Carbon footprint of current and future lithium carbonate production in South America

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The rush to 'go electric' comes with a hidden cost: destructive lithium mining

https://www.theguardian.com/commentisfree/2021/jun/14/electric-cost-lithium-mining-decarbonasation-salt-flats-chile

The spiralling environmental cost of our lithium battery addiction

https://www.wired.co.uk/article/lithium-batteries-environment-impact

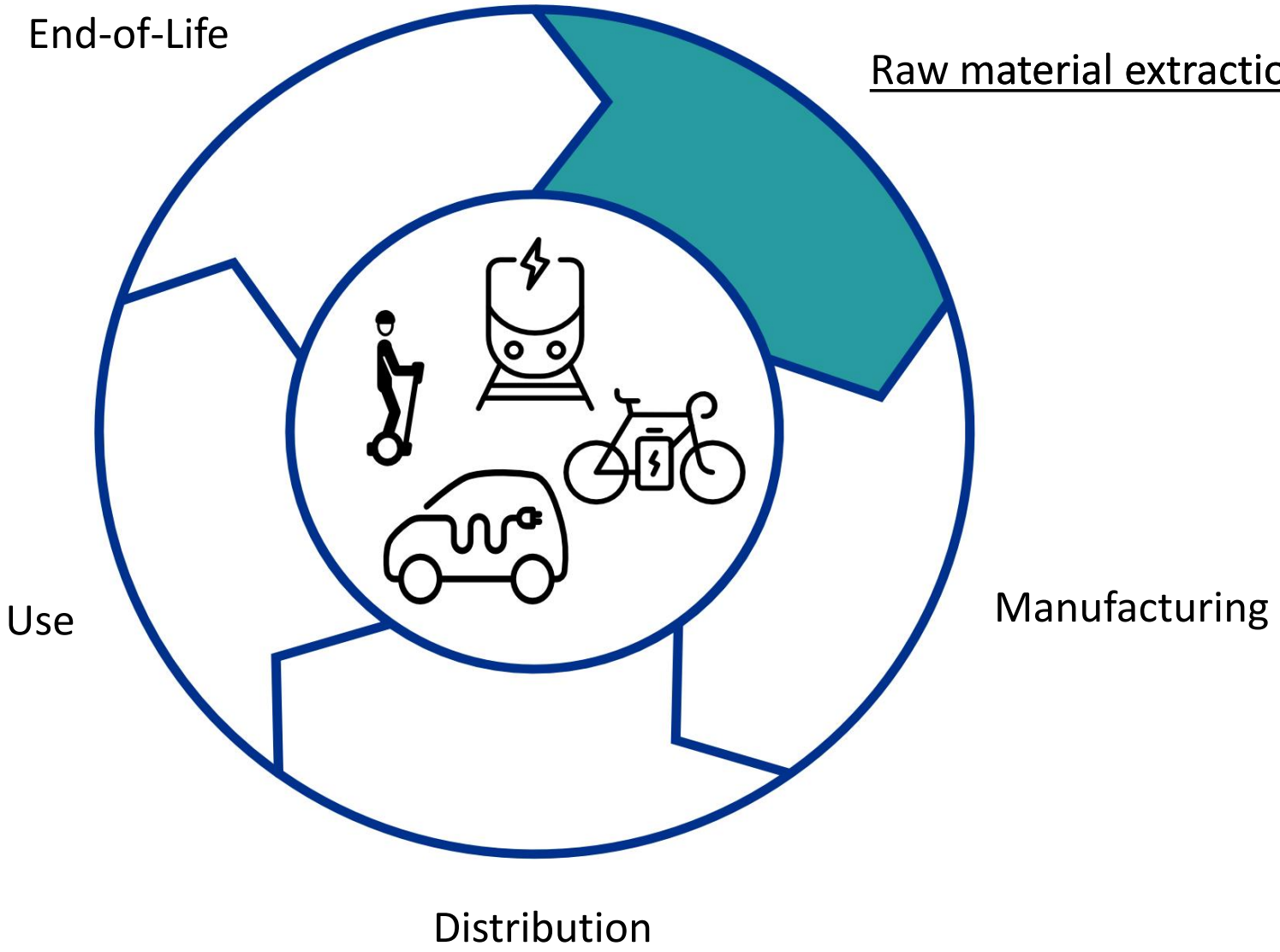
The Paradox of "Clean" EVs and the "Dirty" Lithium Mining Business

https://interestingengineering.com/clean-evs-and-dirty-lithium-mining-business

Lithium is crucial for the transition to renewables, but mining it has been environmentally costly.

https://www.bbc.com/future/article/20201124-how-geothermal-lithium-could-revolutionise-green-energy

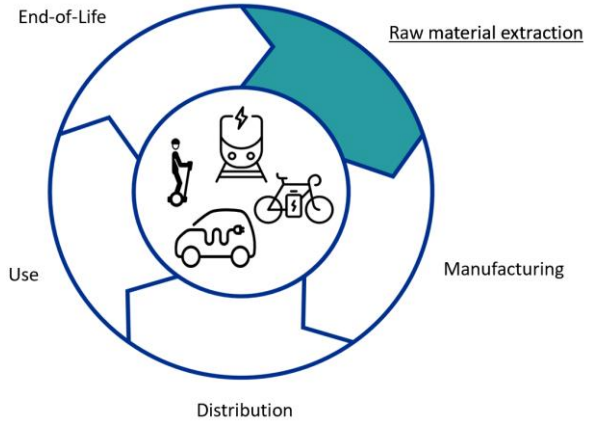
Life cycle assessment



Life cycle assessment

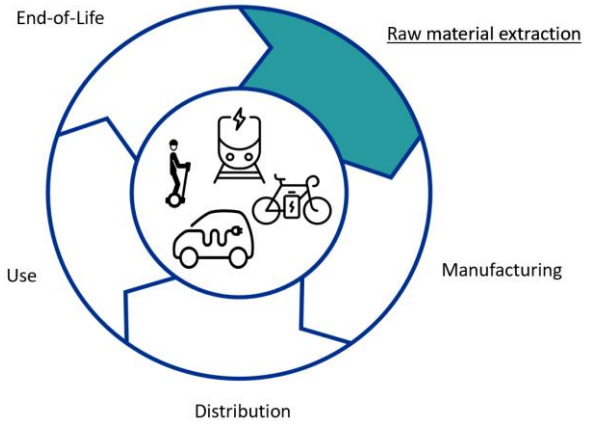
- Goal and scope
- Life cycle inventory assessment
- Life cycle impact assessment
- Interpretation

Based on ISO 14040 (ISO 2006)



What has been done so far?

Life cycle assessments exist – **Comparison between brines & pegmatites**
- Stamp et al. (2014) & Kelly et al. (2021)



<u>Findings by Kelly et al. (2021):</u>

→ Greenhouse gases & freshwater consumption of Li_2CO_3 production

→ Brines < Pegmatites

→ For cathode (NMC811) material – up to 20 % difference of GHG due to Li source

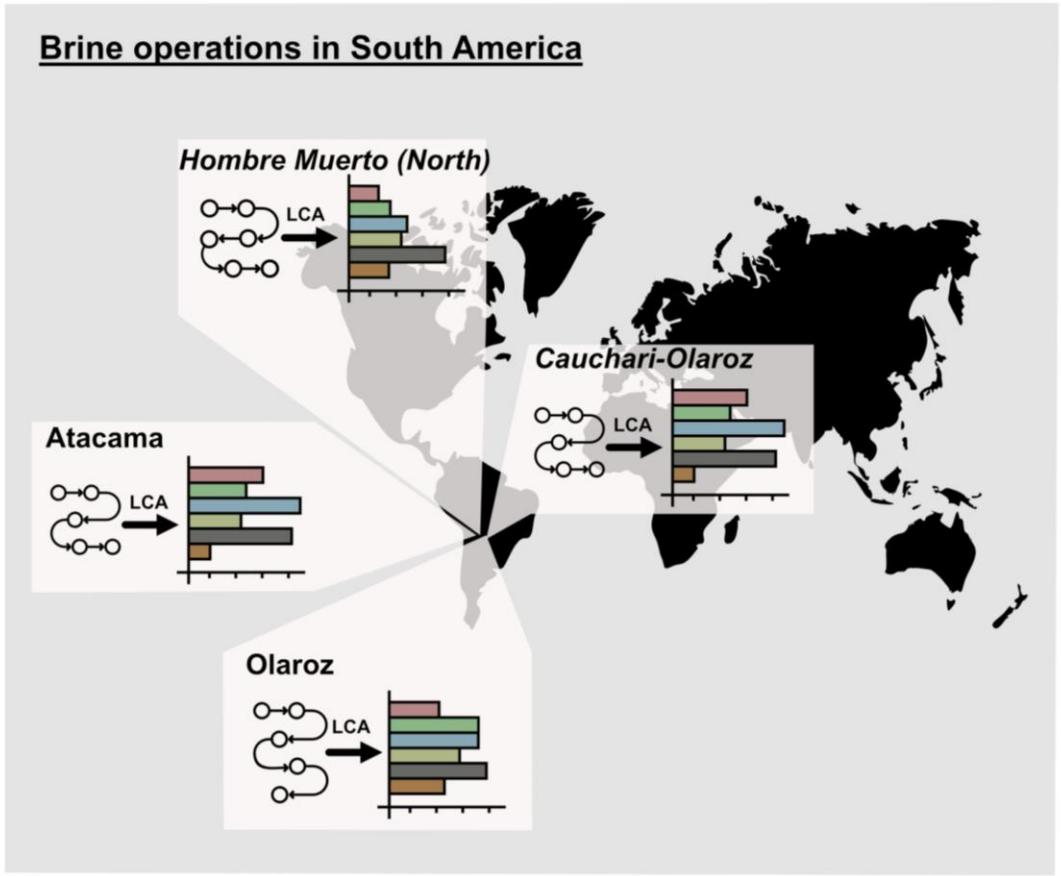
What has been done so far?

Life cycle assessments exist **but mainly focusing on Salar de Atacama**
- Stamp et al. (2014) & Kelly et al. (2021)

How do different processing routes affect environmental impacts?

Salar de Atacama, Chile - Courtesy of Wolfgang Fröhlich

Life cycle assessment: Goal and scope



Goal and scope:

- Production of **1 kg Li_2CO_3 (battery grade)**
- Defining system boundaries

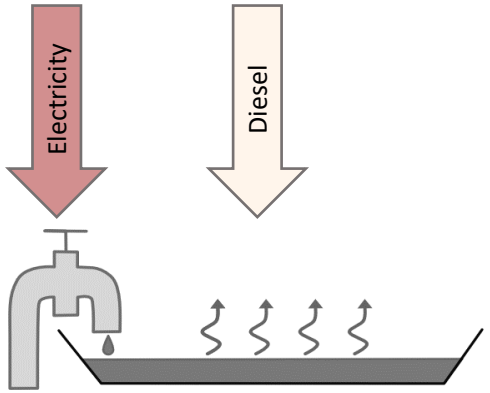
Life cycle inventory modeling:

- Estimation of energy, water and chemical demand for each process

Quantification of environmental impacts

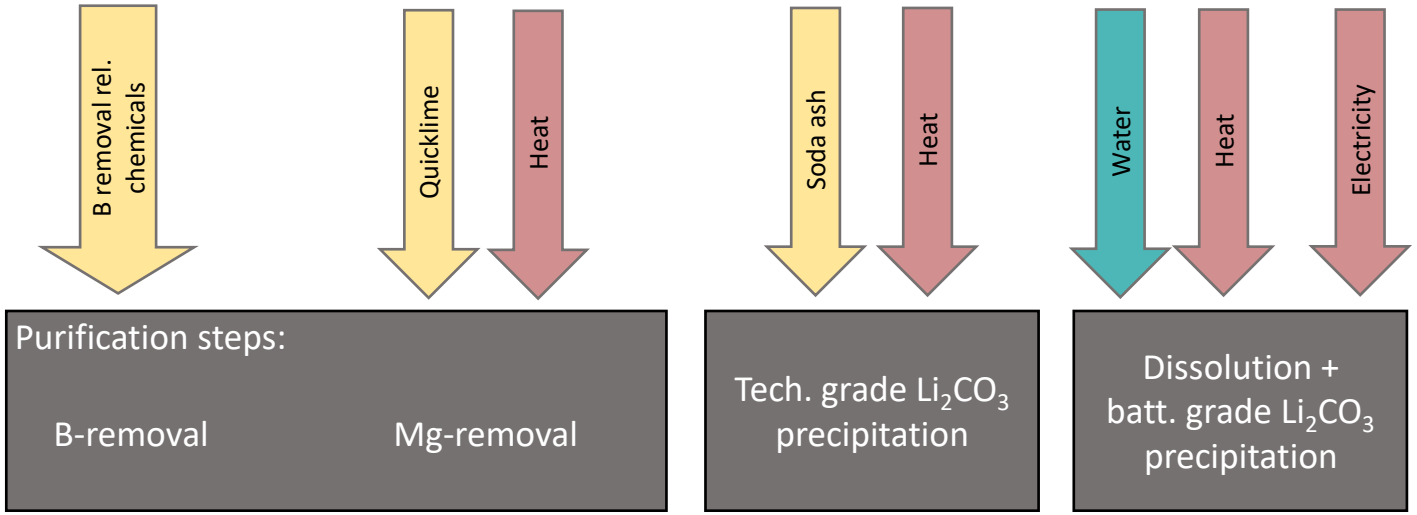
- Global warming (100 years) based on IPCC (2013)

Salar de Atacama

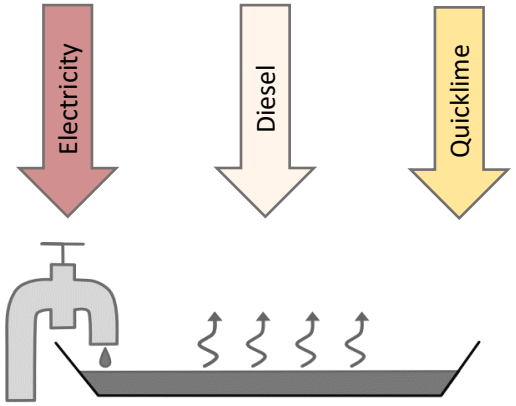


Li enrichment until **6 wt. %**

Enriched brine

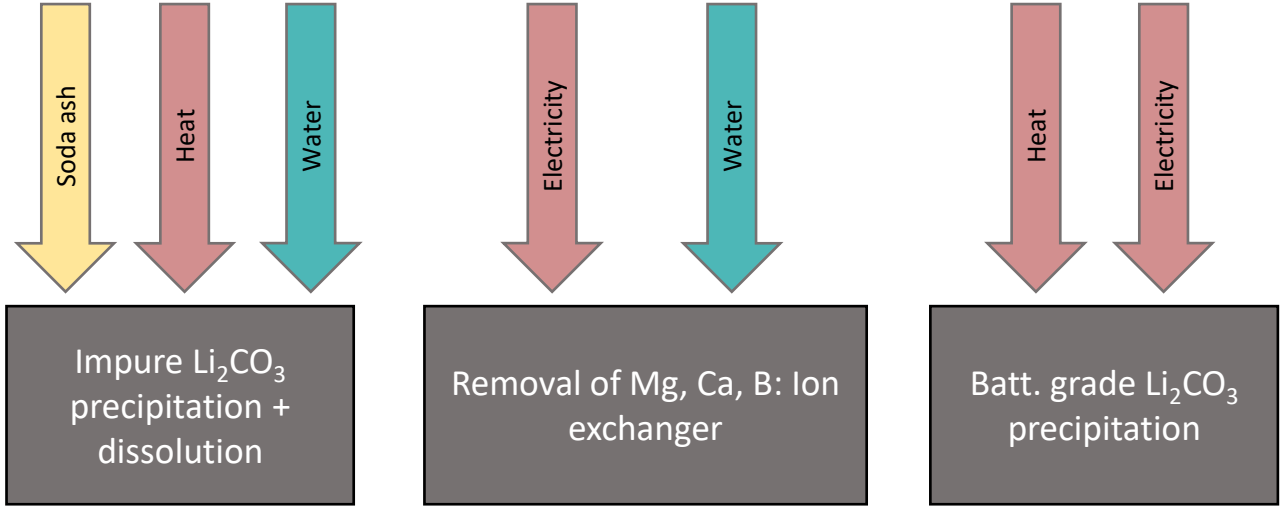


Salar de Olaroz

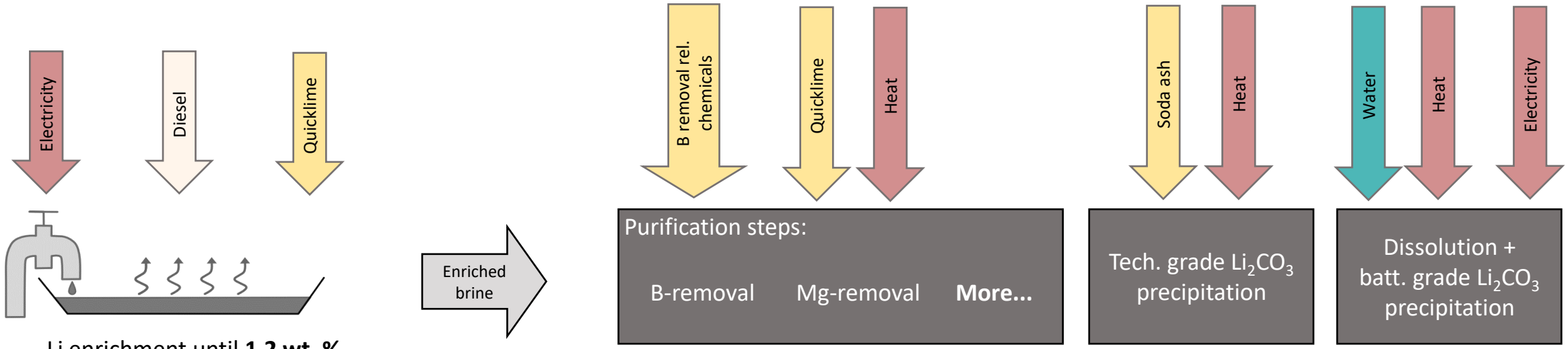


Li enrichment until **1.2 wt. %**

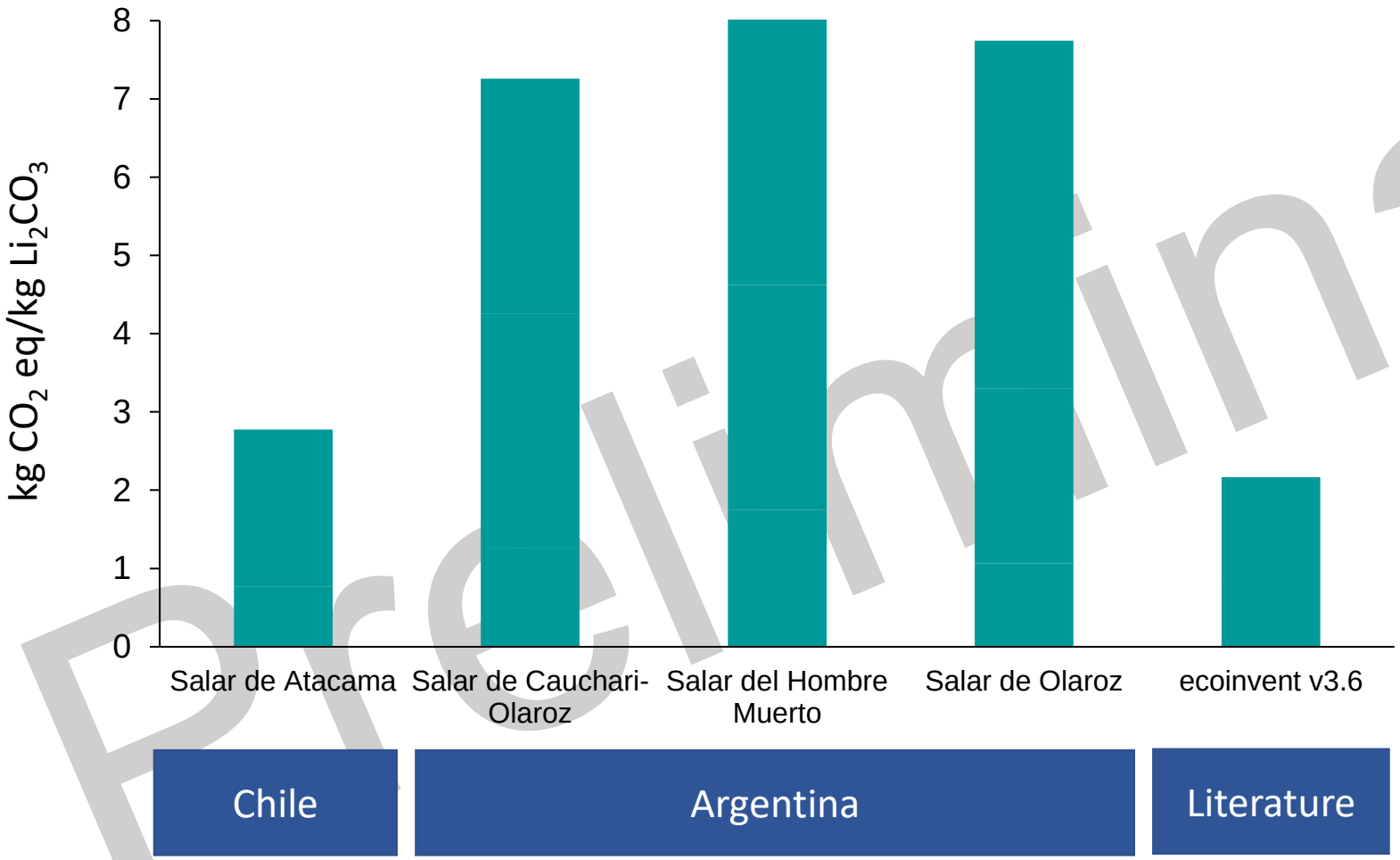
Enriched brine



Salar del Hombre Muerto (North) & Salar de Cauchari-Olaroz

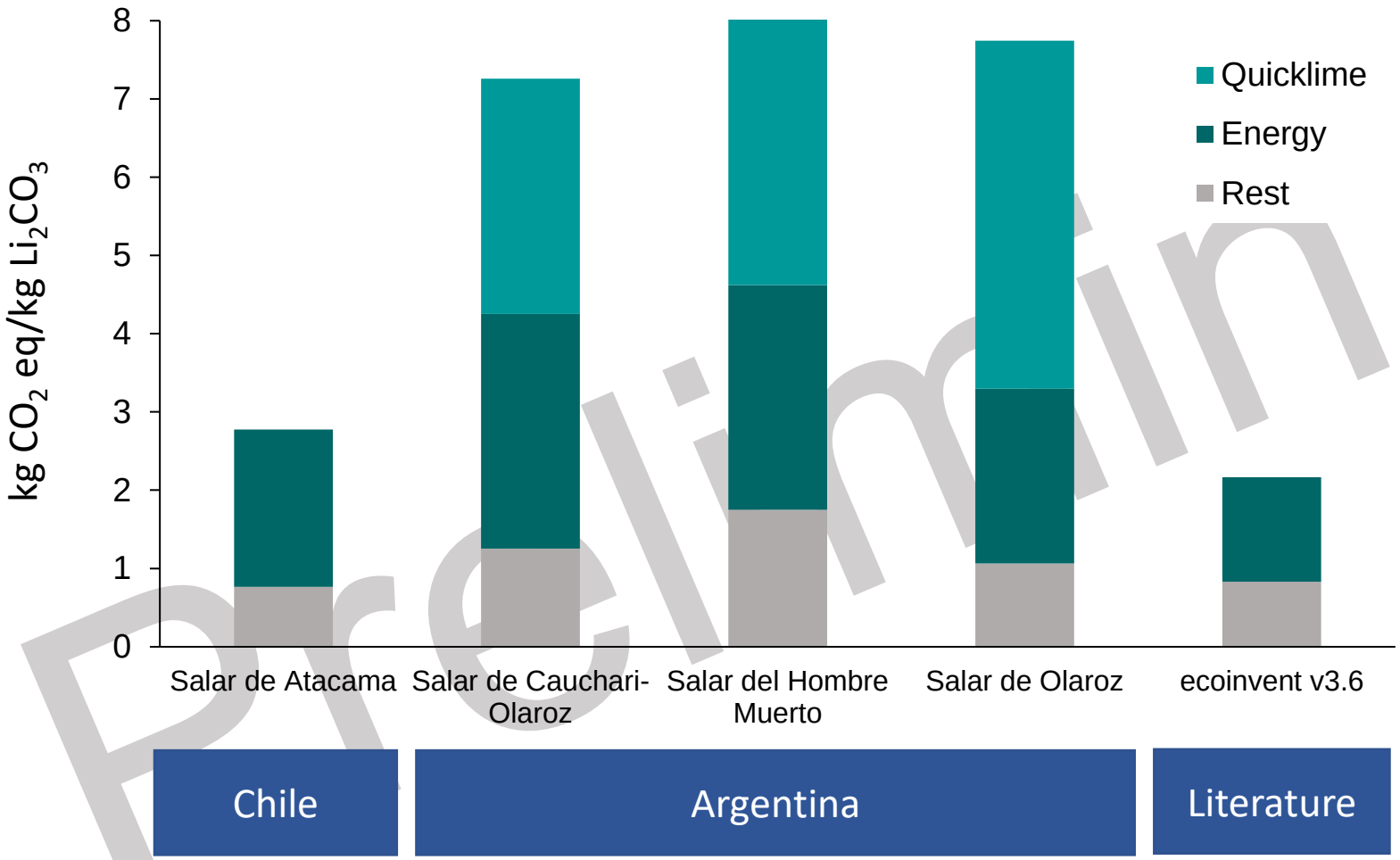


Results: Carbon footprint



Literature data (ecoinvent v3.6) based on Salar de Atacama (Stamp et al. 2012)

Results: Carbon footprint



Energy supply – often fossil fuel-based

Quicklime – energy-intensive production + CO_2 as a co-product → Reduction potential 29 % (Eula 2014)

Discussion

What we achieved...

- Process-based assessment

- Enables comparison between brine sites

- Inventories used in various supply chains

Difficulties...

- Average data of resource supplier

- Hydrology of salt lakes → impacts on water

- Local impacts require massive data

Conclusions & outlook

Site-specific assessment of lithium carbonate production is crucial

Identifying environmental impacts + elaborating mitigation options

Transparency is key → Example: Assessment of electrical vehicles

References

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Graphics:

- Noun project: Cycle from Brad Avison, E-bike & E-train by Martin Königsmann, E-car by Koson Rattanaphan, E-mobility by Jems Mayor, World map by Nikita Kozin, Flowsheets by Planning Glyph Collection, Bar diagram by Srinivas Agra

Thanks for your attention!

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