Transition Asia
Global Efficiency Intelligence
SFOC Solutions for Our Climate

Green Steel Economics

Japan Factsheet

Introduction

The global steel industry accounted for over 7% of global greenhouse gas (GHG) emissions and over 11% of global CO_2 emissions. Japan ranks as the third-largest steel producer in the world, contributing significantly to global steel output. 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.

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

In Japan, without carbon pricing, green H_2-DRI-EAF steelmaking initially shows a higher cost than both the BF-BOF and NG-DRI-EAF methods. To match the cost of NG-DRI-EAF, the H_2 price must be around \$2/kg, and to achieve cost parity with BF-BOF, it drops to roughly \$1.3/kg. Introducing a carbon price of \$15 per ton of CO_2 shifts these dynamics. At this carbon price, producing steel with H_2 at \$1.7/kg in the green H_2-DRI-EAF process has the same LCOS as the BF-BOF. The green steel economics improves with a carbon price of \$30 per ton, aligning the costs of green H_2-DRI-EAF with BF-BOF at a H_2 price of \$2.0/kg. As the carbon price increases to \$50 per ton, the cost competitiveness of green H_2-DRI-EAF further improves, matching BF-BOF costs at even higher H_2 prices.

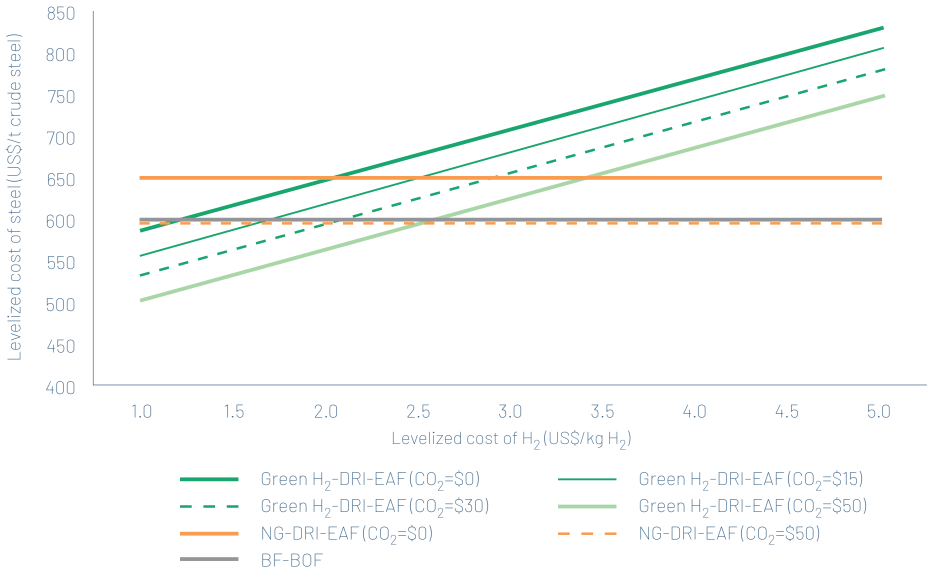


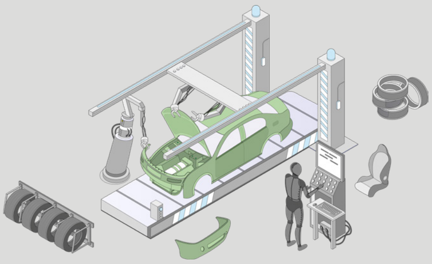
Figure 1. Levelized Cost of Steel (\$/t crude steel) with varied levelized costs of H_2 at different carbon prices in Japan (Source: this study)

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.

In Japan, an Emissions Trading System has not yet been implemented as a solid policy, and the amount of carbon credits that steelmakers are utilizing is still relatively small. However, a tax credit scheme was adopted in the national Diet earlier this spring. Steelmakers can now benefit from the tax deductions of up to JPY 20,000 (US\$128) per tonne of low-carbon steel, effectively providing a subsidy for operating expenses that the steelmakers have long advocated for.

<1%

price increase on an average price of passenger car in Japan

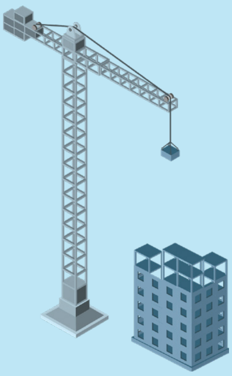


Impact of Green Steel Premium on Car Prices

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 the automotive sector as a likely first mover for green steel procurement and demonstrates minimal impact on overall vehicle pricing. For example, in Japan, 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 $231 per ton steel. Assuming on average 0.9 ton of steel used in a passenger car, this translates to an additional cost of about $208 per passenger car, which represents a less than 1% price increase on the average price of a passenger car in Japan ($22,000), maintaining affordability and market stability. Future projections suggest that with H_2 costs potentially reducing to $1.3/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 Japan, 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 $231 per ton of steel, translating into an added expense of about $578 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 Japan.



small added expense of about

$578

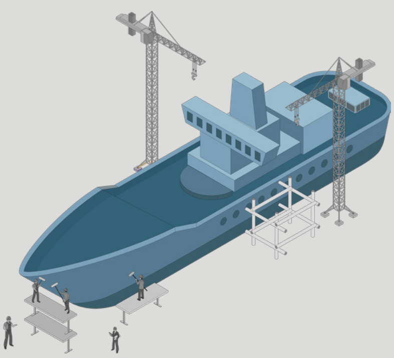
for a

50 m^2

residential building unit

<10%

increase in the ship's price for Japan



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 $5/kg H_2 is used in Japan to build this ship, the additional cost would be about US$ 3 million per ship in Japan. 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 Japan.

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 hydrogen production.
- Implement public procurement policies that prioritize green steel in publicly funded projects to boost market demand.

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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