Technoeconomic assessment of Western Australia's onshore green steel production

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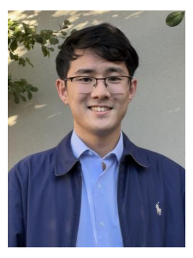



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Introduction

An avenue for decarbonisation to meet climate goals includes utilising H_2 as a sustainable chemical feedstock and storage vector within the steel industry. This study compares various case studies based on levelised cost, emissions intensity and Carbon Abatement Cost (CAC), to investigate the production of green steel and various intermediary products in Australia (Pilbara) versus hydrogen and iron ore export for steel production in China (Beijing).

Methods & Results

This scoping study is based on a Class 5 estimate, with an acceptable error range [-50, 100%][1]. The analysis incorporates 1.4 mtpa production capacity of Hot Rolled Coil (HRC) Steel and includes material shipment. Electrical energy in Australia is sourced from a hybrid renewable system of 50/50 solar and wind energy with 12 hours of battery storage, while grid electricity is utilised in China. The case studies are described below alongside **Figure 1.**

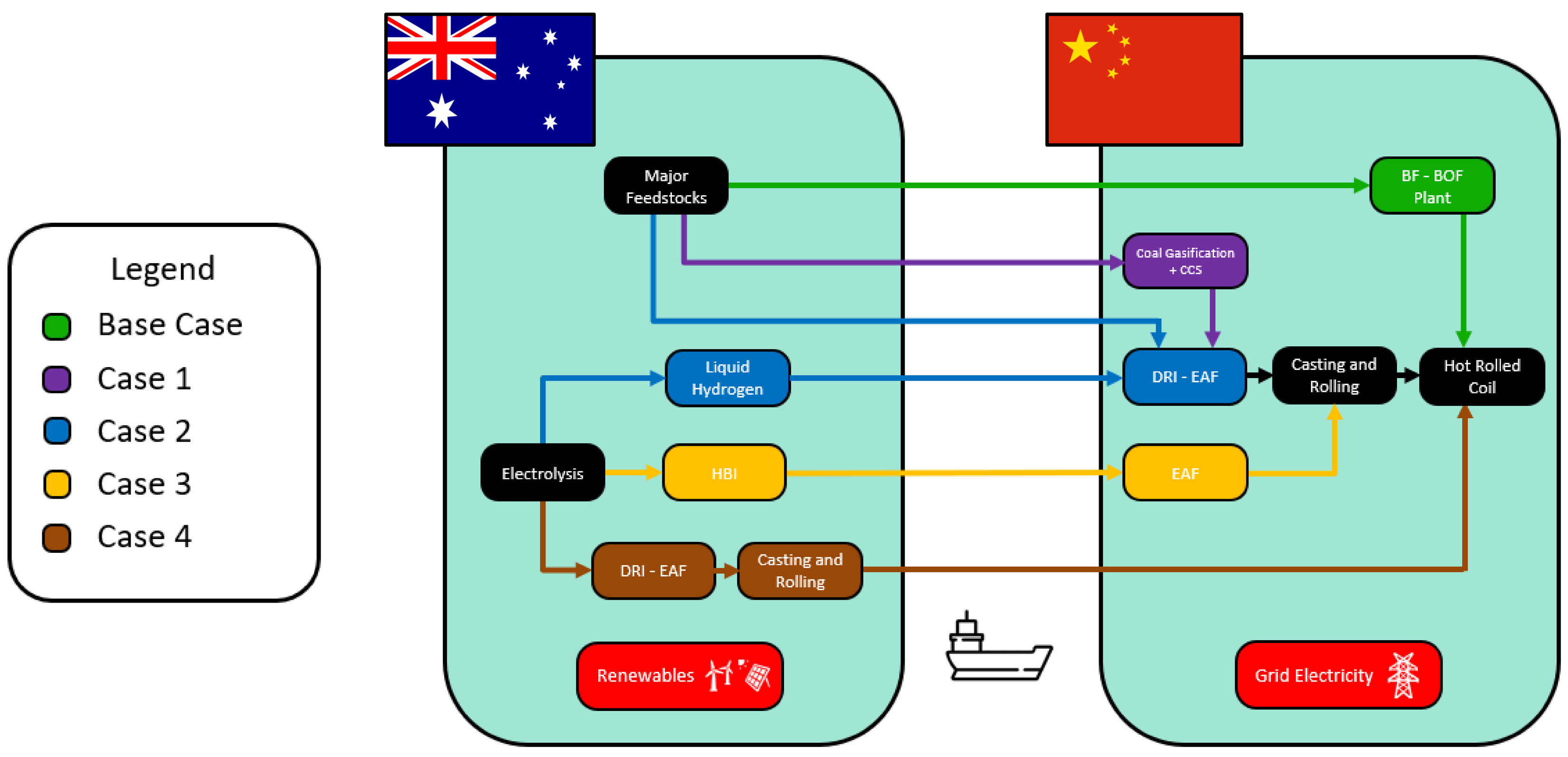

Figure 1 Flow Diagram of the five case studies examined.

- **Base Case:** The conventional Blast Furnace - Basic Oxygen Furnace (BF-BOF) steel production in China.
- **Case 1:** Production of 'blue steel' via blue hydrogen from coal gasification with CCS in China. The hydrogen is utilised in the Direct Reduced Iron - Electric Arc Furnace (DRI-EAF) pathway with sequential casting and rolling.
- **Case 2:** LH_2 is produced, stored and transported to China for green steel production offshore.
- **Case 3:** Hot Briquetted Iron (HBI) is produced onshore and shipped to China for further processing into Steel.
- **Case 4:** Producing green steel onshore in Australia and exporting it to China.

The means of heating hydrogen (Electric or Natural Gas) has minimal influence on results as shown in **Figure 2** and **Figure 3.** Furthermore, 'blue steel' is comparable to conventional steel production.

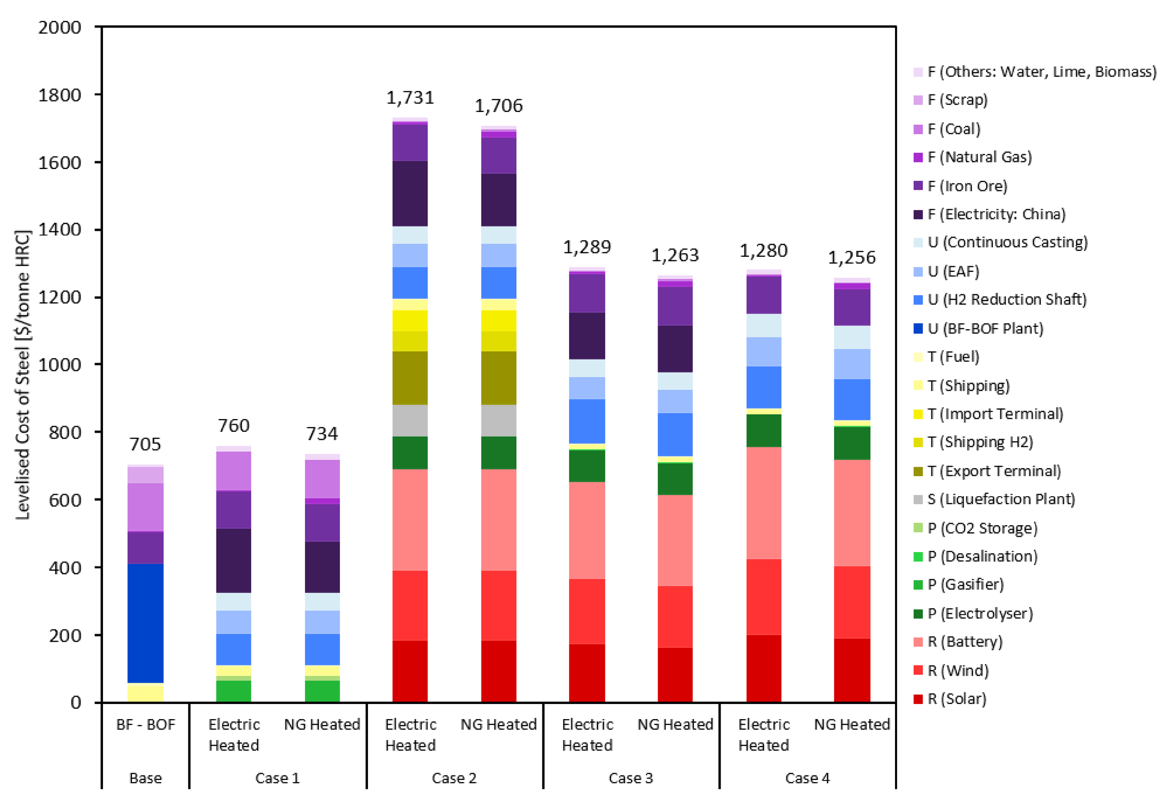

Figure 2 Levelised Cost breakdown for the cases considered.

Exporting hydrogen as a feedstock vector for green steel production offshore is limited by distribution costs, while exporting HBI as an intermediate product is comparable to onshoring green steel in Western Australia.

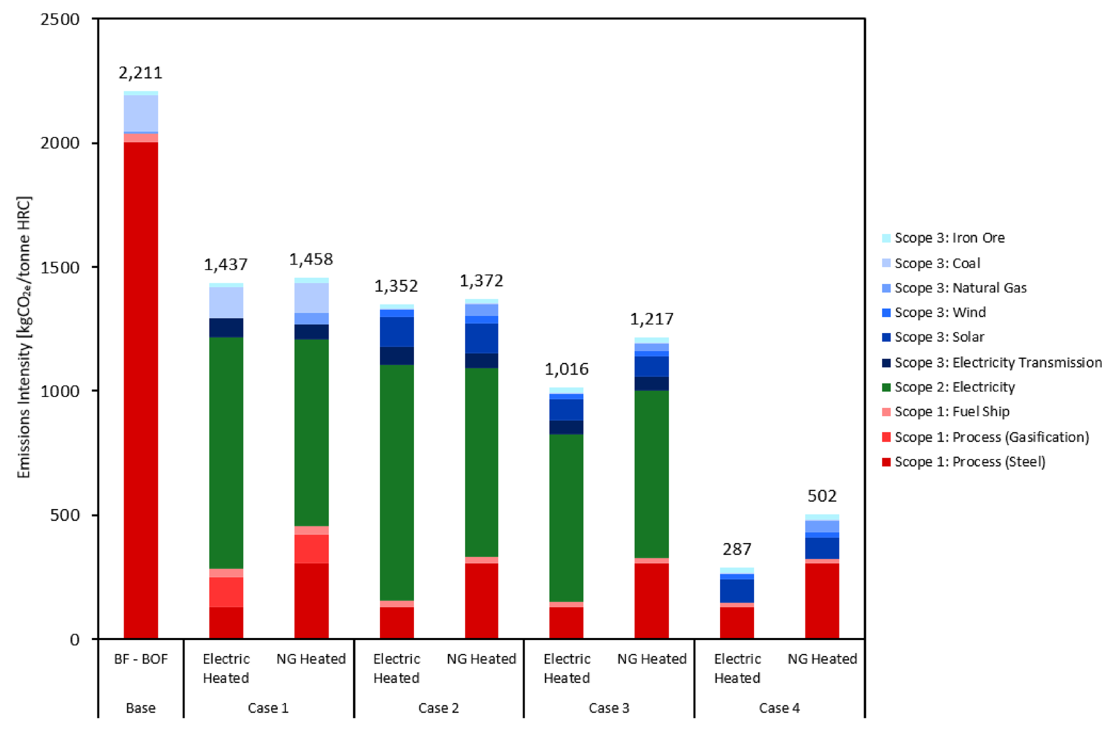

Figure 3 Emissions Intensity breakdown for the cases considered.

The CAC for 'blue steel' is comparable to recent Australian Carbon Credit Unit prices[2] between \$15 - 42/tonne CO_{2e} suggesting that such a scheme would be particularly effective in enabling such technology adoption as presented in **Figure 4.**

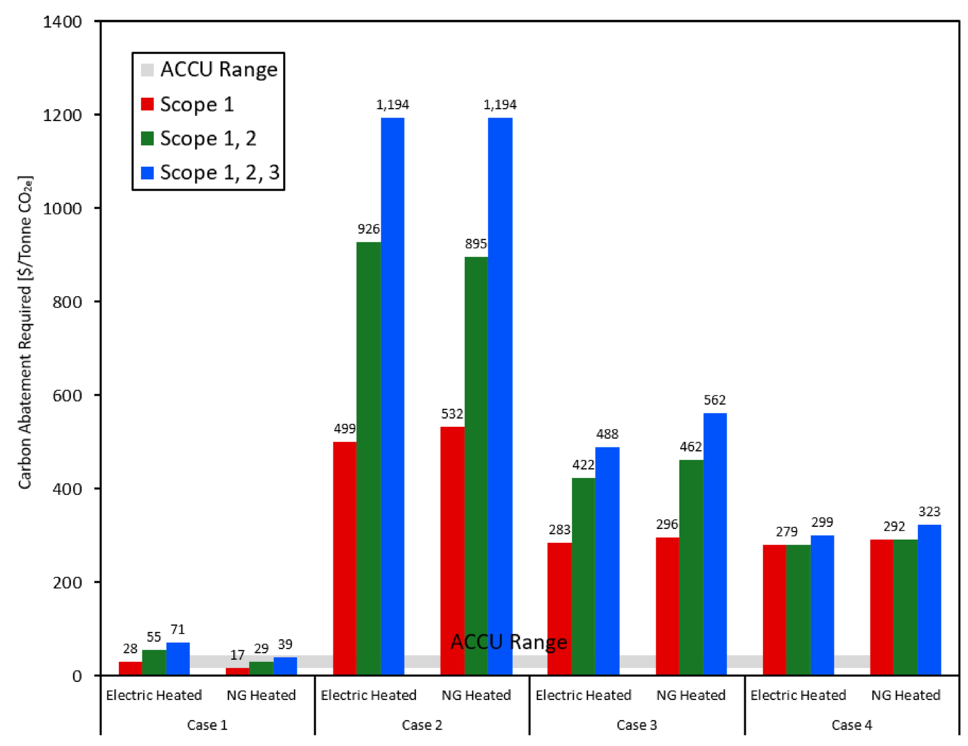

Figure 4 Carbon Abatement Cost relative to the base case.

Future predictions on location factors (through labour wage), decreasing CAPEX costs and rising ACCU prices indicates that green steel can become competitive in 2050 with appropriate subsidies as presented in **Figure 5.**

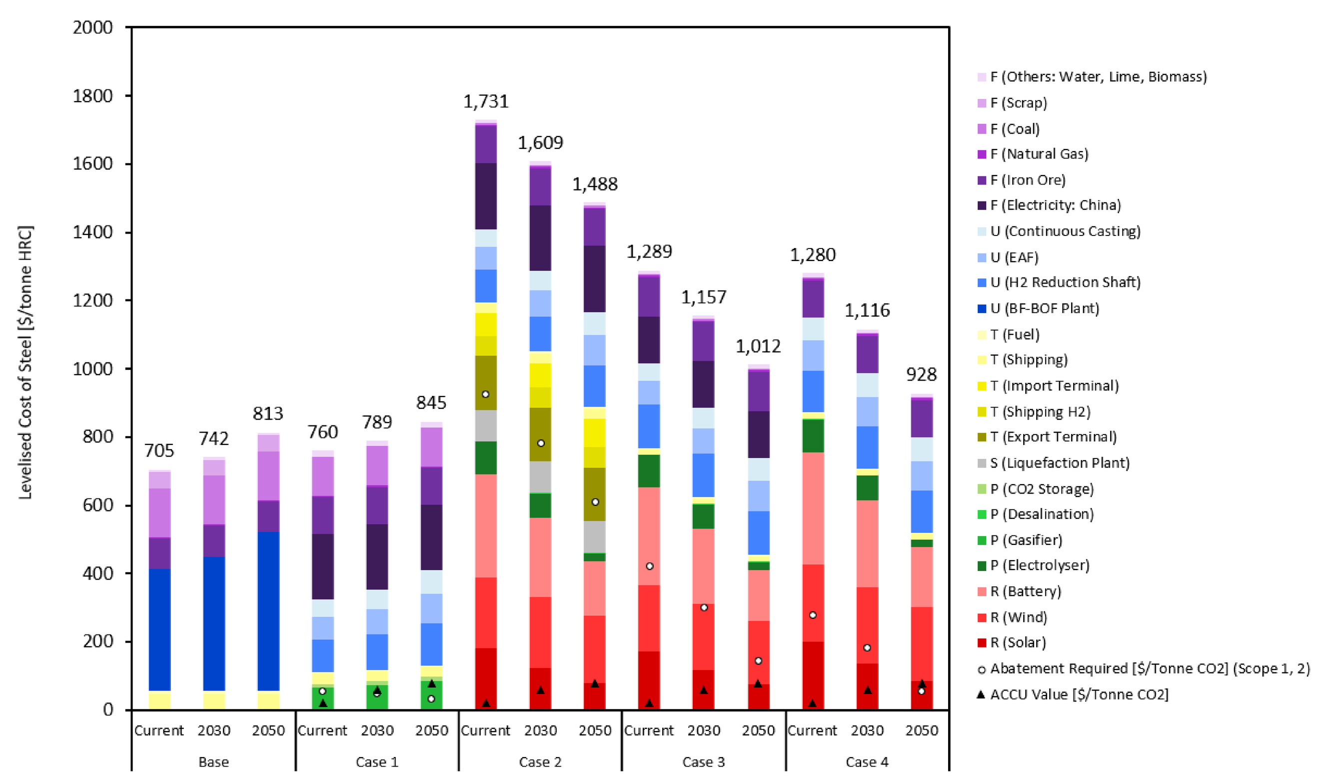

Figure 5 Future cost prediction of all cases for electric hydrogen heating.

Conclusion

The successful implementation of green steel is further affected by social and political factors including; attainment of a skilled workforce and maintaining supportive international relations. Future works should consider alternative storage methods and its optimal combination for diurnal and long-term storage (salt caverns) to reduce costs. This study indicates blue steel as a potential transition pathway while cost reductions occur for green steel in the future.

References

1. P. Christensen and L. Dysert (2005) AACE International Recommended Practice No. 18R-97, Cost estimate classification system – as applied in engineering, procurement, and construction for the process industries
2. Clean Energy Regulator. Australian carbon credit units (ACCUs) 2023.