Valorising Desalination Waste Brines to Upgrade Low-Grade Iron Ores for Green DRI Production

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Project Aim and Overview

Australia, being the world's driest continent and the largest supplier of iron ore, relies heavily on seawater desalination to meet its freshwater demands. However, this increases waste brine production and deep-sea disposal leading to negative environmental impact. To combat greenhouse gas emissions from steel production and deep-sea waste brine disposals, the HILT CRC and its partners propose to utilize waste brines to produce the reagents necessary for the hydrometallurgical upgrade of low-grade iron ores to direct reduce iron (DRI) grade, enabling a process route for green steel production from Australian iron ores.

Methods

Production of reagents from waste brines will be achieved by membrane technologies, commercial water treatment techniques and water splitting by electrodialysis. Nanofiltration will reduce scaling ions such as Ca^{2+} and Mg^{2+} from desalination brines. Lithium ions will be extracted as a by-product before brines undergo salt splitting.

Salt splitting produces an alkaline NaOH solution and an acidic HCl solution. The alkaline solution is used in the water-softening step and the hydrometallurgical removal of silica, alumina, and phosphorous from the iron ores. The acidic solution neutralises alkaline streams and acts as a stripping agent in lithium extraction. When precipitated with calcium and magnesium ions from the seawater brines, the alkaline leachate produces zeolites, silica, and phosphate-rich fertiliser byproducts.

The study demonstrates the concept at a laboratory scale by performing component testing of nanofiltration, brine softening, lithium removal, salt splitting, hydrometallurgical iron ore upgrading, zeolite production and by-product precipitation.

Analytical techniques include inductively coupled plasma optical emission spectroscopy (ICP-OES) to characterise liquid streams, while solid products are analysed using X-ray fluorescence, X-ray diffraction, and scanning electron microscopy techniques.

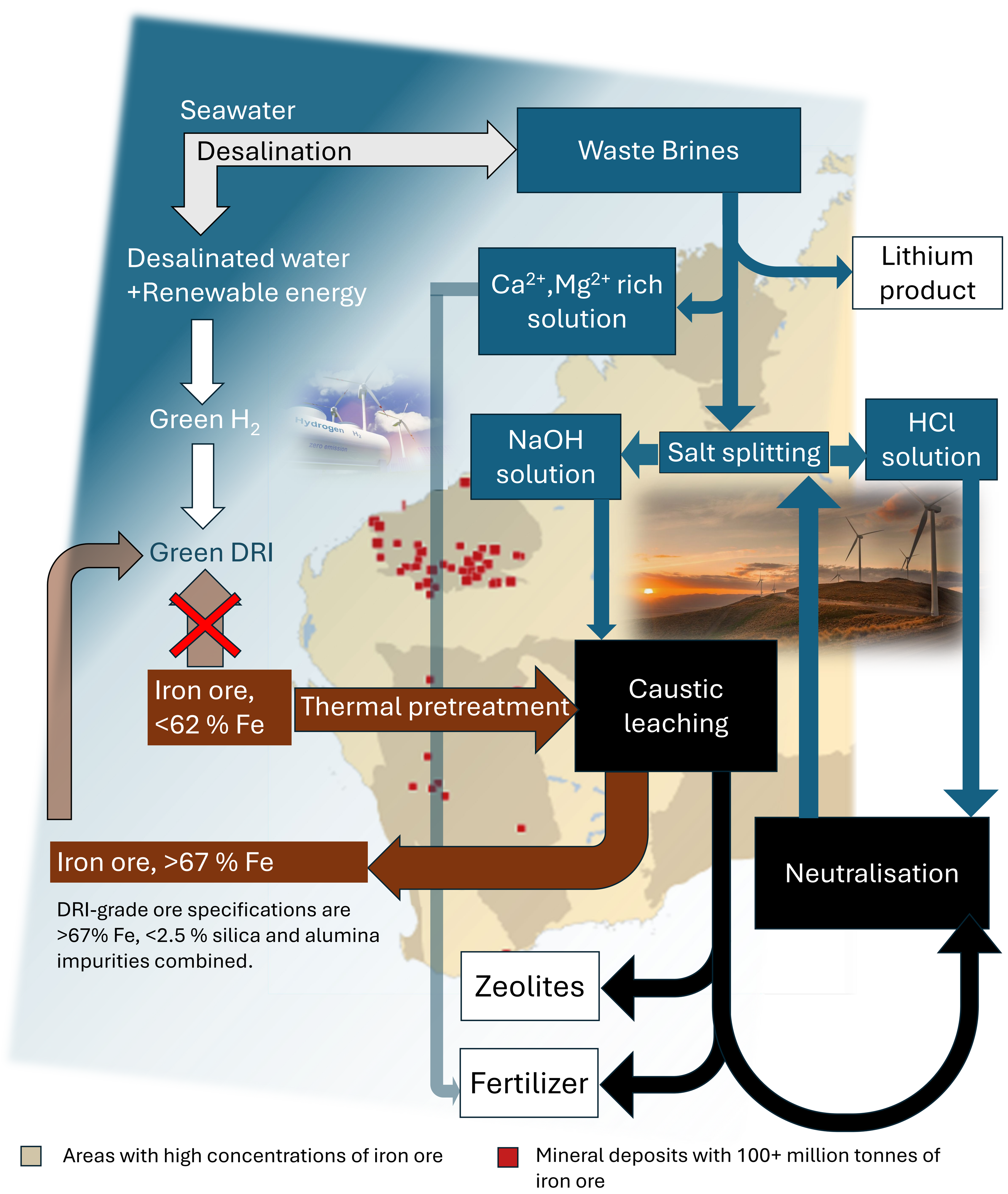
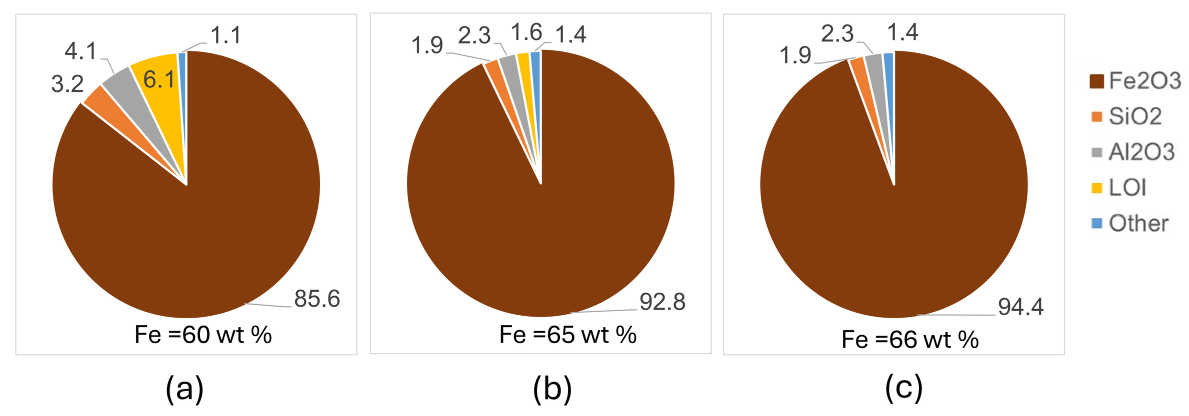


Diagram 1. Visualisation of products and reagents from reverse osmosis brines used to upgrade iron ores

Preliminary results

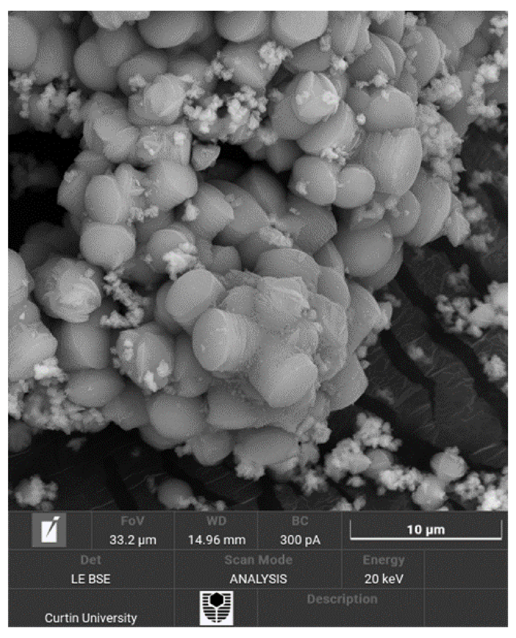
Iron Ore Upgrade



The illustrative results above show the composition of an untreated mined iron ore (a), the upgraded iron ore after thermal pretreatment and caustic leaching for an hour (b), and the product composition on a dry, zero loss on ignition (LOI) basis (c), as determined by X-ray fluorescence analysis of the products of preliminary alkaline leaching tests. A NaOH concentration of 5 M, a leaching temperature of 95 °C, and a 20 % solid-to-liquid ratio were used to upgrade the ore.

Zeolite Production

Scanning electron microscopy (SEM) to the right shows the alumina silicates produced from concentrated caustic leachate after treatment in an autoclave for 24 hours at
160 °C.



Next steps

- Investigate the preferred hydrometallurgical upgrade conditions
- Investigate the energy demand of the salt-splitting process to generate reagents.
- Estimate commercial viability based on the conceptual flowsheet

Over three years, testing will progress to integrated testing, linking the components together.

Acknowledgement

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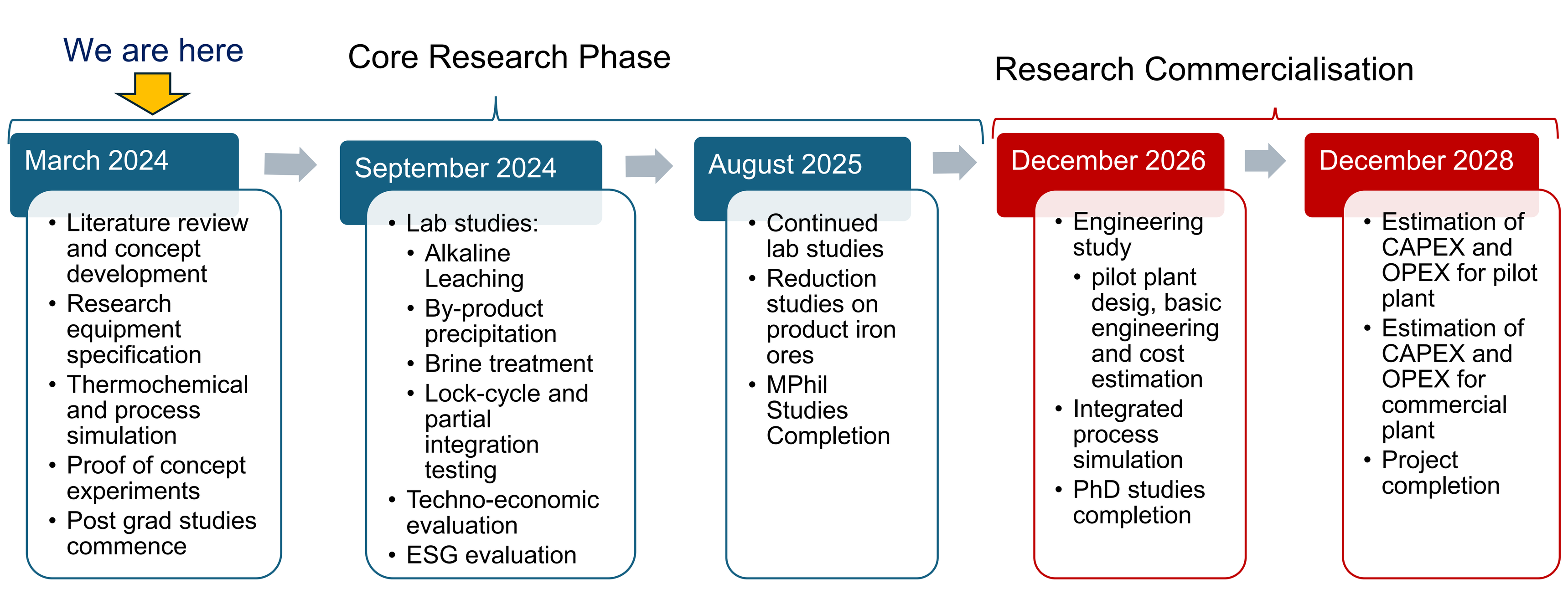
Timeline



Project Partners

HILT CRC, Curtin University, Proxa, Fortescue, The University of Adelaide, Roy Hill, BG&E Resources, MRIWA, Government of Western Australia