HYDROGEN IRONMAKING

Experimental study on hybrid hydrogen direct and plasma reduction of iron ore

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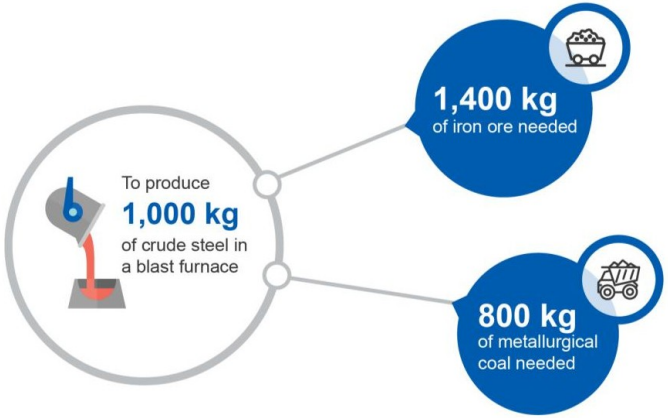
ANU New Research Showcase: Climate, Energy & Disasters, 8 Mar 2023

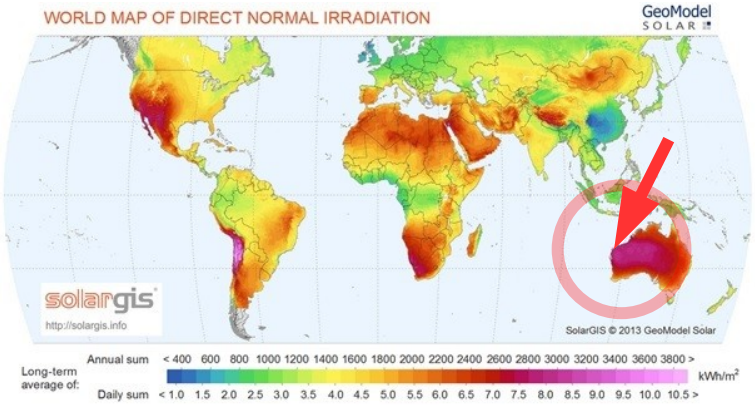
Australian National University

Introduction

Iron and Steel makes up **~7–9%** of the global GHG emissions.



Australia is the world #1 exporter of **iron ore** and **metallurgical coal**, together worth $100B/y to our economy.



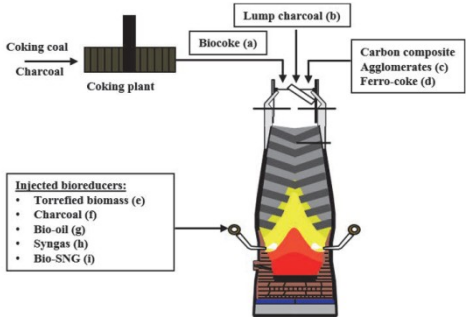
Our mining takes place in one of the sunniest regions in the world.

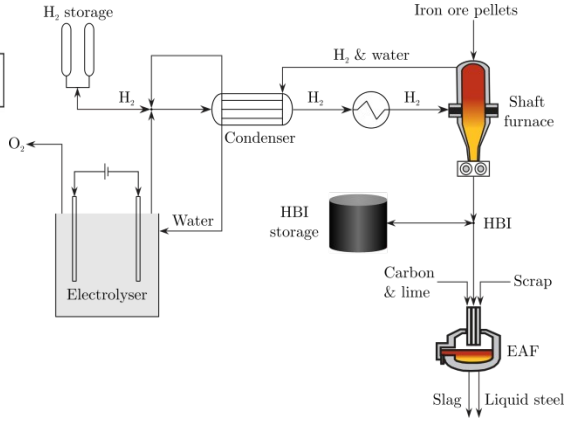
No technology exists which produces steel commercially without heavy use of fossil fuels. Existing industry already extremely optimised.

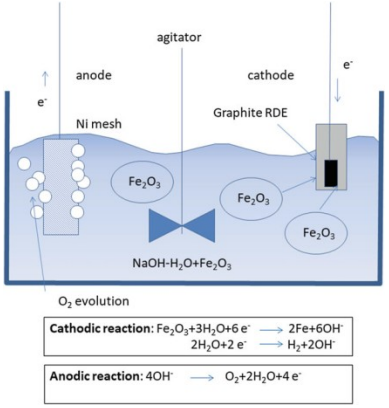
Can Australia **develop**, and then **benefit from**, new zero-carbon technologies to process iron ore using renewables?

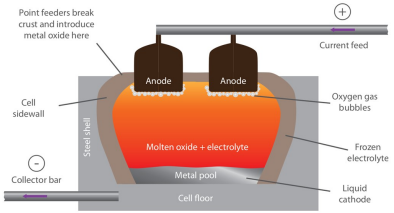
Zero-carbon steelmaking: technical challenges

Biomass-based steelmaking	Hydrogen-based steelmaking	Electrowinning	Pyroelectrolysis







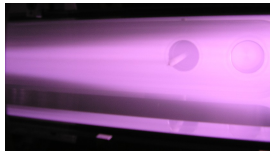


Land-use change	High-quality fines	Low-energy efficiency	High-temp. electrolytic
High alkali content	Sticking phenomenon	Low-productivity rate	Corrosivity of electrolytes
Biomass availability	Gangue removal	Reduction mechanism	Ohmic losses

Integration of renewable energy supply at large-scale

Hydrogen direct and plasma reduction of iron ore

MAGPIE



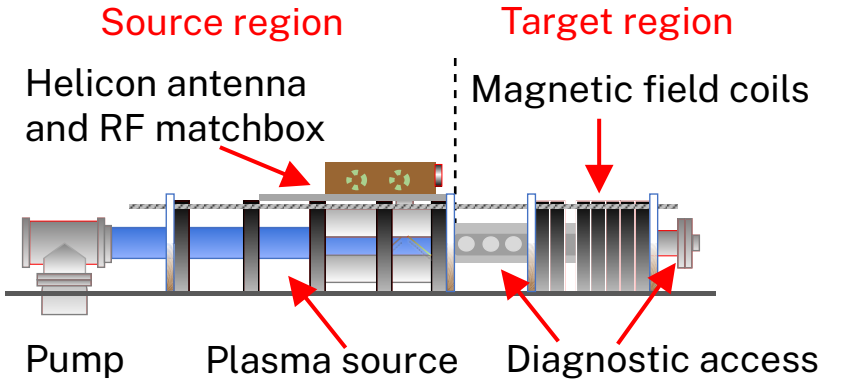
Needs and motivation: Concerns with hydrogen direction reduction (HDR) pathway:

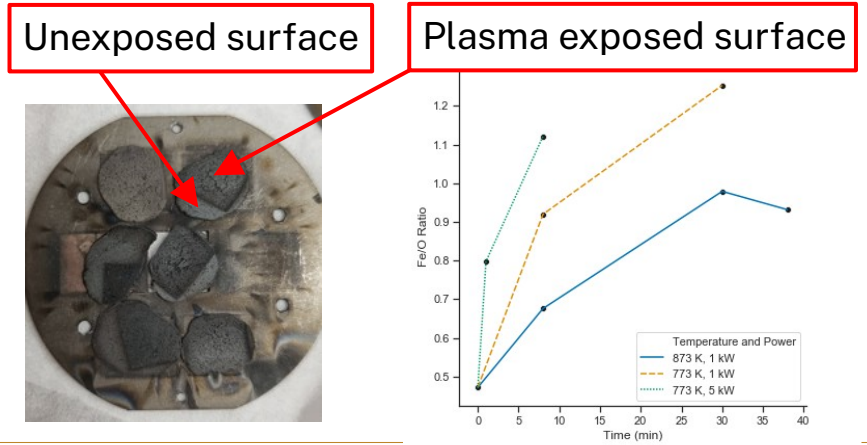
- High cost of hydrogen relative to conventional fuels
- Slow kinetics in the final wüstite to metallic iron step.

Hydrogen plasma reduction (HPR) offers:

- Potential for a more efficient and effective use of hydrogen at the cost of some added electricity
- Melting of the product.

Activities to date: Reduction of hematite pellets in MAGPIE facility. XRD data showing reduction from hematite to magnetite and metallic iron.





Plan for future work

$261k support for next-stage work via Heavy Industry Low-carbon Transition **(HILTCRC)**

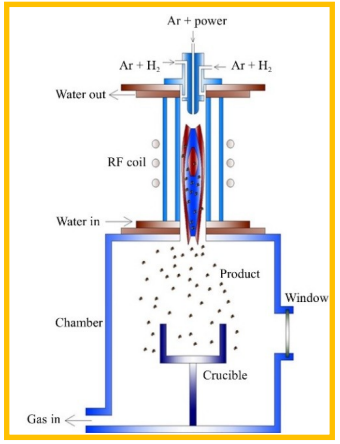
- Develop an experimental setup for the HDR-HPR tests.
- Material characterisation before and after the reduction process.
- System-level technoeconomic analysis.
- Evaluating the impact of Australian ore grades on the overall process conditions.
- Understanding gangue removal via HPR liquid phase
- Conceptual design for large-scale operation.

HILTCRC hiltcrc.com.au

Research programs:

- **RP1: process technologies** (iron/steel, alumina, cement)
- **RP2: cross-cutting technologies** (VRE, hydrogen, heat, CCU/S)
- **RP3: facilitating transformation** (transition strategies, supply chains, sustainability)

Stage 1 (TRL2)
Proof of concept



Stage 2 (TRL 4)
Reactor design development