The role of Sustainability and Circularity in Australia's Energy transition

Dr. Tara Hosseini

Team Leader & Senior Research Scientist
CSIRO Energy, Australia

Email: Tara.Hosseini@csiro.au

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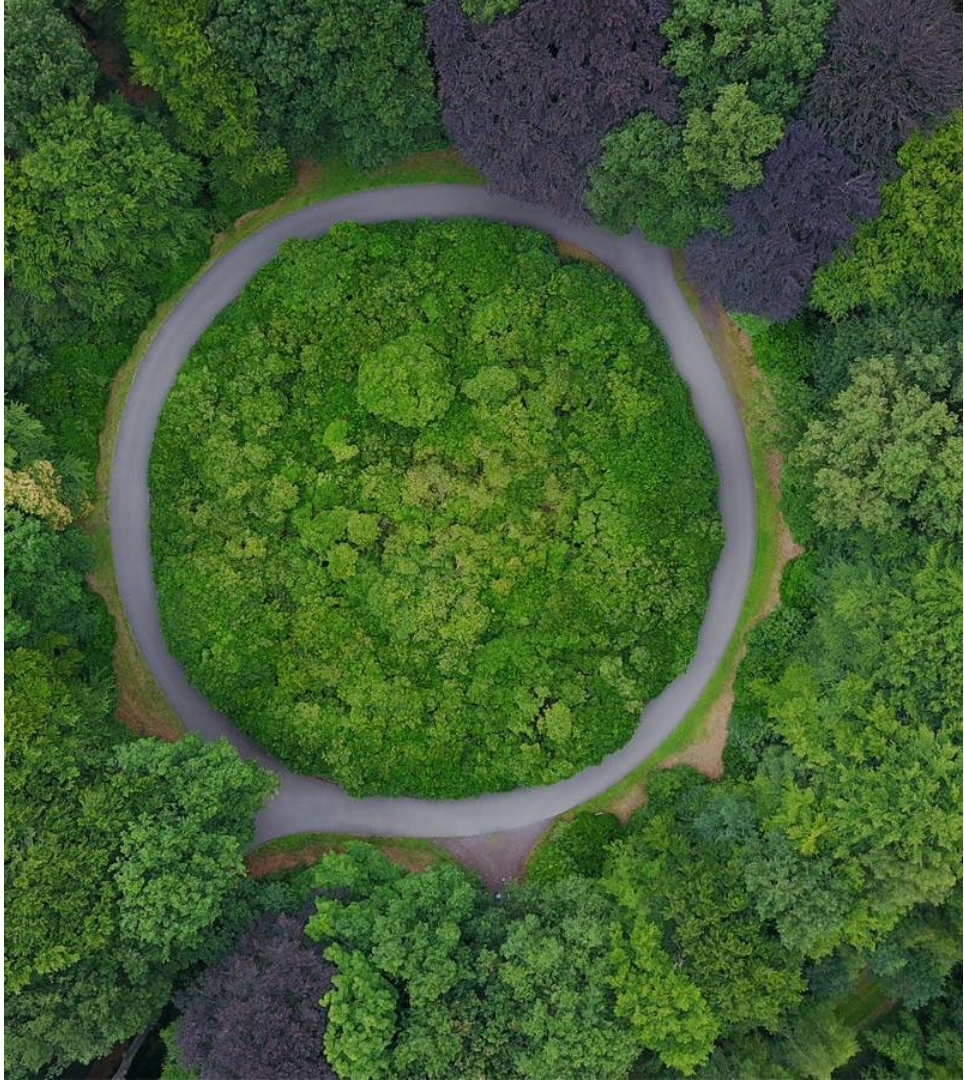
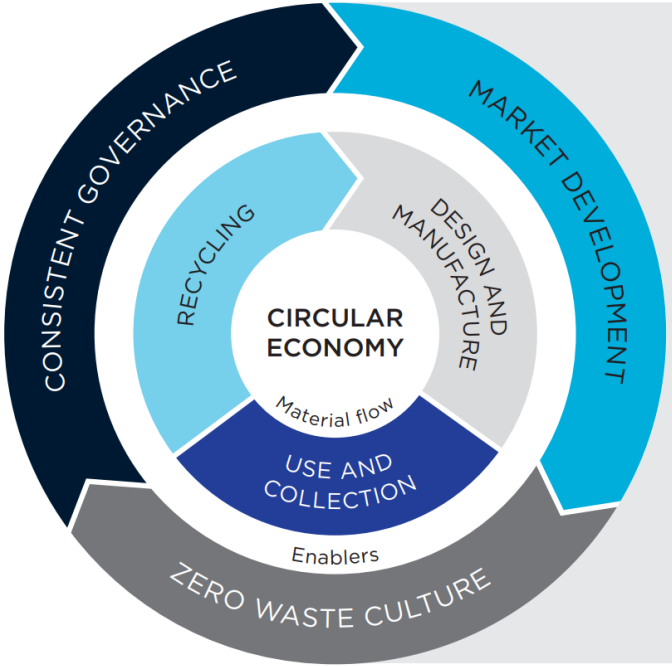


The importance of establishing a circular economy

- In 2022, the world used over 100 billion tonnes of various resources, three times of 50 years ago, and on a path to 160 billion tonnes by 2060.
- One-third of all extracted material is discarded within a year.
- Australia relies heavily on resource extraction and primary industries.
- A circular economy can foster new industries and strengthen Australia's global economic role.
- Australia's strengths include world-leading sectors, diverse workforce, innovation, and international trade.

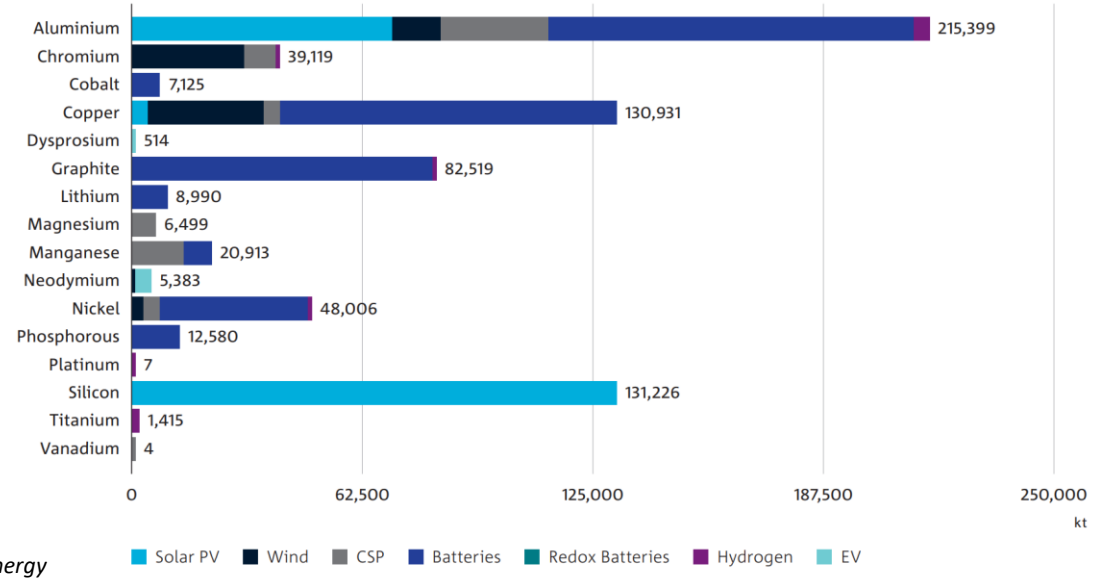


Schandl, H., Walton, A., Okelo, W., Kong, T., Boxall, N.J., Terhorst, A. and Porter, N.B. (2023). Australia's comparative and competitive advantages in transitioning to a circular economy. A Report to the Office of the Chief Scientist. CSIRO, Australia

Critical minerals in energy transition

- Renewable energy transition requires critical minerals.
- Critical minerals supply chains have significant environmental, social and governance (ESG) risks and are highly concentrated and thus vulnerable to global disruptions.

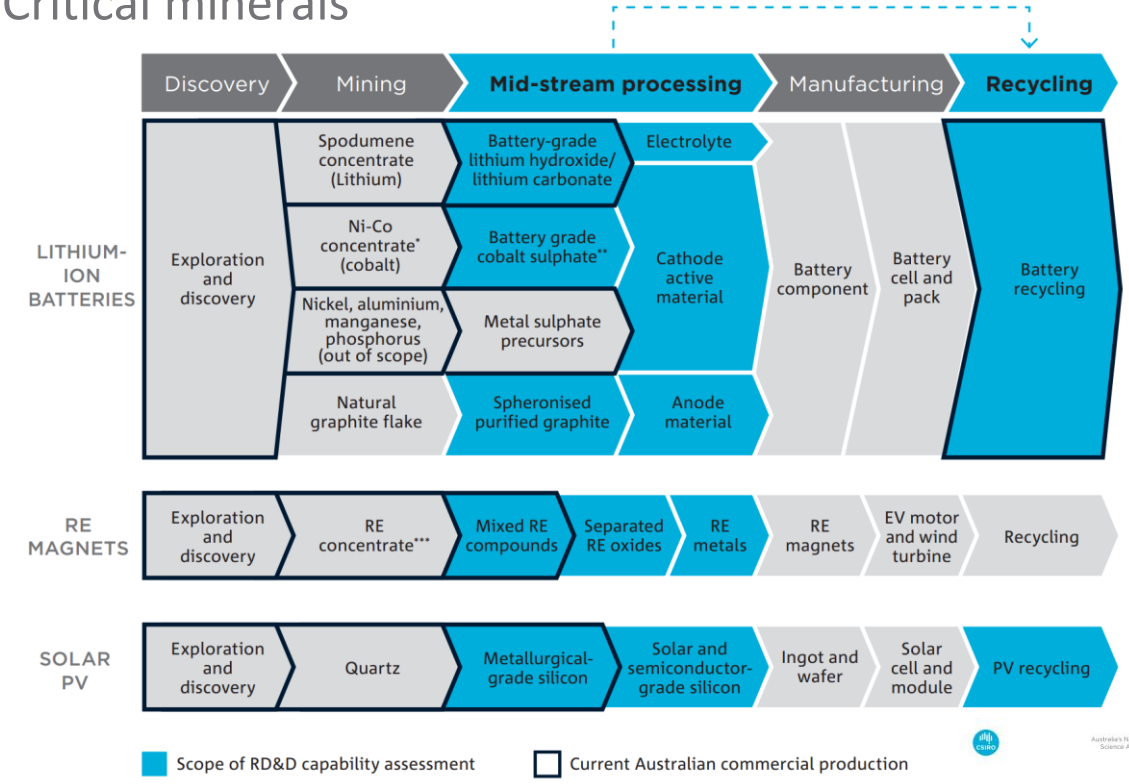
- Graph shows the total cumulative minerals demand for new installed capacity to 2050.
- RD&D plays a key role in expanding mid-stream processing capabilities and unlocking competitive and sustainable production of value-added products.



Bruce S, Delaval B, Moisi A, Ford J, West J, Loh J, Hayward J (2021) Critical Energy Minerals Roadmap. CSIRO, Australia.

RD&D Priorities in Energy Critical minerals

- Energy technology supply chains are highly concentrated, especially in the mid-stream portion of the supply chain.
- Mid-stream processing covers the extraction of compounds from ores and the production of value-added materials:
  - lithium-ion batteries (LIBs),
  - rare earth (RE) magnets (for wind turbines and EVs),
  - and crystalline silicon solar photovoltaic (PV)



CSIRO (2024) From minerals to materials: assessment of Australia's critical mineral mid-stream processing capabilities. CSIRO, Canberra.

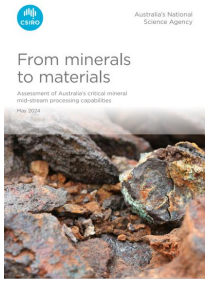
Australia's RD&D capabilities in mid-stream processing

- Australia has had strong activity in the first step of mid-stream processing (i.e. extractive metallurgy)
- Capabilities in the production of value-added intermediates are still developing.
- Lithium and cobalt have received high levels of RD&D activity in Australia relative to other minerals.
- Australia also has very strong patent activity in graphite, and research publication activity in photovoltaic (PV) recycling.

	Extractive metallurgy			Production of intermediate products and advanced materials		
	Research	Patents	Pilots & commercial	Research	Patents	Pilots & commercial
Lithium	●	●	●	●	●	●
Cobalt	●	●	●	●	●	●
Graphite*	n/a	n/a	n/a	●	●	●
RE	●	●	●	●	●	●
Silicon	●	●	●	●	●	●
LIB Recycling	●	●	●			
PV Recycling	●	●	●			

Legend: Australian activity
● Very strong ● Moderate
● Strong ● Limited

*Extractive metallurgy does not apply to graphite (a non-metal).
LIB, lithium-ion battery; PV, photovoltaic.



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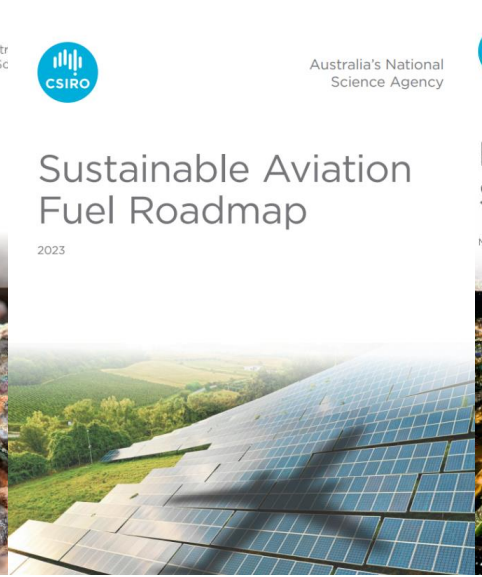
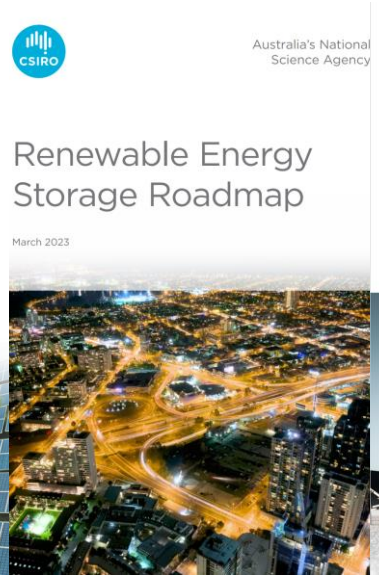
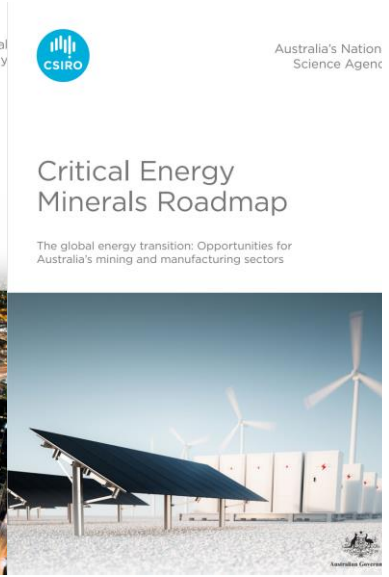
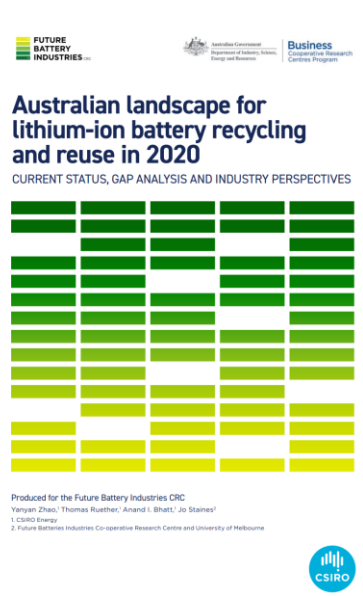
Some of the relevant CSIRO's roadmaps









- CSIRO's research considers circular economy principles in resource and environmental management, manufacturing, supply chain security, behavioural science, energy and more.
- CSIRO conducts research into renewable energy technologies aiming to improve their efficiency, reduce costs and their environmental footprints.

CSIRO's Battery Recycling Technology Hub

EoL LIBs

Batteries
Metals

2nd Life &
Discharge

- Safe Storage & Processing
- Examine discharge steps
- Understand Over-discharge

- Industry adopting safer practises
- Examine thermal events, state of charge, decomposition product formation

Dry
Shredding

Li-salt
extraction

Chem
separation

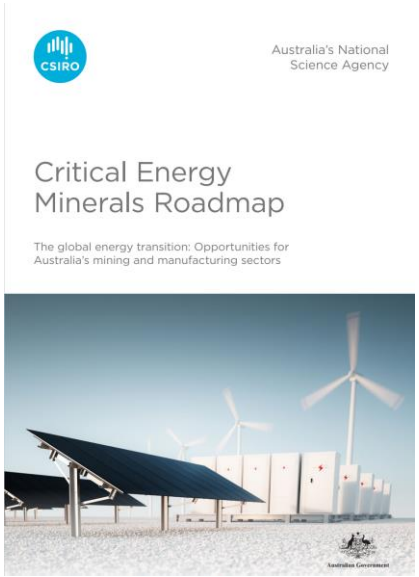
Pure metals

- Production of high-purity electrolyte
- Cathode and anode material separation

Program Strategy

- Technologies for effective Li-battery recycling
- High value Materials
- Less raw material use
- Net zero lifecycle emissions

Investment priorities in energy materials recycling



Commercial

- Design energy technologies for easy recycling and low energy inputs
- Co-locate processing of virgin and recyclable materials
- Implement hub models to reduce transport costs for centralised facilities

Regulatory/policy

- Implement nationally consistent waste regulations (including uniform fees)
- Implement robust product stewardship schemes that consider full technology lifecycles
- Implement extended producer responsibility schemes
- Consider potential for Asia-Pacific recycling hub development

RD&D

- Increase RD&D in metallurgical processing technologies suitable for complex waste streams
- Develop 'stocks and flow' models for optimised critical mineral recovery and use.

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Thank you

CSIRO Energy – Clayton, Victoria, Australia

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