and using Carbon Capture and Storage (CCS). Significant technological and scalability improvements are needed in both cases to push down the cost of these technologies to more competitive prices.

Emerging Markets Rising to the Challenge

Despite the challenges, EM steel manufacturers are making progress in emissions reduction, largely driven by new regulation, such as the EU Carbon Border tax, or higher standards set by global customers, such as

automakers. EM steel producer JSW Steel issued its first Sustainability Linked Bond, aiming to reduce emissions intensity to 1.95tCO_2 a year by 2030, equivalent to a 23% reduction from 2020 baseline. We have seen significant progress in 2021 regarding commitments to identify and sett emissions targets, especially from the major players such as Baowu or Hebei Iron and Steel, including goals that are more stringent than those set at a government level, in terms of peak emissions and net-zero dates.

Low-hanging fruits in emerging markets have depended on available resources rather than on available technology. For instance, cheap access to natural gas in the Middle East has resulted in a faster adoption of

natural gas fuel injection, the main driver of emissions reductions. On the other hand, Brazil is the second-larg¬est producer of iron ore, but it its energy grid is among the cleanest due to a high share of hydro generation and competitive non-conventional renewable energy, with wind projects currently providing energy at USD23/MWh. Rather than export¬ing iron ore, Brazil has an opportunity to reshape the value chain and further process the miner¬al into direct-reduced iron (DRI) in a renewable-powered electric furnace. DRI can then be exported for further pro¬cessing into steel. Not only does this significantly reduce emissions, it also increases the value-add for Brazil and reduces transported weight by around one-third.

China's efforts to tackle emissions is another demonstration of how government policies and regulation can steer certain industries towards cleaner and more value-added products. China has gone through another wave of crackdowns in recent months, with significant consequences for the steel industry, including anecdotal evidence that a few blast furnaces in Hebei province have closed permanently. Earlier this year, China published its "Development Plan for the Circular Economy over the 14th Five-Year Plan Period (2021-2025)", which sets ambitious targets, including scrap usage of 23% by 2025, peak steel industry emissions by 2025, and the explicit mention of substitution of imported iron ore. Despite having relatively new blast furnaces, Chinese steelmakers are among the most determined to decarbonization as explained by government ownership among top players, helping the implementation and coordination of national policies and commitments.

The transition to decarbonizing the steel industry in emerging markets is far from straightforward. Significant investments, lengthy capex cycles, an unclear winning technology, and high political costs are among the main challenges. The transition to green steel thus requires both the public and private sector collaboration in each country. An integrated approach will require government intervention, setting policies, carbon taxes and incentives for recycling and promoting contracts between dismantlers and steelmakers. We are cautiously optimistic about policies, such as the Glasgow Breakthroughs signed at the 2021 United Nations Climate Change Conference, or COP26, which aims to make clean technologies the most affordable, accessible and attractive choice for all globally in each of the most polluting sectors by 2030, particularly supporting the developing world to access the innovation and tools needed to transition to net zero[2], including steel. To fund this transition, the industry will need government subsidies and/or financing from multilaterals, whose efforts thus far have been focused on other industries such as energy and infrastructure.

2. https://www.gov.uk/government/news/world-leaders-join-uks-glasgow-breakthroughs-to-speed-up-affordable-clean-tech-worldwide

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