Parametric Life Cycle Assessment of Critical Battery Minerals Industry: Case of Lithium

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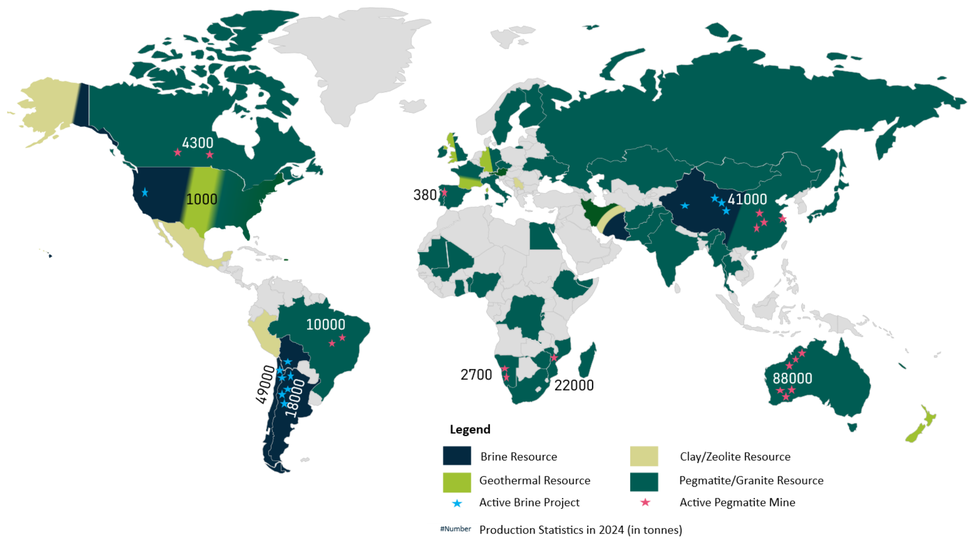
Why Life Cycle Assessment is the answer?

Clean Energy Transition | Fast Market Surge | More Mining Resources

Environmental concerns are increasing in the mining, processing, and refining industries.

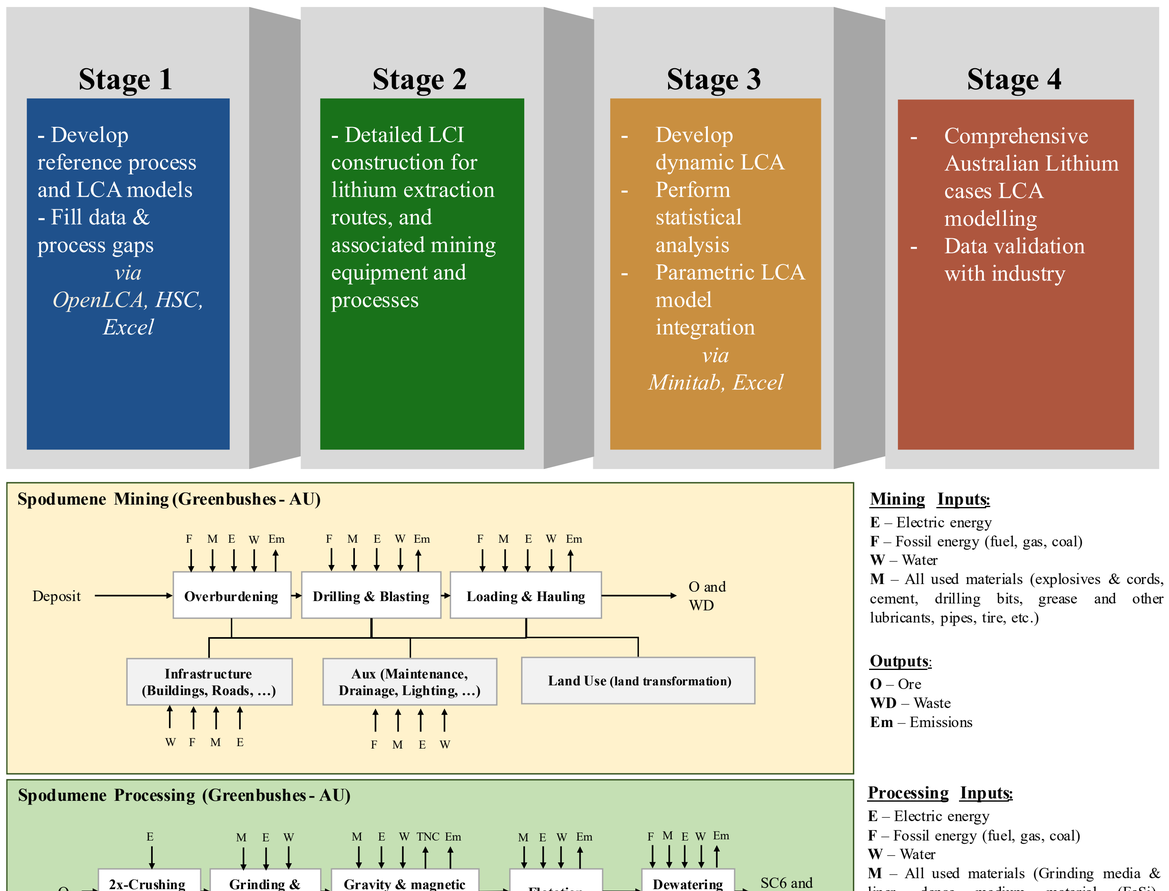


World map of lithium resources with productions in 2024, (created based on data from USGS, BGS, BRGM, IMPASCO)

But Conventional LCA has multiple limitations

- Low data quality and approximations
- Huge data gaps and oversimplifications
- Lack of completeness for complex systems
- Static models – snapshot of a dynamic reality

Method



Mining Inputs:
E – Electric energy
F – Fossil energy (fuel, gas, coal)
W – Water
M – All used materials (explosives & cords, cement, drilling bits, grease and other lubricants, pipes, tire, etc.)

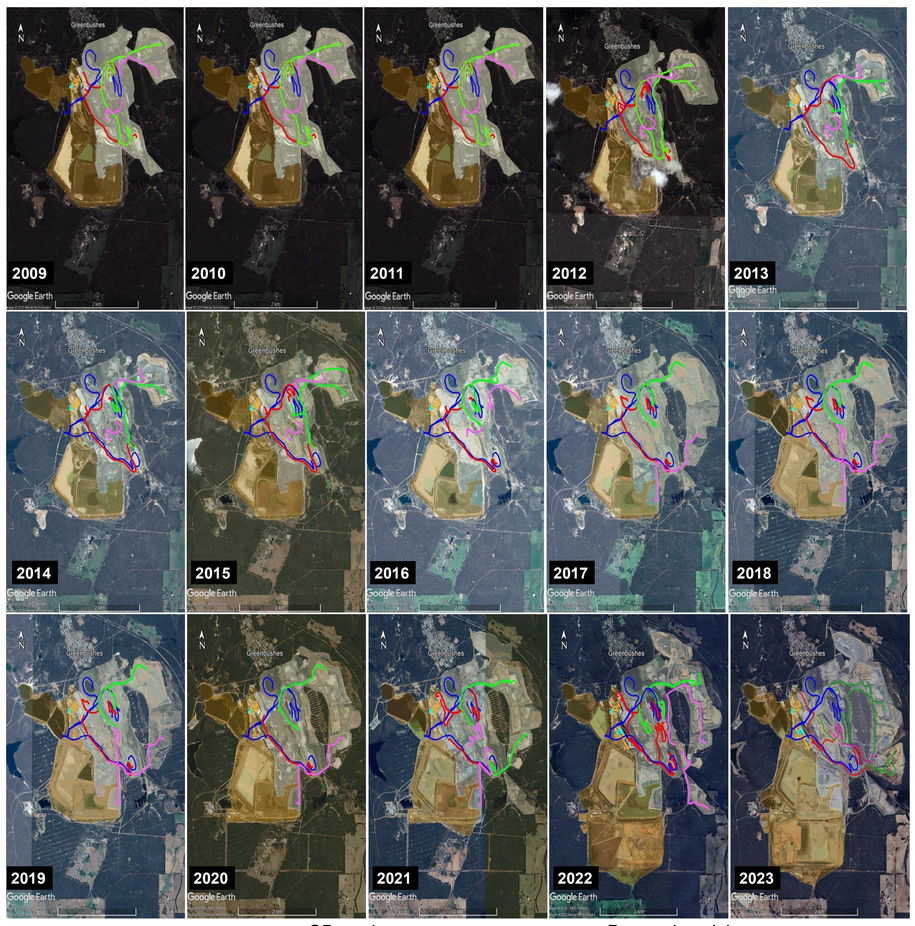
Outputs:
O – Ore
WD – Waste
Em – Emissions

Processing Inputs:
E – Electric energy
F – Fossil energy (fuel, gas, coal)
W – Water
M – All used materials (Grinding media & liner, dense medium material (FeSi), Flotation reagents (frother, collector, pH adjustment), conveyor belt, thickening flocculant, grease and other lubricants, pipes)

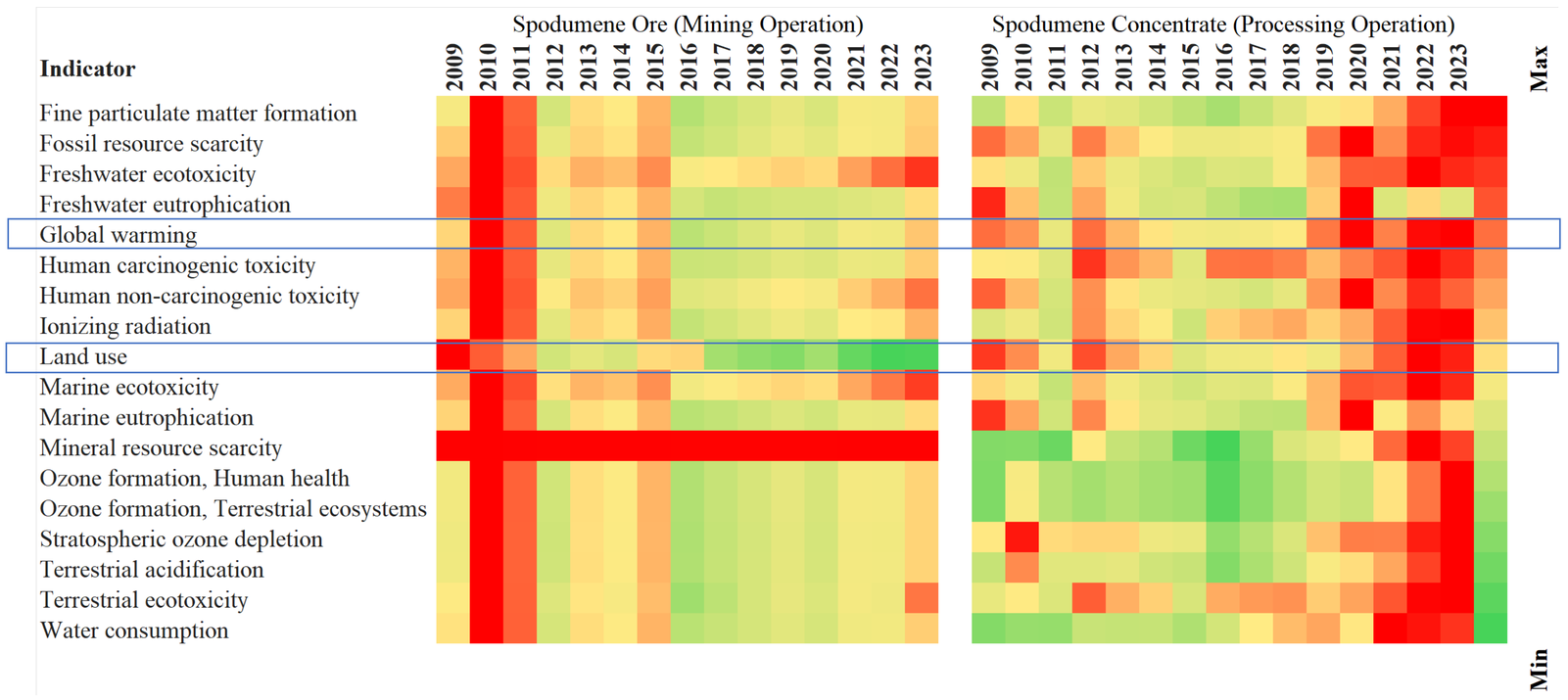
Outputs:
SC6 – Spodumene concentrate
TNC – Tantalum concentrate
T – Tailings
Em – Emissions

Greenbushes mining and processing operations LCA system boundary

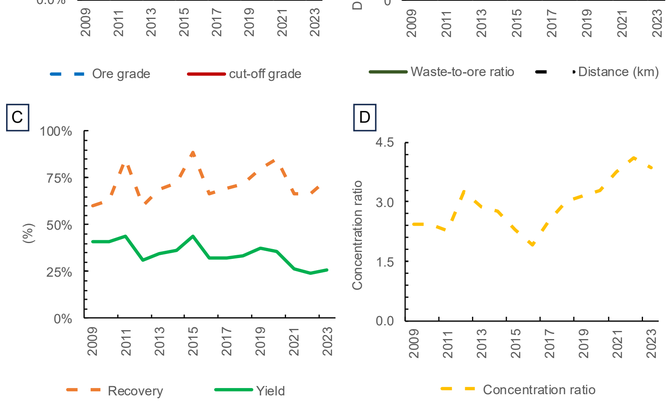
Research Results



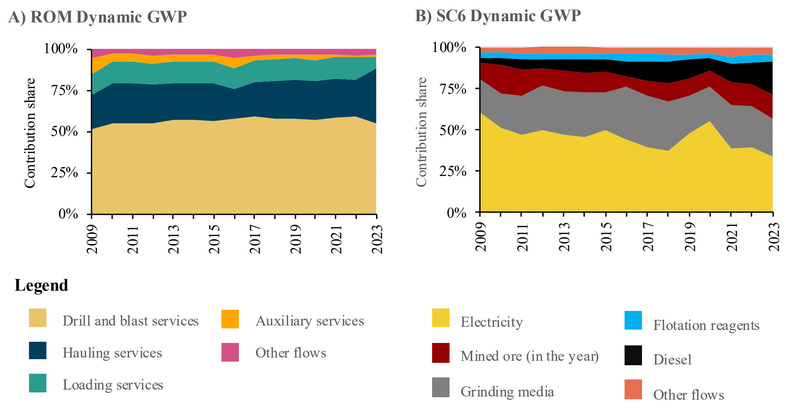
Greenbushes operation 2009-2023



*Heatmap of the dynamic LCIA of: **Left)** spodumene ore production, **Right)** concentrate production*



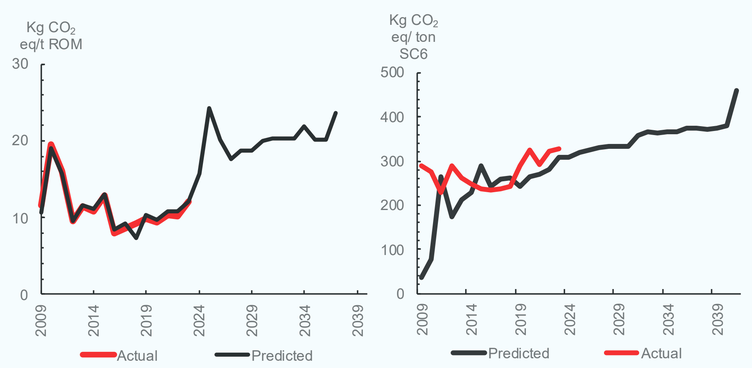
*Range of variable parameters between 2009-2023, **A** and **B**) mining, **C** and **D**) processing*



*Dynamic hotspot analysis **Left**) mining, **Right**) processing operation*

Key Findings:

- Waste to ore ratio increases from 2.2 (2009) to 6.9 (2036), causing an 80% rise in the carbon footprint of ore production.
- Ore grade decreases from 4.1% (2009) to 1.6% (2041), leading to a 60% rise in the carbon footprint of concentrate production.



***Left**) Actual vs predicted GWP for spodumene ore*

***Right**) Actual vs predicted GWP for spodumene concentrate*

Contributions

- Increasing the LCA accuracy.
- Giving robustness to Policy & Decision-making processes.
- Toward responsible sourcing and responsible mining.
- Increasing transparency for all stakeholders.
- Level of significance of several mine design, processing, and refining operational variable parameters are checked.

References

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