Green Steel Economics

China Factsheet

Introduction

The global steel industry accounted for over 7% of global greenhouse gas (GHG) emissions and over 11% of global CO_2 emissions. China accounts for more than half of global steel production. The Hydrogen Direct Reduced Iron (H_2-DRI) process utilizing green hydrogen made with renewable/no-carbon electricity promises significant emission reductions and a transition to greener steel production in the sector. The adoption of green H_2-DRI-EAF steelmaking involves financial considerations varying by country, influenced by hydrogen costs and carbon pricing mechanisms. This study assesses the costs of green H_2-DRI-EAF steelmaking compared to traditional Blast Furnace-Basic Oxygen Furnace (BF-BOF) and Natural Gas Direct Reduced Iron-Electric Arc Furnace (NG-DRI-EAF) routes across seven major steel-producing countries, including China.

Green Steel Premium: Impact of H_2 Prices and Carbon Prices in China

At zero carbon pricing, green H_2-DRI-EAF steelmaking in China is costlier than both BF-BOF and NG-DRI-EAF methods, requiring a H_2 price of about \$2/kg to match the costs of NG-DRI-EAF and around \$1.4/kg to reach cost-parity with BF-BOF. However, when a carbon price of \$15 per ton of CO_2 is introduced, the cost-parity point changes. At this carbon price, producing steel via green H_2-DRI-EAF at \$1.0/kg H_2 costs \$491 per ton, undercutting the BF-BOF method's \$539 per ton, illustrating a substantial economic incentive for adopting greener steel production methods. This cost benefit becomes more pronounced at a carbon price of \$30 per ton, where the LCOS for green H_2-DRI-EAF matches the BF-BOF cost at a H_2 price of \$2.2/kg. As the carbon price increases to \$50 per ton, green H_2-DRI-EAF becomes even more competitive, aligning its costs with the BF-BOF process at H_2 prices over \$2.8/kg.

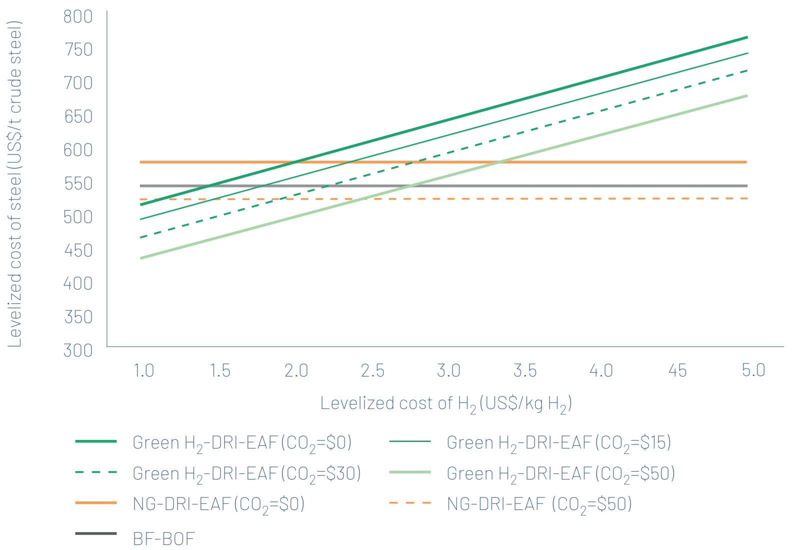
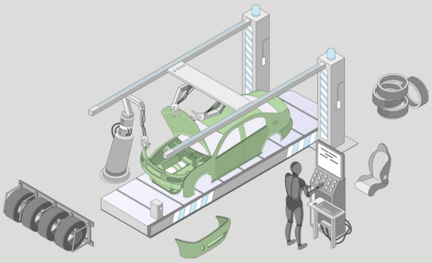


Figure 1. Levelized Cost of Steel (\$/t crude steel) with varied levelized costs of H_2 at different carbon prices in China (Source: this study)

This analysis underscores the significant role of carbon pricing in enhancing the financial viability of green steel technologies by rewarding lower carbon intensity, thereby supporting adoption of green H_2-DRI-EAF steelmaking. The potential income from selling carbon credits generated by a given green H_2-DRI-EAF plant could help mitigate the initially higher costs linked to green H_2 production. This financial relief can facilitate quicker adoption of this technology.

<1%

price increase on an average price of passenger car in China

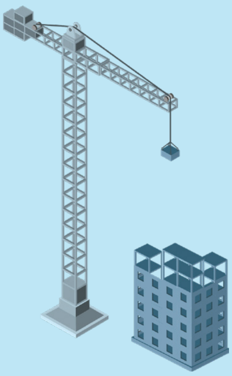


Impact of Green Steel Premium on Car Prices

The automotive industry accounts for 12% of global steel demand. The additional cost attributed to using green H_2-DRI-EAF steel in passenger vehicles—known as the green premium—is aligned with studies that estimated automotive sector as a likely first mover for green steel procurement and demonstrates minimal impact on overall vehicle pricing. For example, in China, when the price of H_2 is at $5/kg, the green premium for steel produced via green H_2-DRI-EAF, compared to the traditional BF-BOF methods, stands at approximately $225 per ton steel. Assuming on average 0.9 ton of steel used in a passenger car, this translates to an additional cost of about $203 per passenger car, which represents a less than 1% price increase on an average price of passenger car in China ($22,000), maintaining affordability and market stability. Future projections suggest that with H_2 costs potentially reducing to $1.4/kg, the green premium could effectively disappear, making green H_2-DRI-EAF steel economically comparable to conventionally produced steel. With the introduction of carbon price/credit, the green premium for H_2-DRI-EAF steel can substantially drop even further.

Impact of Green Steel Premium on Building Construction Cost

The construction industry (building and infrastructure) accounts for 52% of global steel demand. In the context of building construction in China, the economic effect of adopting green steel produced by H_2-DRI-EAF route can be considered minimal when compared to conventional BF-BOF steelmaking route. Using the green H_2-DRI-EAF route, the additional cost of steel at a H_2 price of $5/kg is approximately $225 per ton of steel, translating into an added expense of about $563 for a 50 m^2 residential building unit (assuming 50 kg steel per m^2 used for low to mid-rise residential building). This represents a small fraction of the total cost of a residential building. In addition, with future reductions in H_2 cost or the introduction of carbon pricing, the green premium could diminish or even disappear, making green H_2-DRI-EAF an economically viable alternative for building construction in China.



small added expense of about

$563

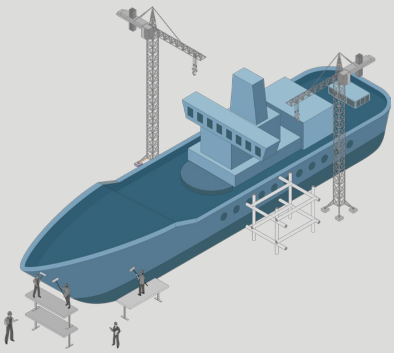
for a

50 m^2

residential building unit

<10%

increase in the ship's price for China



Impact of Green Steel Premium on Shipbuilding Cost

The top three shipbuilding nations, China, South Korea, and Japan, account for over 90% of global shipbuilding. Incorporating green H_2-DRI-EAF steel into shipbuilding shows a small cost increase for ship building. While there are many types of ships in the global market. This study focused on a bulk carrier ships which are built in large numbers every year around the world. For example, to build an average 40,000 DWT (Deadweight tonnage) bulk ship, approximately 13,200 tons of steel are needed. If green H_2-DRI-EAF at $5/kg H_2 is used in China to build this ship, the additional cost would be about US$ 3 million per ship in China. Considering the average cost of a new 40,000 DWT bulk ship is over $30 million, this represents less than 10% increase in the ship's price for China.

The reason for this relatively higher green steel premium as a share of total cost for shipbuilding compared to cars and buildings is higher share of steel cost in the shipbuilding cost. Over 95% of a ship consists of steel. Anticipated reductions in H_2 costs in the future could nullify this green premium, aligning the costs of green H_2-DRI-EAF steel with those of traditional BF-BOF steelmaking. Moreover, the introduction of carbon pricing could further reduce the green premium costs, enhancing the financial attractiveness of adopting green H_2-DRI-EAF steel in the maritime sector.

Our Recommendations

Financing the transition to H_2-DRI steelmaking requires both public and private investments to mitigate financial risks. Our recommendations for stakeholders include:

Government:

- Enact tax rebates and other incentives for green H_2 production to make it more economically viable.
- Invest in R&D and infrastructure to drive down the costs of green H_2 production, transportation and storage.
- Implement public procurement policies that prioritize green steel in publicly funded projects to boost market demand.
- Include the steel sector in the carbon trade market and utilize the carbon pricing mechanism to drive its transition to low-carbon practices.

Steel Companies:

- Transition from traditional BF-BOF routes to green H_2-DRI by forming partnerships for a reliable hydrogen supply.
- Engage in industrial-scale pilot projects to demonstrate the feasibility and benefits of green H_2-DRI.
- Secure market demand through long-term supply agreements with major end-use sectors and share the costs of the green premium.

Automotive and Construction Companies:

- Integrate green steel into procurement strategies to stimulate demand and help cover the green premium.
- Enhance market positioning by promoting the climate, environmental, and health benefits of green steel.
- Cater to climate-conscious clients by engaging in green private procurement practices.

Shipbuilding and Shipping Companies:

- Utilize both public and private procurement strategies to boost the adoption of green steel in the industry.
- Establish robust supply chains with green H_2-DRI steel manufacturers to ensure a steady demand for green steel.
- Promote broader industry adoption through government policies and commercial agreements to reduce the green premium.

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Contacts

Ali Hasanbeigi	hasanbeigi@globalefficiencyintel.com
Alastair Jackson	alastair@transitionasia.org
Daseul Kim	daseul.kim@forourclimate.org