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CHINA'S STEEL SECTOR DECARBONISATION: WHY HYDROGEN AND RENEWABLES HOLD THE KEY

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KEY POINTS

- China's steel industry faces multiple challenges, including overcapacity, high carbon emissions, green steel premiums and tariffs. However, with the support of peak carbon and carbon neutrality policies, the industry is gradually emerging from its high-carbon model, stepping into a new low-carbon era that brings both opportunities and significant challenges.

- Scrap-based electric arc furnaces (EAFs) and hydrogen-based direct reduced iron with electric arc furnaces (H_2DRI-EAF) are the two major low-carbon steel production processes. Green hydrogen and renewable energy (RE) offer a more self-sufficient and scalable decarbonisation pathway for China's steel industry, reducing reliance on external supply chains and avoiding subsidy-driven competition.

- While awaiting further updates on capacity suspension, we recommend prioritising electric arc furnaces as the cornerstone of steel decarbonisations. Additionally, refining policies to improve scrap steel recycling and bolster the scrap steel sector is essential. Furthermore, enhancing hydrogen connectivity with the steel industry and efficiency, while promoting regional development through self-production projects, will strengthen the transition to low-carbon steelmaking.

THE CURRENT STATE OF CHINA'S STEEL DECARBONISATION

In 2024, China's crude steel production remained above the one-billion-tonne mark, while consumption fell to 892 million tonnes, a 5.4% year-on-year decline.[1] Thus, even as demand for steel has decreased, overcapacity persists. While both production and consumption may have peaked, carbon intensity remains relatively high due to the dominance of the coal-reliant blast furnace-basic oxygen furnace (BF-BOF) production process. At the corporate level, factors such as green steel premiums and international tariffs are putting pressure on profit margins, which could deter low-carbon investments and result in financial losses or even more significant challenges, ultimately slowing the industry's transition to a low-carbon future.

To advance China's peak carbon and carbon neutrality goals, China has introduced a series of policies aimed at strengthening its dual carbon control system.[2] The government has also launched the *Special Action Plan for Energy Conservation and Carbon Reduction in the Steel Industry*, setting clear targets for 2025, such as improving

1 http://www.worldmetals.com.cn/viscms/xingyeyaowen3686/266724.jhtml
2 https://www.gov.cn/zhengce/content/202408/content_6966079.htm

energy efficiency, increasing scrap steel usage, and raising the share of EAF-based steel production.[3] [4] During the Two Sessions in 2025, the National Development and Reform Commission (NDRC) has outlined "ongoing regulation of crude steel production as well as promoting capacity reduction and restructuring" as a key priority in the 2025 National and Social Development Plan.[5] Furthermore, China has explicitly supported hydrogen metallurgy and unveiled detailed implementation plans, promoted upstream and downstream demonstration projects within the "green electricity–green hydrogen–pure hydrogen metallurgy" value chain, facilitating an integrated approach to steel decarbonisation.[6]

Indeed, 2025 is an important year as it marks both the final year of China's 14th Five-Year Plan and a crucial transition year for steel decarbonisation, in the lead-up to the release of the 15th Five-Year Plan. Currently, steel production capacity swaps remain suspended, while steel has just been included in China's national emissions trading scheme.[7] The steel industry is gradually moving away from its high-carbon model and entering a new era, entering a low-carbon era where opportunities and challenges coexist.

GREEN HYDROGEN AND RENEWABLE ENERGY ARE DECISIVE ADVANTAGES FOR CHINA'S STEEL DECARBONISATION

The reasons China can be well-positioned as a global leader in green steel production, particularly in low-carbon hydrogen metallurgy, stem from its significant advantages in green hydrogen and renewable energy.

In the context of decarbonising steel, electric arc furnaces are essential infrastructure for low-carbon steel production, while scrap steel, renewable energy and green hydrogen act as the key resources, helping steel production break away from coal-based emissions and achieve a full low-carbon transformation. Together, these elements support two key low-carbon steel manufacturing processes: scrap-based EAFs (or in China, this is commonly referred to as "短流程 short process") and hydrogen-based direct reduced iron with electric arc furnaces (H_2DRI-EAF). These processes can achieve near-zero carbon emissions in steel production.

- Decarbonisation Effects of Electric Arc Furnaces: Short Process vs. H_2DRI-EAF

  Using electricity instead of coal can greatly cut emissions. One way is to melt down scrap steel, skipping the coal-heavy ironmaking step. Another method uses hydrogen instead of coal to extract oxygen from iron ore. If the electricity for these processes comes from renewable sources, emissions drop even further.

  While the Chinese government is implementing policies that steer the steel industry

3 https://www.ndrc.gov.cn/xwdt/tzgg/202406/P020240607590381066762.pdf
4 https://www.ndrc.gov.cn/xwdt/tzgg/202406/P020240607590381066762.pdf
5 https://www.gov.cn/yaowen/liebiao/202503/content_7013429.htm
6 https://www.nea.gov.cn/20241231/22b72793b0c946a4b9bfc2b06612b32e/2024123122b72793b0c946a4b9bfc2b-06612b32e_02b0cba335b5a04a9d96979fe0b49bd0e3.pdf
7 https://transitionasia.org/steel-enters-chinas-national-emissions-trading-scheme/

in a more sustainable direction, it maintains a relatively low proportion of EAF capacity in its fleet. According to Global Energy Monitor (GEM), as of January 2024, China's EAF capacity accounts for about 14% of total steel capacity, significantly lower than the global average of 31%.[8] Additionally, China's EAF capacity utilisation rate is relatively low, resulting in an EAF steel output share of only about 10%, compared to the global average of 28.6%.[9] At the time of writing, China is suspending the steel capacity replacement programme, and the future development details of EAFs remain unclear. However, with the official establishment of the Electric Arc Furnace Steel Sub-Association of the China Iron and Steel Industry Association, EAFs are likely to become a greater part of China's low-carbon steel development.[10]

- Resources, Capacity and Development of Scrap Steel, Green Hydrogen and RE

  China still has significant potential for increasing the use of scrap steel. In 2023, the country consumed around 214 million tonnes of scrap steel, but only about 30% was used in short process steelmaking, resulting in limited decarbonisation benefits. In terms of resource distribution and supply-demand dynamics, scrap steel in China is near a balanced state. However, regional disparities in resource availability and demand have caused scrap steel to move across areas, raising logistics costs and somewhat hindering the rapid development of the short process.[11] [12] On the policy side, China is supporting the efficient, high-quality use of scrap steel resources, expanding the import of recycled steel materials, and aiming to reach a target of 300 million tonnes of scrap steel usage by the end of 2025.[13]

  On the other hand, green hydrogen and renewable energy offer distinct competitive advantages. China's abundant wind and solar resources provide a robust foundation for the growing RE industry, which in turn supports the production of green hydrogen through electrolysis. China currently leads the world in both renewable energy capacity and the installation of hydrogen electrolysis units. Unlike scrap steel, RE and hydrogen production can scale up domestically without relying on external markets. As production expands, the production cost and prices of green hydrogen are expected to become more competitive. Moreover, both sectors have benefited from strong policy support. The recent Implementation Plan for Accelerating the Application of Clean and Low-Carbon Hydrogen in Industry encourages the development of an integrated "green electricity–green hydrogen–pure hydrogen metallurgy" value chain.[14] This initiative not only accelerates the growth of green hydrogen and RE but also strengthens the industrial linkages between hydrogen, RE, and steel. One example is HBIS Group's Zhangjuan Technology, which has begun moving in this direction by utilising Zhangjiakou's abundant renewable energy resources to construct its Yantongshan distributed

8 https://globalenergymonitor.org/wp-content/uploads/2024/03/GEM-China-steel-brief-March-2024.pdf
9 https://worldsteel.org/wp-content/uploads/World-Steel-in-Figures-2024.pdf
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11 http://www.csteelnews.com/xwzx/djbd/202502/t20250226_97452.html
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photovoltaic project. The company also plans to develop green power direct supply, green hydrogen production, and green energy storage projects this year.[15] This represents a significant step forward for HBIS toward achieving near-zero carbon hydrogen metallurgy using fully green hydrogen, while reinforcing China's confidence in scaling up and commercialising low-carbon hydrogen metallurgy.

RECOMMENDATIONS

1. **Make Electric Arc Furnaces the Core of Steel Decarbonisation**

   Both short process and H_2DRI-EAF steelmaking methods rely on electric arc furnaces. Guiding the phased retirement of BF-BOFs, or replacing their capacity with electric arc furnaces, offers a practical solution to tackle overcapacity, optimise China's steel production structure and drive carbon reduction. Although capacity replacement has been suspended for now, we expect future policies will be supportive towards electric arc furnaces. We also recommend that steel producers increase the utilisation rates of electric arc furnaces to boost production and help China meet the goal of having electric arc steel account for 15% of total steel production by the end of 2025.[16]

2. **Improve the Economic Feasibility of the Short Process**

   One of the main challenges for China's short process development is the limited availability and high cost of scrap steel. As global attention on short process steel grows, scrap steel may become a strategic resource, with prices subject to supply-demand fluctuations. To improve the economic feasibility and international competitiveness of short process steel production in China, we need to establish an efficient scrap steel recycling system, better allocate scrap resources across the country, and reduce logistics costs. We also hope that new policies will offer subsidies or incentives for short process steel and scrap steel, enabling Chinese companies to stay competitive while reducing carbon emissions.

3. **Proactively Deploy H_2DRI-EAF to Maintain China's Global Leadership in Green Steel**

   Green hydrogen and renewable energy are key strengths for China in decarbonising steel production. Given China's vast land area, effectively integrating green hydrogen and renewable energy with downstream steel enterprises is crucial. Improving hydrogen storage and transportation efficiency, enhancing renewable energy storage and grid delivery efficiency, and establishing long-term green electricity purchase agreements between renewable energy companies and steel companies will strengthen their connection to the steel industry, maximising carbon reduction benefits, supporting steel makers gradually develop diverse innovative low-carbon development models such as "RE + energy storage + green hydrogen". At the same time, we recommend supporting regions and steel enterprises with suitable conditions to develop green electricity self-production and green hydrogen

15 https://heb.chinadaily.com.cn/a/202503/05/WS67c7e803a310510f19ee9d85.html
16 https://www.ndrc.gov.cn/xwdt/tzgg/202406/P020240607590381066762.pdf

projects. This will create demonstration sites for integrated "green electricity—green hydrogen—pure hydrogen metallurgy" supply chains while advancing regional low-carbon development.

Secure a stable supply of high-grade iron ore and accelerate low-grade ore utilisation. Producing hydrogen-reduced iron requires high-grade iron ore (approximately 67% iron content), but China's domestic supply of such ore is limited, and it relies heavily on imports. In light of current geopolitical uncertainties and supply chain risks, China must ensure a stable iron ore supply and diversify its import sources. Additionally, investments in technologies for utilising low-grade ores will reduce dependence on imports, improve resource efficiency, and enhance production autonomy.

Introduce incentive policies and subsidies. Steel companies' low-carbon transformation requires substantial upfront investments in research, development, and equipment, along with stable cash flow to cover operational costs. With a green premium of around 40% for H_2DRI-EAF, reducing green hydrogen production costs is essential. However, subsidies for hydrogen prices, tax breaks, low-interest loans, or special funding can help alleviate the short-term economic pressure on low-carbon steel production. These measures will accelerate China's transition to green steel and foster the development and maturity of H_2DRI-EAF technologies.

In summary, both the short process and H_2DRI-EAF low-carbon steelmaking methods can achieve significant decarbonisation. China has provided various levels of incentives and guidance for the four key elements supporting these processes—electric arc furnaces, scrap steel, green hydrogen, and renewable energy. Considering the current policy and market environment in China, EAFs are set to become the mainstream method for steel decarbonisation in the future. Meanwhile, green hydrogen and renewable energy stand out in terms of resource availability and policy support, making H_2DRI-EAF a safer and potentially more cost-effective green steel production solution in the long run compared to the short process. This positions China to take the lead in the global green steel race.

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