Rare Earth and Life Cycle Management

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ESSRI, 29th September 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004730

Intro

What is Life Cycle Assessment (LCA)?

“Decisions are taken on the basis of available information, and almost always with a narrow focus, e.g. on the short-term profitability.

This is, however, in contrast with the idea of sustainability.”[1]

Source: Heijungs R., Huppes G. & Guinée J.B. (2010), Life cycle assessment and sustainability analysis of products, materials and technologies. Toward a scientific framework for sustainability life cycle analysis, *Polymer Degradation and Stability* 95(3): 422-428

→Widen the focus
→Get more info

Life cycle assessment

Approach and Definition

LCA is the “compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle”[3]

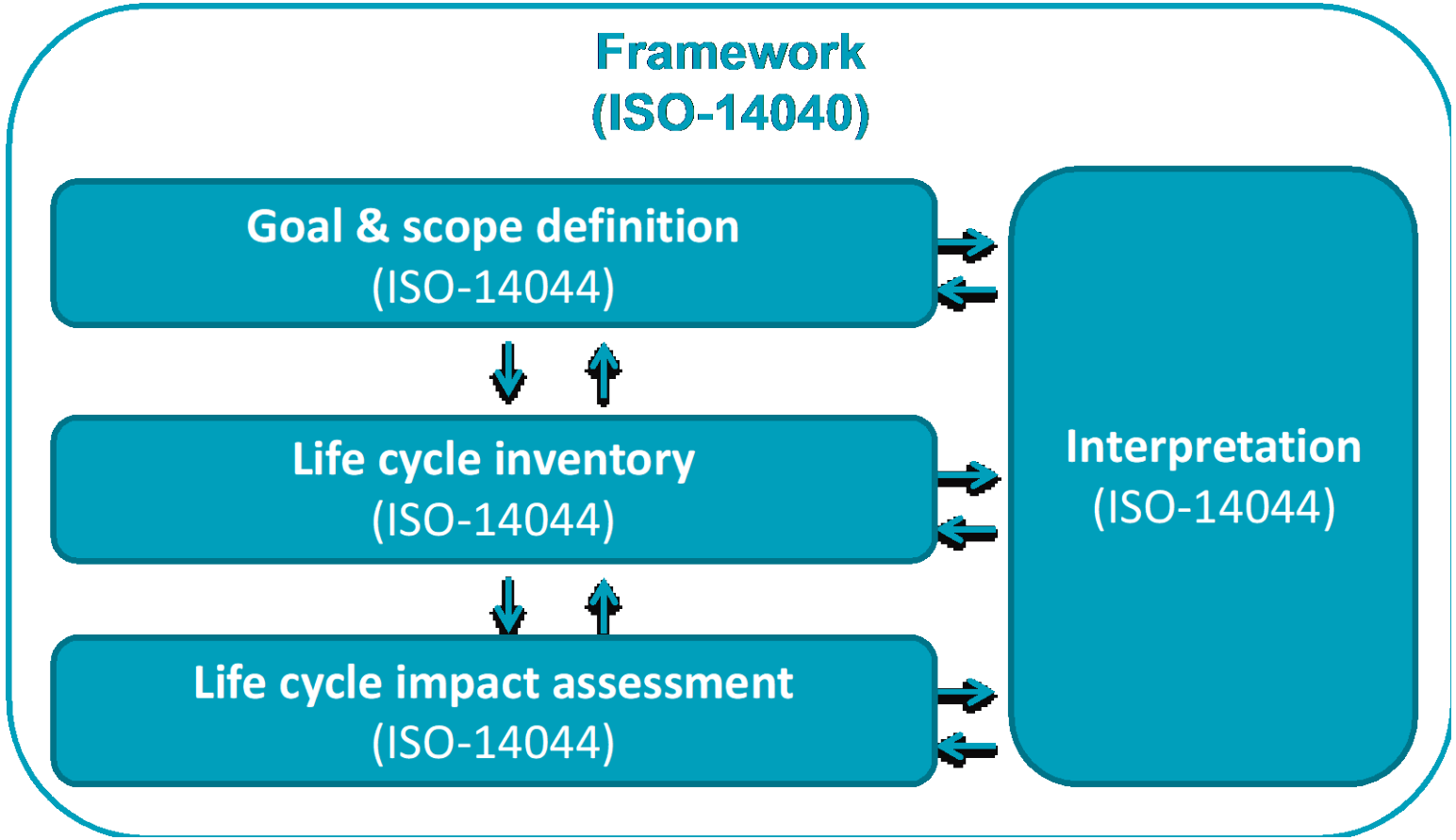
Source: https://eplca.jrc.ec.europa.eu/plasticLCA.html

Life cycle assessment

ISO 14040

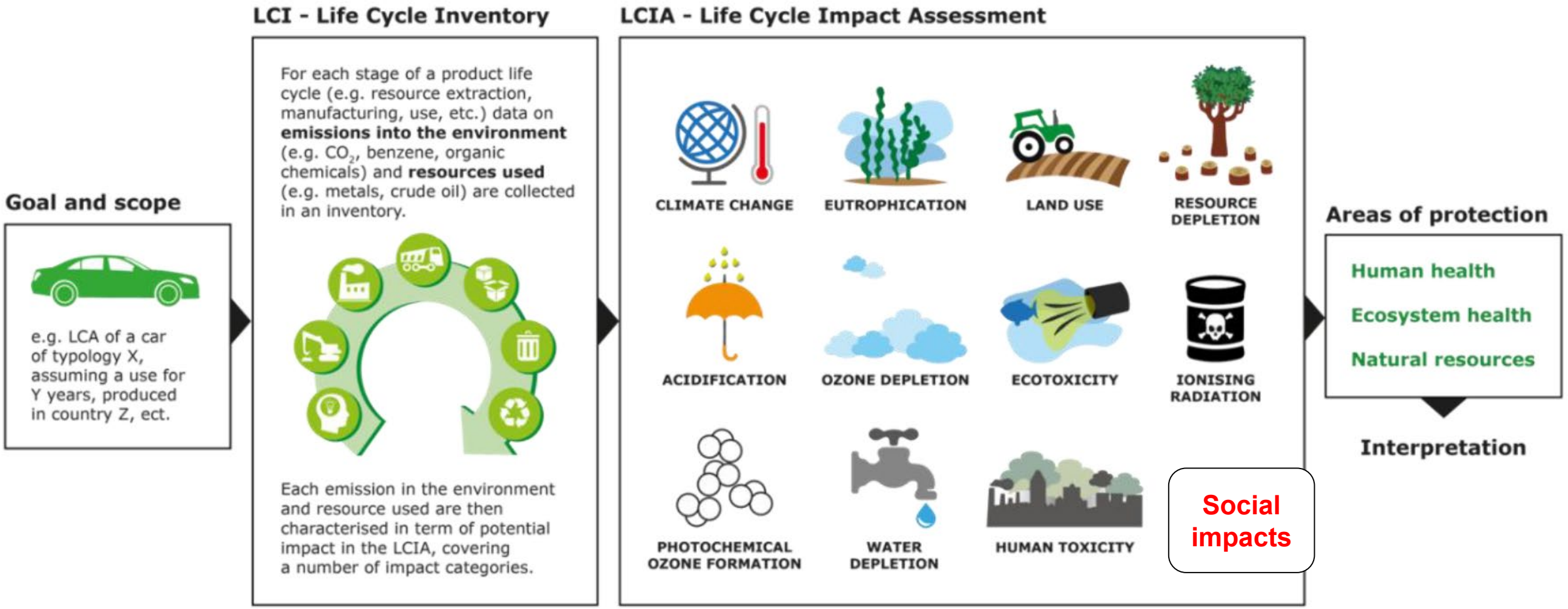
ISO: Enviromental management- life cycle assessment- principles and framework (**ISO 14040**). Geneva: ISO; 2006

European Platform on Life Cycle Assessment
https://eplca.jrc.ec.europa.eu/?page_id=86



Life cycle assessment

Scope



Source: Content of a Life Cycle Inventory
Source: https://eplca.jrc.ec.europa.eu/lifecycleassessment.html

Life cycle assessment for Research Infrastructures

Technological Components

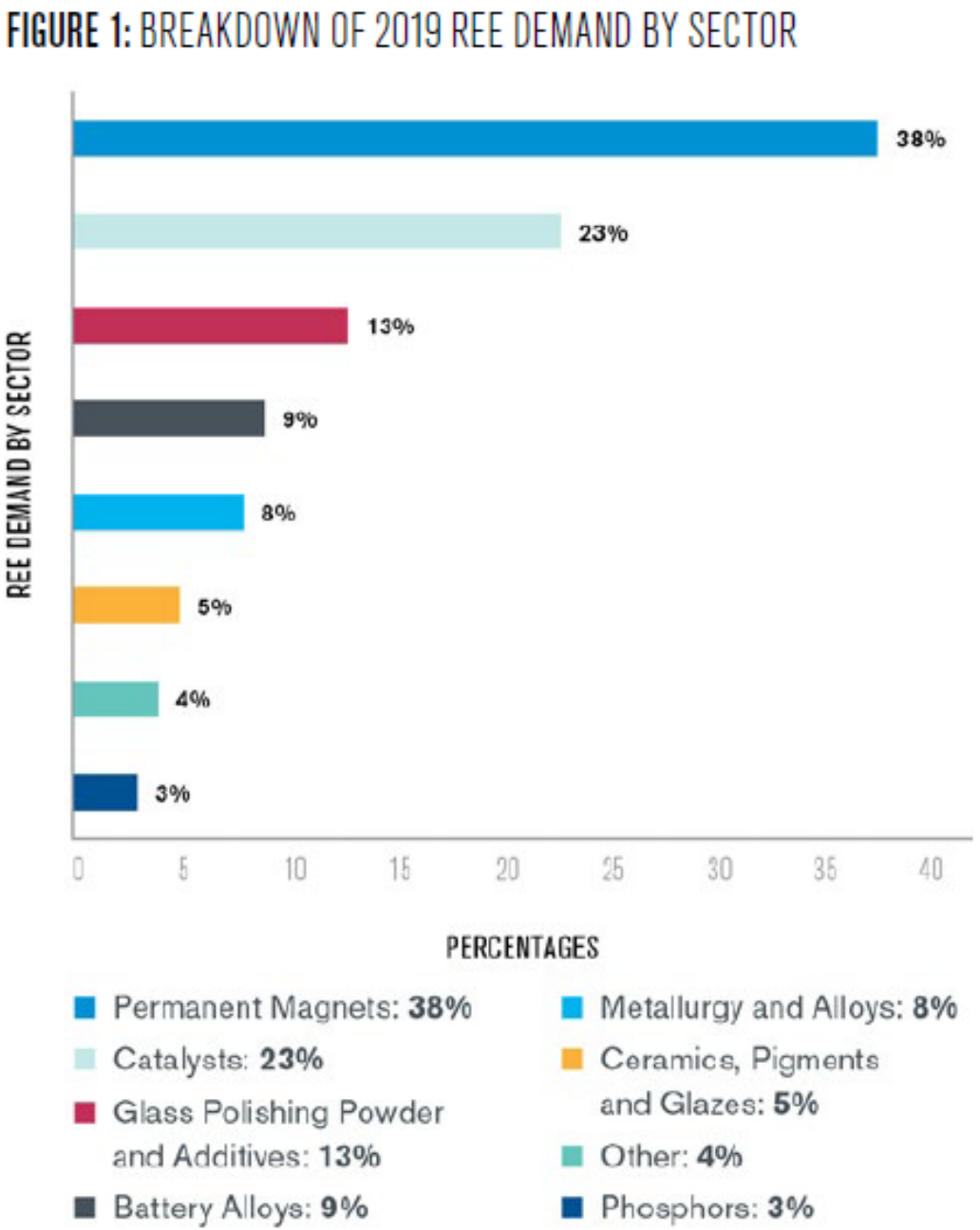
Consider entire life cycle of machines and components meaning construction – running – deconstruction

Example 1

Permanent Magnets

Rare Earth Elements

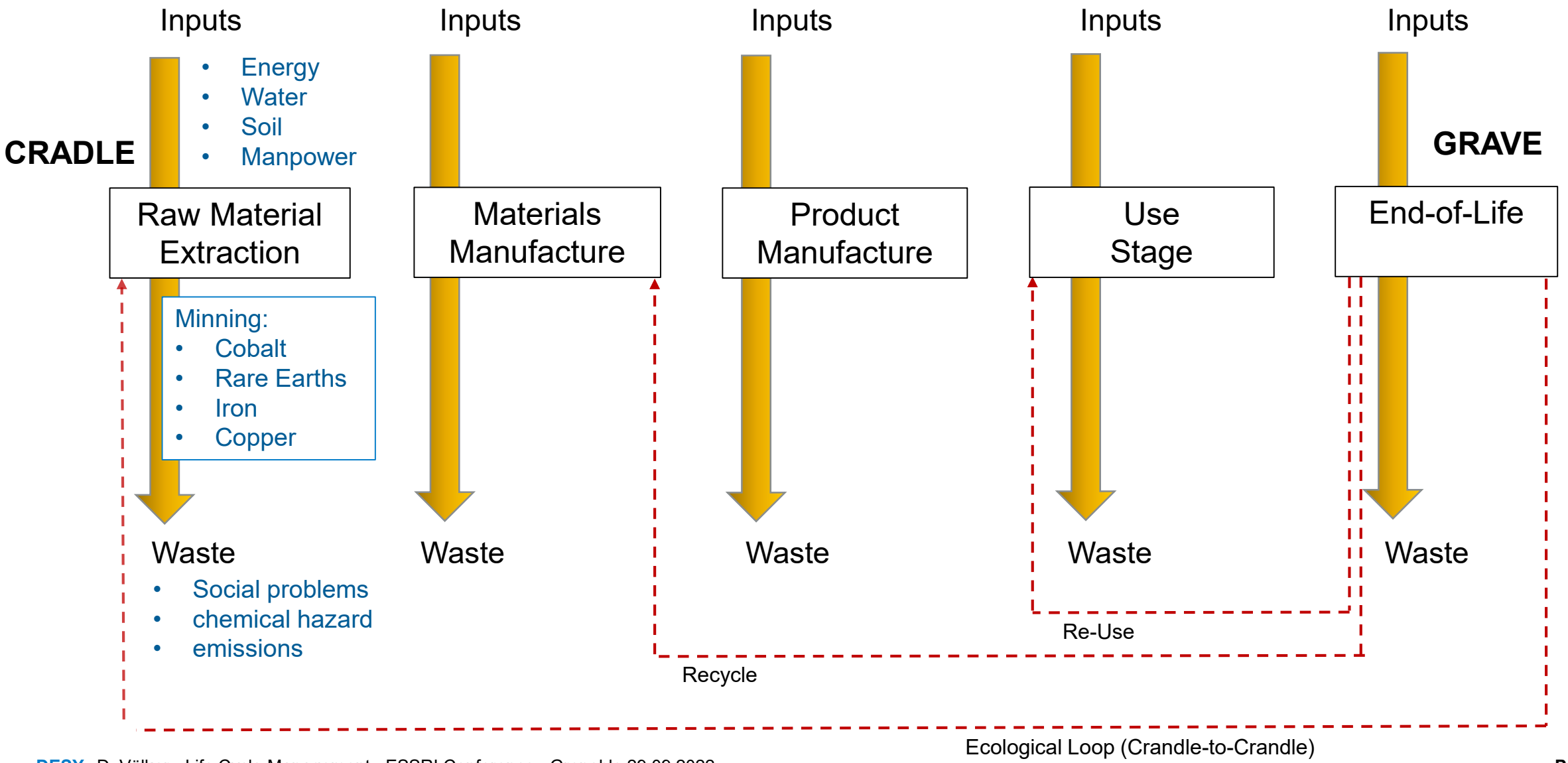
Importance of Permanent Magnets



Source:
https://kleinmanenergy.upenn.edu/research/publications/rare-earth-elements-a-resource-constraint-of-the-energy-transition/

Life cycle assessment from the cradle to the grave

Permanent Magnets



LCA Step 1

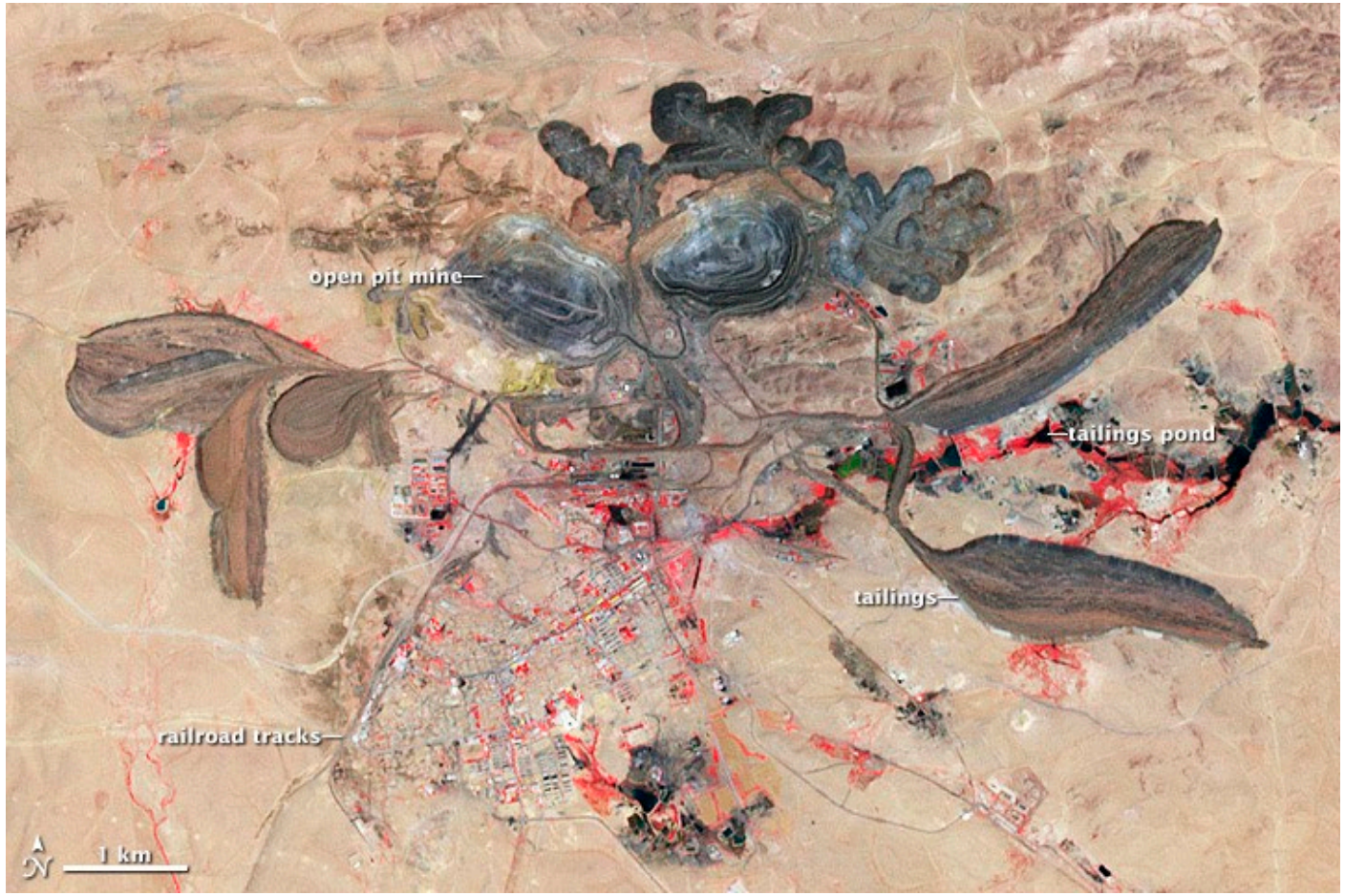
The Cradle of PM

newspaper (UK Guardian) article on shocking working conditions in cobalt mining, cobalt is also to be used in PM

Children as young as seven mining cobalt used in smartphones, says Amnesty

Amnesty International says it has traced cobalt used in batteries for household brands to mines in DRC, where children work in life-threatening conditions

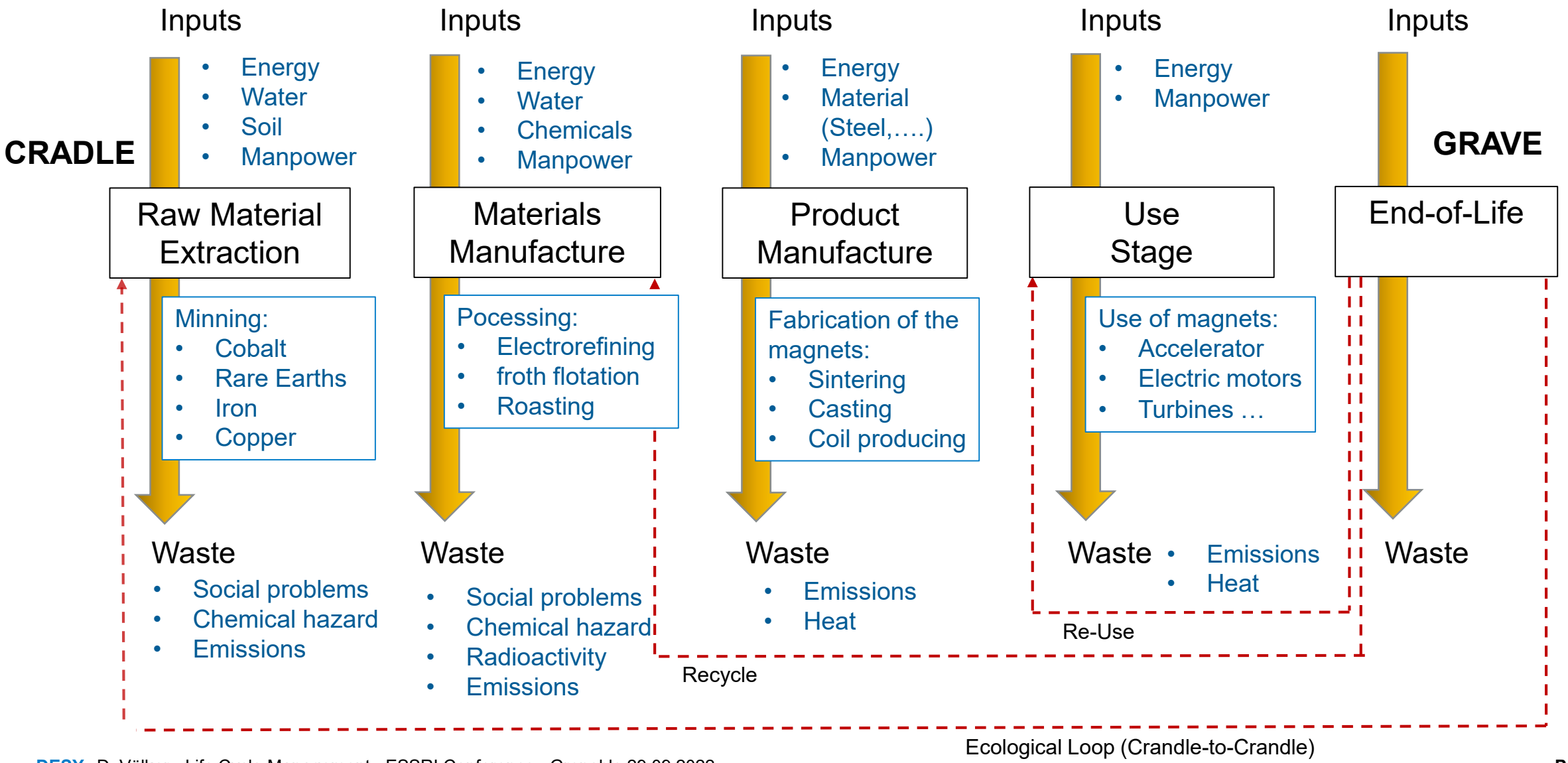
▲ A cobalt mine between Lubumbashi and Kolwezi in the Democratic Republic of the Congo. Photograph: Federico Scoppa/AFP/Getty Images



Minning of Rare Earths in Bayan Obo, 2006
false color ASTER image by NASA

Life cycle assessment from the cradle to the grave

Permanent Magnets



Permanent Magnets…

… and the Rare Earth Problem

Pro:

- Smaller
- Permanent Magnets save huge amounts of energy
- Similar facilities at ESRF in France and PSI in Switzerland showed that a modern accelerator design can lead to power savings on the order of 20% to 30% compared to a traditional storage ring design[1]

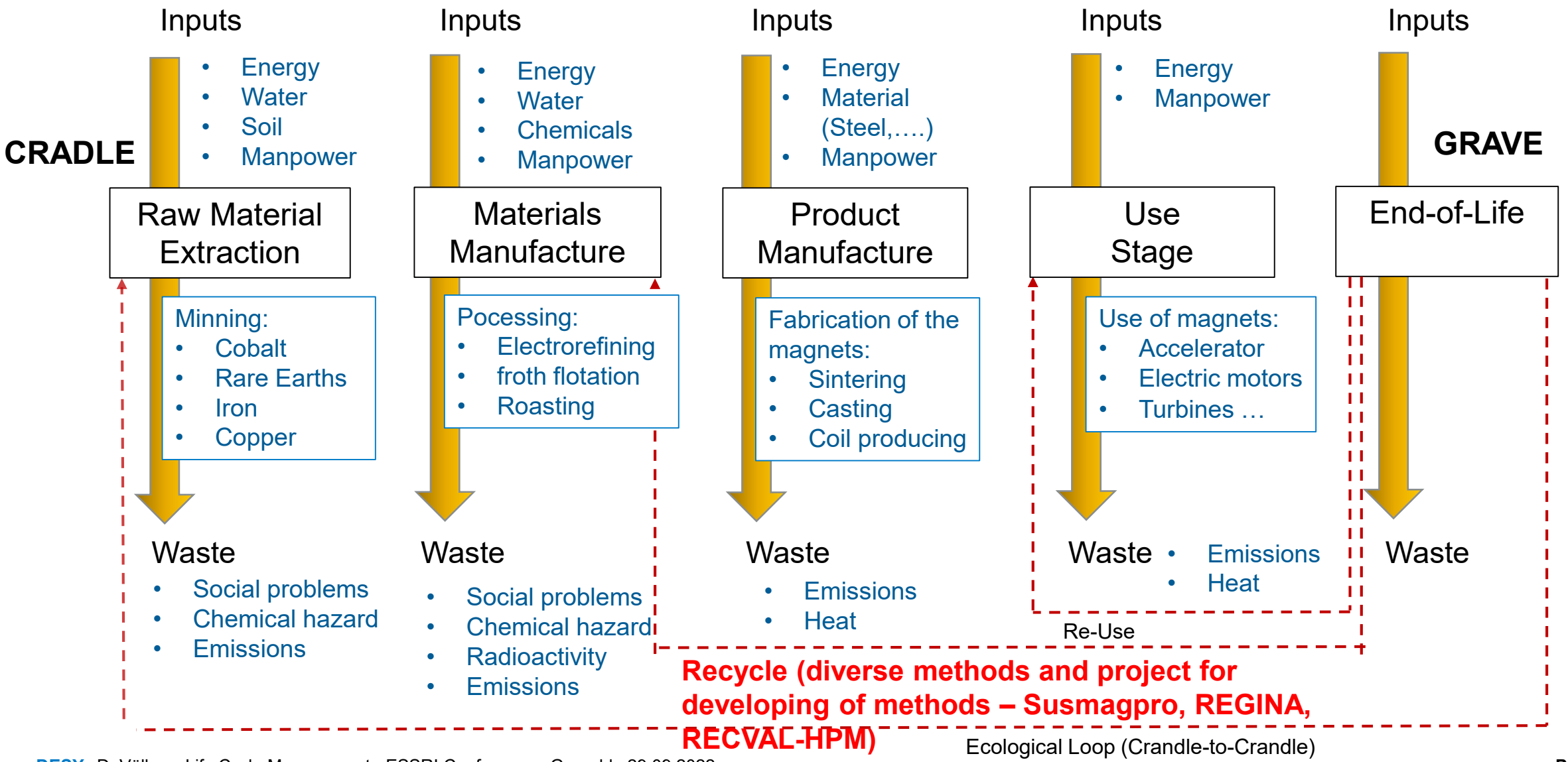
Contra:

- rare earths needed for PM mined and processed under destructive social and environmental conditions
- In 2019 38% of rare earth elements demand was for PM
- no alternative sources or certified mining and processing available
- So far no sufficient progress on recycling of old PM

[1] **source:** PSI : Talk M. Seidel; I.FAST Accelerator Industry Co-Innovation Workshop 2022, CERN, ESRF: Talk H. Reichert (The Upgrade of the ESRF & Energy Sustainability); ESSRI 2017, CERN

Life cycle assessment from the cradle to the grave

Permanent Magnets



Permanent Magnets

Critical Materials and Life Cycle Management

The Example of Rare Earths – Curse or Blessing?

Save-the-date: Workshop on 6th - 8th February 2023 at DESY in Hamburg/Germany

- **Life cycle management:** Consider entire life cycle of technical components using critical materials: construction – operation – deconstruction
- **Mining and processing of rare earths:** A socio-ecological approach – energy savings versus destructive mining and processing
- **Using permanent magnets:** Examples of the use of permanent magnets and its Pro and Con
- **Certification for mining and processing of rare earths:** How to force more sustainable thinking in the production of rare earths
- **Recycling of permanent magnets:** New processes for the re-use and recycling of permanent magnets
- **Alternatives for permanent magnets with rare earths:** New magnetic materials as well as improved electromagnets

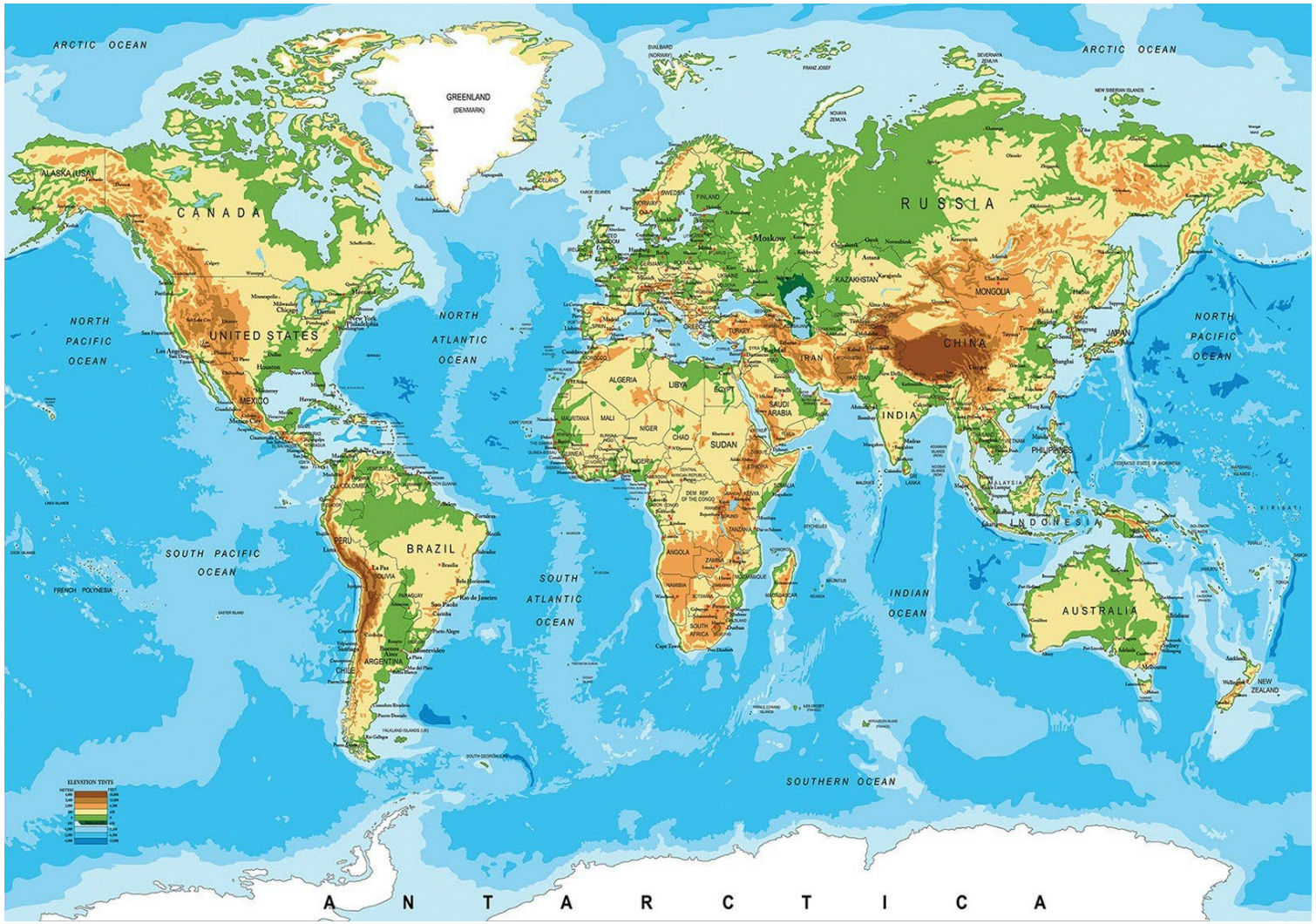
→ https://indico.desy.de/event/35655/

Example 2

Niobium

Life cycle assessment

Where is the Cradle?



Origon of Niobium

<90% in the Amazon Rainforest

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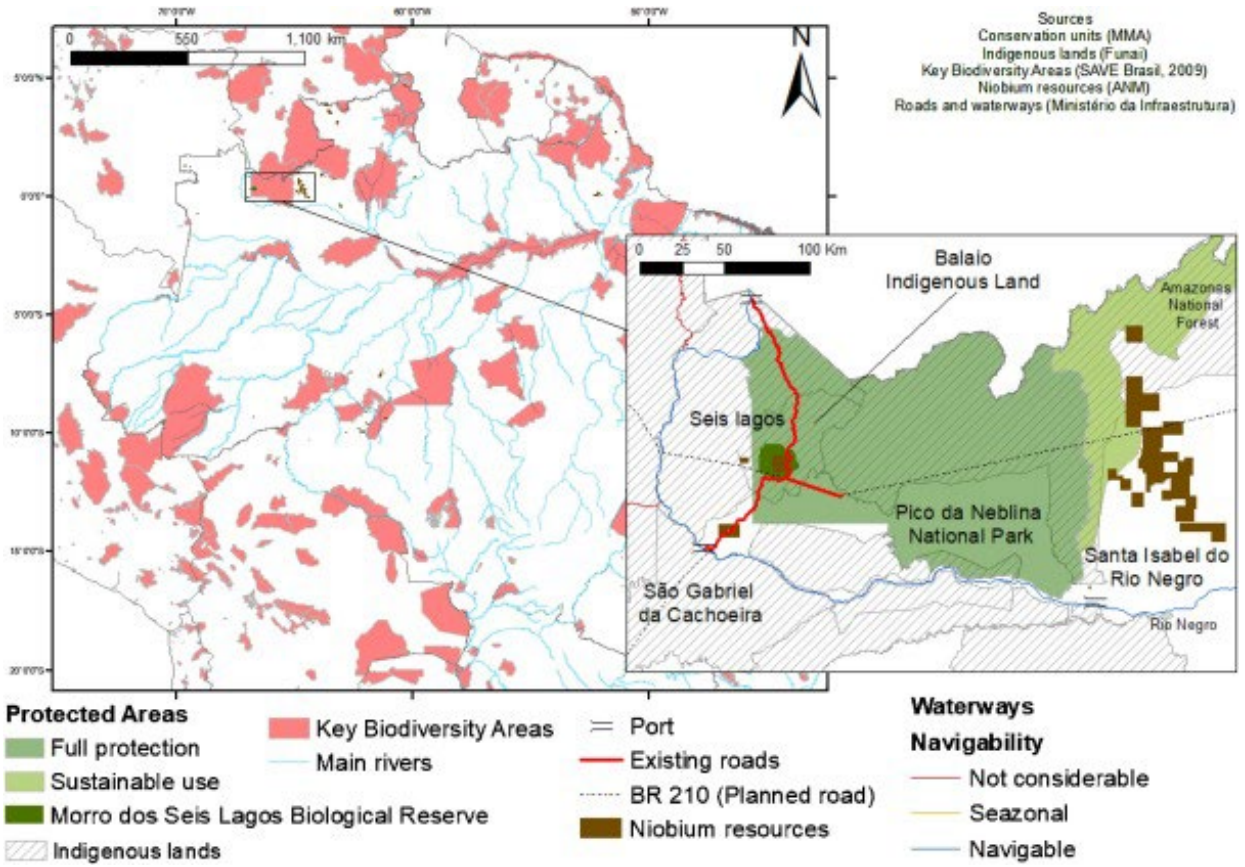
Environmental Science & Policy

Volume 111, September 2020, Pages 1-6

Short communication

Keep the Amazon niobium in the ground

Juliana Siqueira-Gay, Luis E. Sánchez



Conclusion

Challenges in the LCA

- Results depending on the used approach (closed loop or only Cradle-to-Gate)
- Results depending on the involved data (only energy or also landuse and socio-ecological facts)
- Difficulties getting the data
- Displacement of impacts
- Costs (economical, ecological and social) at different time scales and
- Judge/benchmark of the data
- Interpretation of the data

What to do now?

- Step 1: be aware!
- Start looking into the life cycle of all the products/materials you use
- LCA is the method to understand the problem better
- Is it not the method to change it, make it better
- As it is so complicated to get all the data, to identify all the interconnections and to interpret the data → dont wait till it´s complete, start tackling the problems

THANK YOU!

Questions?