TransitionAsia
ACCELERATING EAST ASIAN CORPORATE CLIMATE ACTION

NIPPON STEEL - DECARBONISATION CASE STUDIES

Two examples of H_2-DRI-EAF on the new Steel map

February 2023

INTRODUCTION

Decarbonising Japanese steel involves navigating key challenges such as remaining competitive with China, securing financing for the transition, and developing strategies which account for Japan's geographic lack of essential natural resources.

Transition Asia is working with technical experts to produce modelling and analysis that highlights these challenges and helps **generate investor and government support** in solving them.

We have modelled **Nippon Steel's options for H_2-DRI-EAF (in India) AND H_2-DRI-HBI-EAF (shipping HBI from India to Japan)** and believe the joint venture with ArcelorMittal is a significant opportunity as the basis of a strategy that can compete with China.

We believe **Nippon Steel and its investors are right to be concerned about CAPEX** and **would like do further analysis to support this lobbying**. Preliminary analysis suggests lobbying for subsidies of $17.3bn should be nearer to $33.4bn.

CASE STUDY ANALYSIS

- Transition Asia is a purpose-built organisation working with global experts to produce investor-focused steel technology transition analysis on Chinese and Japanese steel companies.
- Along with **Transition Zero**[1] and **The University of Oxford**[2] we have developed a DRI-EAF production model configured for discussion with and based on Nippon Steel's outlook and possible strategy.
- The model is a work in progress that will be open source.
- To ensure Nippon Steel's perspectives are considered, we would welcome early discussion on design and set up, and to exchange perspectives on addressing the key challenges companies face in the technology transition.
- It is follow up analysis to our insight on Japan and a new steel map[3].

1 https://www.transitionzero.org/
2 https://eng.ox.ac.uk/people/alli-devlin/
3 https://transitionasia.org/research/

H_2-DRI-EAF WITH ORIGINATION IN INDIA

Far from being an existential threat, this is **an opportunity for Nippon Steel**. One which is beginning to be seen in their business and corporate strategy. Our previous analysis shows India is **competitive with China** on H_2-DRI-EAF and would be for AM/NS.

The declining demand for steel in Japan as an economy that is post-maturity and flatlining on many metrics (like population and total emissions) has led Nippon Steel to seek a "Tectonic Shift to Secure Non-consolidated Operating Profit". It has successfully engaged in joint ventures and acquisitions of overseas businesses to create a broader operational footprint. The analysis validates this strategy to look elsewhere for business opportunities and new technology.

Large scale renewable electricity for islanded energy systems is more credible and much cheaper in India than Japan at present. Even in Japan, a commitment to "green steel" from Nippon Steel's current EAF plant in 2023 and investment in **a new "large scale [hybrid] EAF" by 2030** capable of processing DRI could actually be **consistent with overseas expansion**.

Transportation is important and we are modelling this here. Whereas BF-BOF processes have led to highly integrated steel mills, DRI could be compacted at high temperatures into Hot Briquetted Iron (HBI) and stored and transported at the same kind of marginal costs as iron ore. This raises the tantalising strategic prospect that Nippon Steel could separate HBI production from EAF steelmaking and expand the latter for a green steel market in Japan e.g. **HBI processing and shipping from Hazira to Japan**.

CASE STUDIES

In this context, we are currently modelling Nippon Steel's options for H_2-DRI-EAF (in India) AND H_2-DRI-HBI-EAF (shipping HBI from India to Japan). The latter keeps islanded energy systems married to H2-DRI in India, and energy intense hydrogen electrolysis in particular, but transports HBI to EAF facilities in Japan.

Case Study 1	Case Study 2
H_2-DRI in India • Electrolyser CAPEX • Hydrogen electricity costs • Iron ore cost	**H_2-DRI in India** • Electrolyser CAPEX • Hydrogen electricity costs • Iron ore cost
DRI input hot into an integrated EAF • EAF CAPEX • Scrap costs • DRI costs	**HBI processing and shipping**
Islanded and renewable electricity	**HBI input cold into an EAF in Japan** • EAF CAPEX • Scrap costs • DRI/HBI costs • Renewable electricity input from PPA

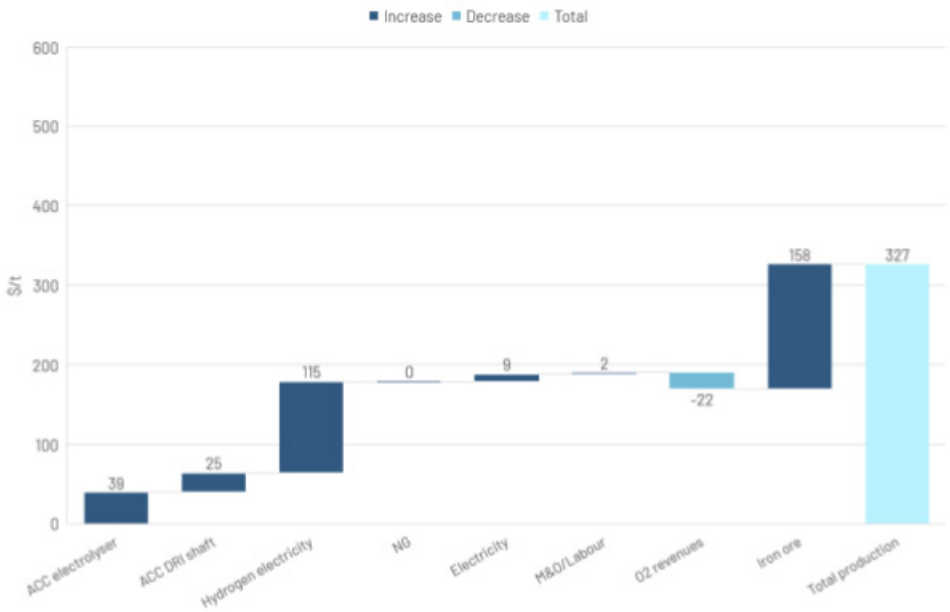
OVERVIEW

	Case Study 1	Case Study 2
H_2 DRI Assumptions	India	India/Japan
H_2 DRI Charts	$/t No process emissions*	Identical to Case Study 1*
EAF Assumptions	India, integrated	Japan, includes HBI processing and shipping from Hazira to Nagoya
EAF Charts	$/t Total process emissions	$/t Total process emissions

**No slides included in the following sections*

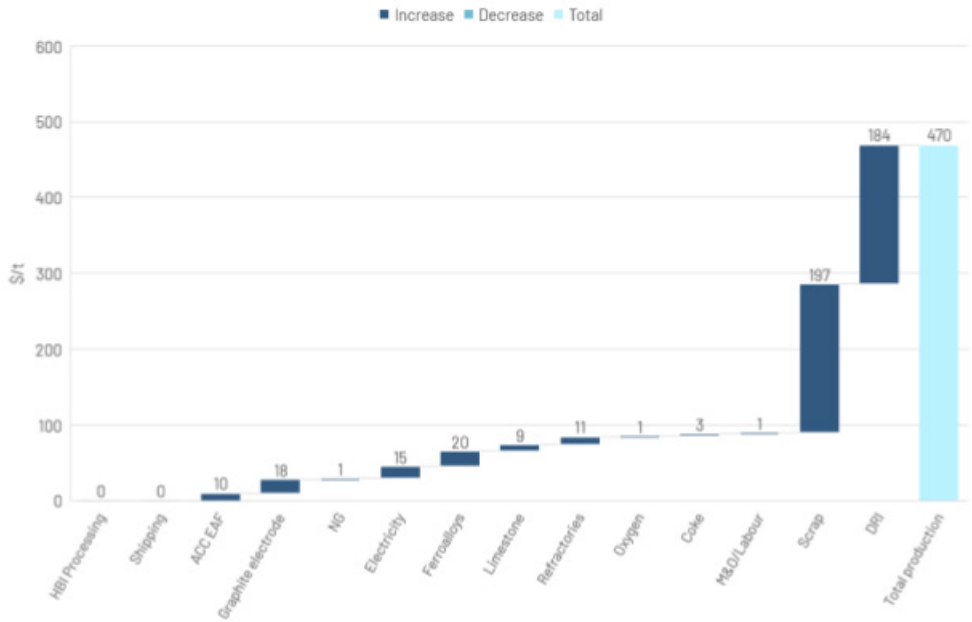
CASE STUDY 1 - INDIA, DRI $/T

Figure 1 - A waterfall of costs per tonne of DRI , India



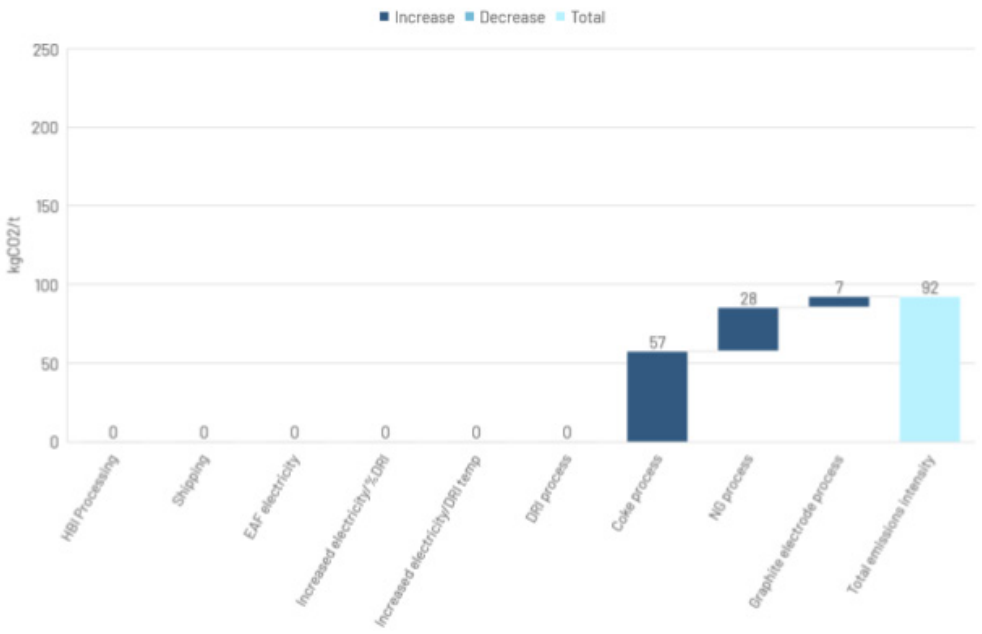
CASE STUDY 2 - INDIA, EAF $/T

Figure 2 - A waterfall of costs per tonne of EAF production, India



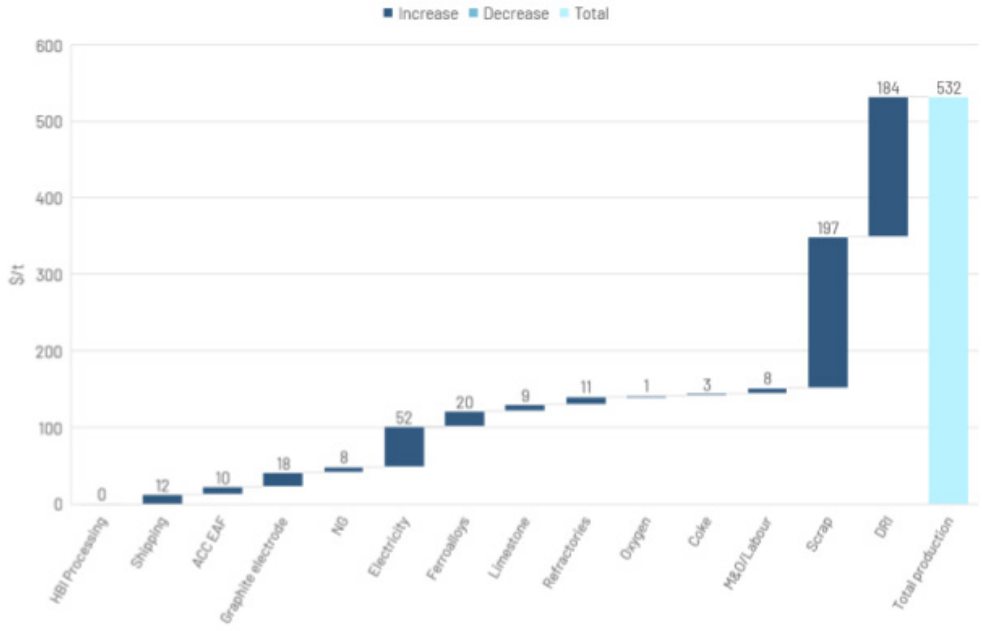
CASE STUDY 1 - INDIA, TOTAL EMISSIONS

Figure 3 - A waterfall of emissions per tonne of DRI , India



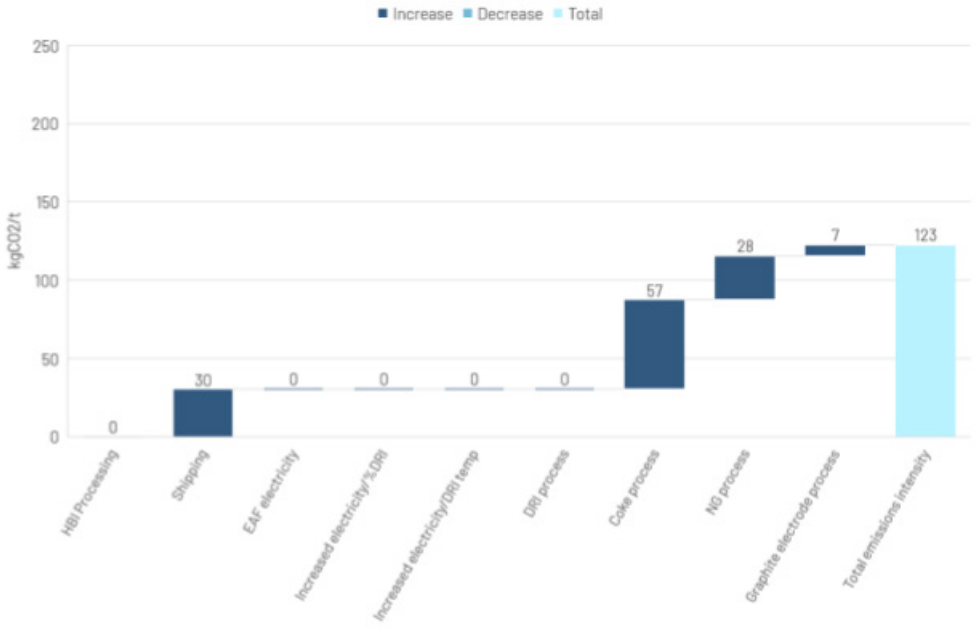
CASE STUDY 2 - INDIA/JAPAN, EAF $/T

Figure 4 - A waterfall of costs per tonne of EAF production, Japan (DRI produced in India)



CASE STUDY 2 - INDIA/JAPAN, TOTAL EMISSIONS

Figure 5 - A waterfall of emissions per tonne of EAF production, Japan (DRI produced in India)



SENSITIVITY ANALYSIS

Case Study 1

Electrolyser CAPEX (USD/W)

	0.5	0.7	0.9
DRI $/t	316	327	339

Electricity cost (USD/MWh)

	20	30	40
DRI $/t	286	327	369

Iron Ore (USD/t)

	80	100	120
DRI $/t	296	327	359

DRI (USD/t)

	310	327	350
EAF $/t	460	470	483

Scrap (USD/t)

	300	350	400
EAF $/t	442	470	498

Identical

Identical

Identical

Case Study 2

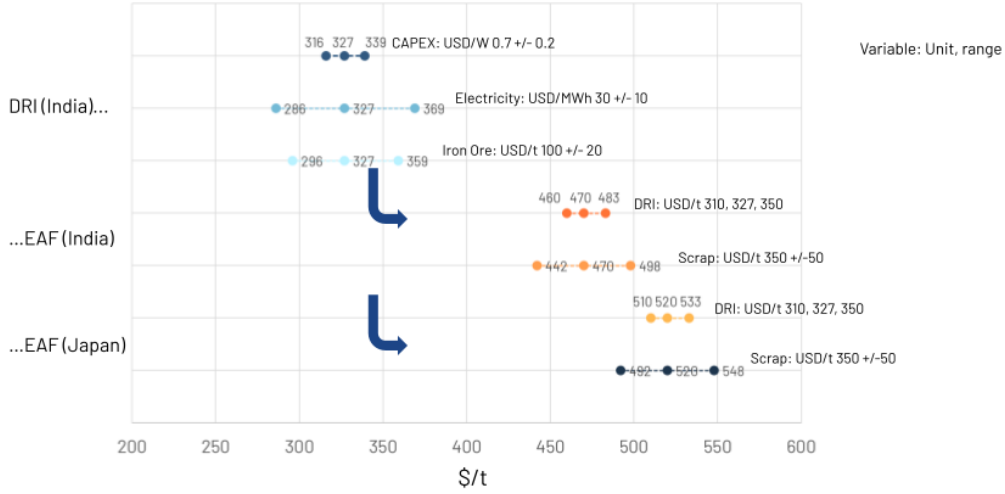
DRI (USD/t)

	310	327	350
EAF $/t	510	520	533

Scrap (USD/t)

	300	350	400
EAF $/t	492	520	548

Figure 6 - A sensitivity analysis of costs per tonne of steel by location for DRI and EAF



SENSITIVITY ANALYSIS, JAPAN EAFS

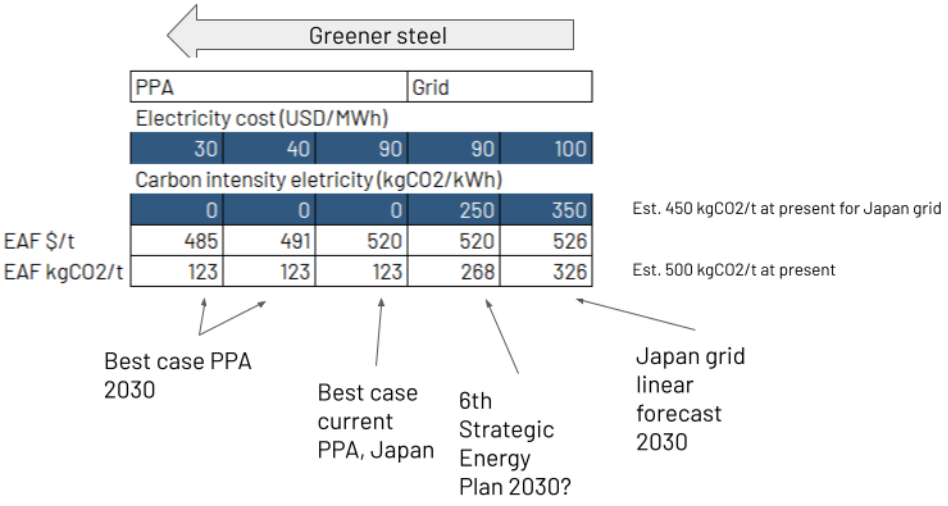


Figure 7 - A sensitivity analysis of costs per tonne of steel against carbon intensity and price of electricity, by location, for DRI and EAF

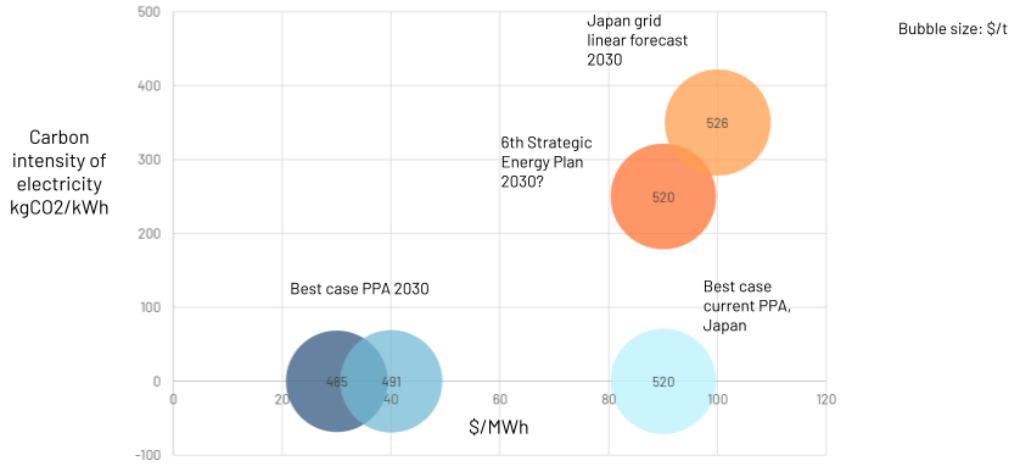
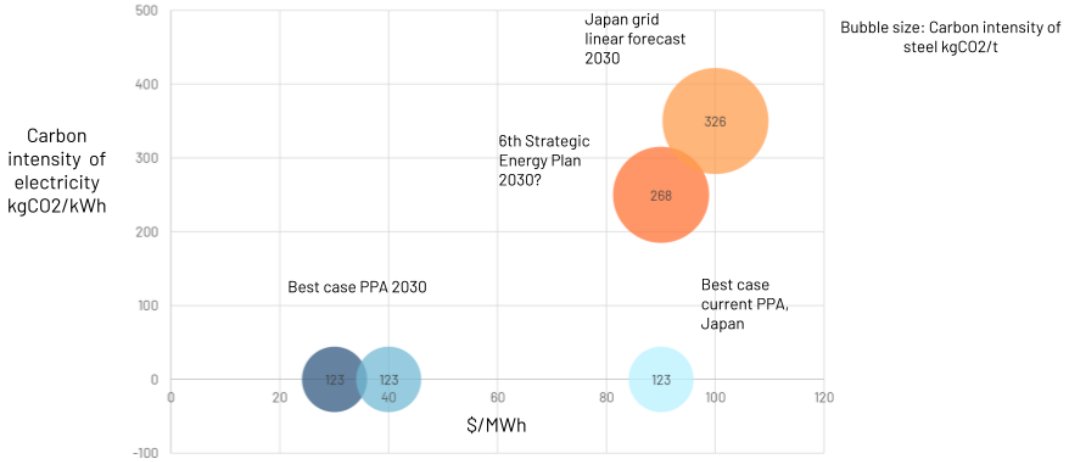


Figure 8 - A sensitivity analysis of emissions per tonne of steel against carbon intensity and price of electricity, by location, for DRI and EAF



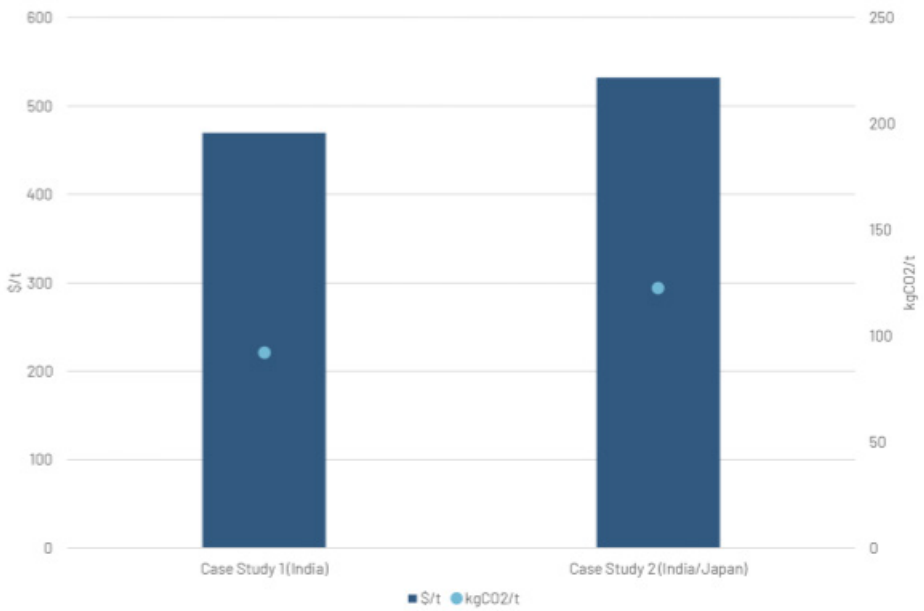
CAPEX

- CAPEX for electrolysers, DRI shafts and EAFs in both case studies falls out of this analysis
- The CAPEX for electrolysers is particularly significant
  - ◊ We have assumed that CAPEX for hydrogen production is in house and CAPEX for renewable electricity generation is external similar to Arcelor Mittal in Gijon or Voestalpine in Linz
- Scaling CAPEX to 40m tonnes of steel production annum on a greenfield basis would be of the order of **$33.4bn**
- While this would be all new technology at current prices this is significantly above the **$17.3bn**[4] call for subsidies from Nippon Steel
- We will undertake further analysis based on industry feedback

4 https://www.bloomberg.com/news/articles/2022-02-16/nippon-steel-s-net-zero-bid-hinges-on-17-billion-of-state-funds

SUMMARY COMPARISON

Figure 9 - Comparison of price of a tonne of steel and carbon intensity of Case Study 1 & 2



SUMMARY COMPARISON

Case Study 3?

- H_2-DRI in India
  - ◊ Electrolyser CAPEX
  - ◊ Hydrogen electricity costs
  - ◊ Iron ore cost
- HBI processing and shipping
- HBI input cold into an EAF in Thailand
  - ◊ EAF CAPEX
  - ◊ Scrap costs
  - ◊ DRI/HBI costs
  - ◊ Renewable electricity input from PPA

OUR TEAM

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ABOUT TRANSITION ASIA

Founded in 2021, Transition Asia is a Hong Kong-based non-profit think tank that focuses on driving 1.5°C-aligned corporate climate action in East Asia through in-depth sectoral and policy analysis, investor insights, and strategic engagement. Transition Asia works with corporate, finance, and policy stakeholders across the globe to achieve transformative change for a net-zero, resilient future. Visit transitionasia.org or follow us @transitionasia to learn more.