

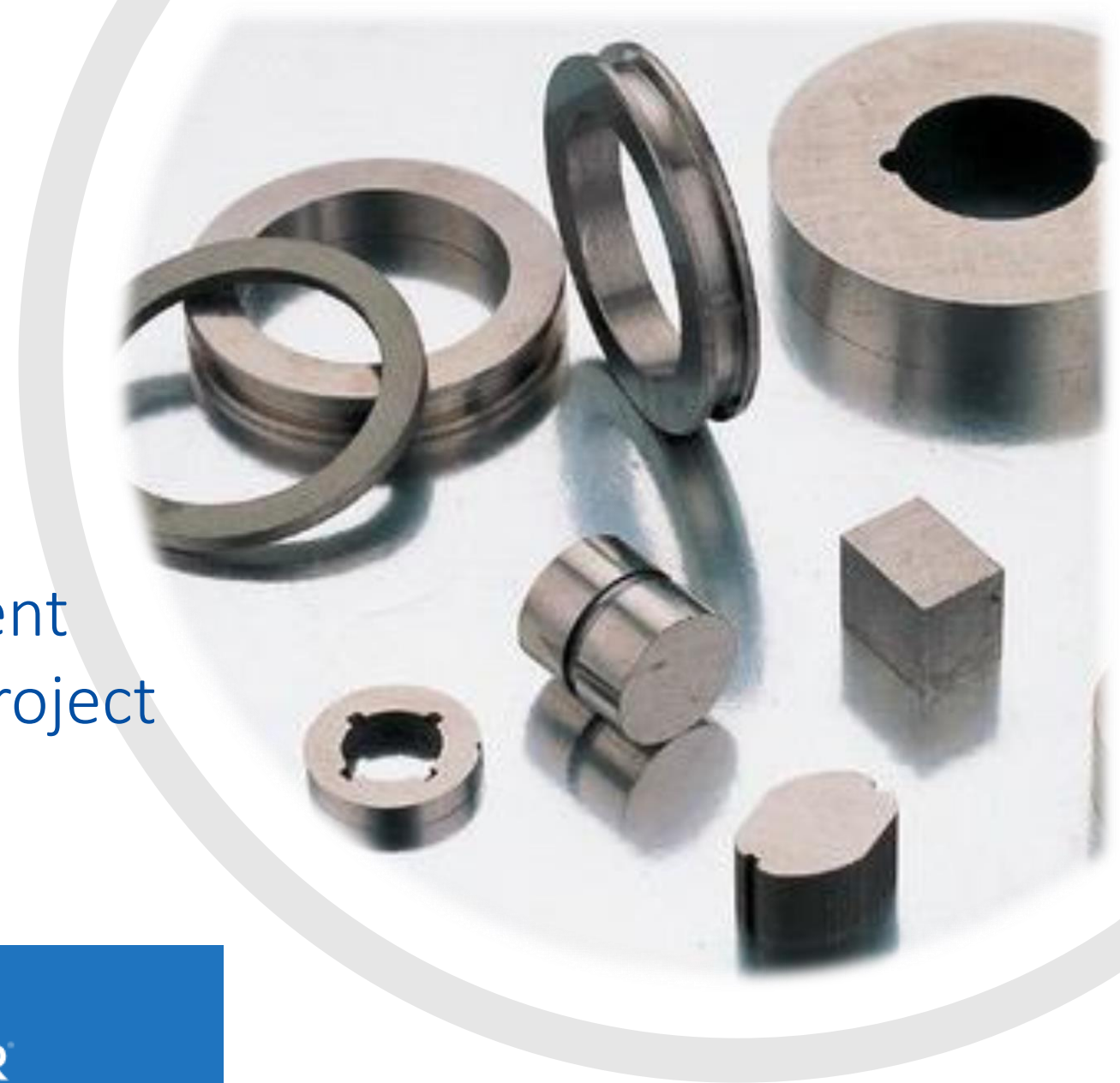
Towards the Recycling of Permanent Magnets through VALOMAG EU project

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15th September, 2022

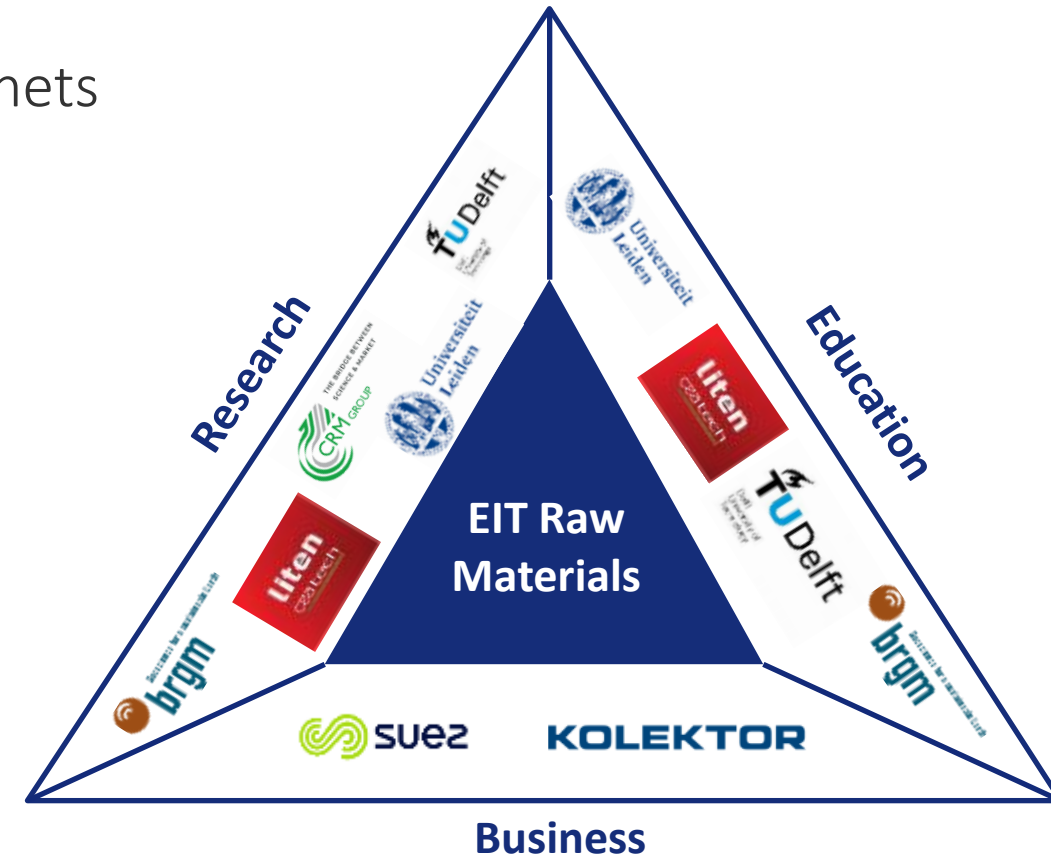
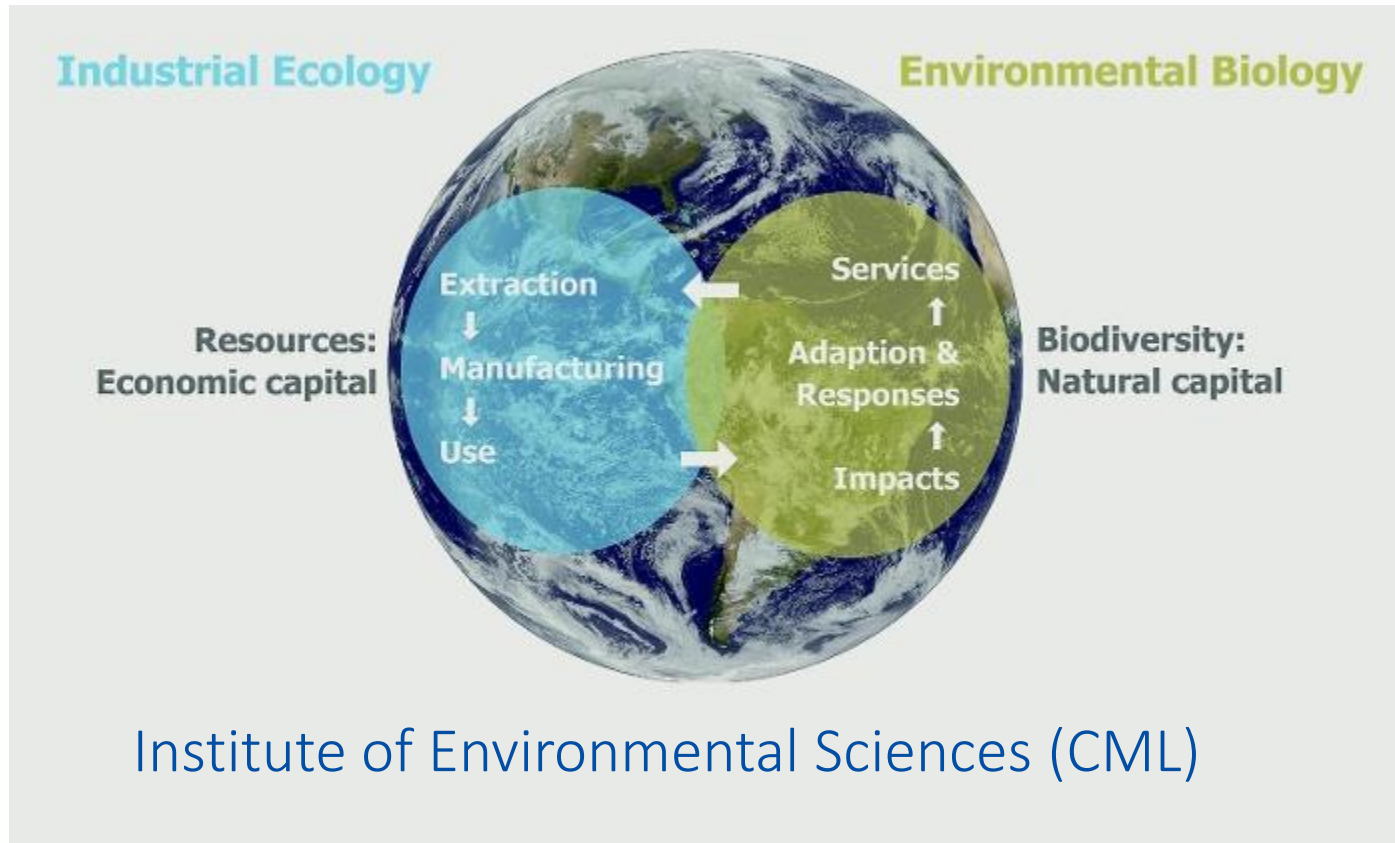


Co-funded by the
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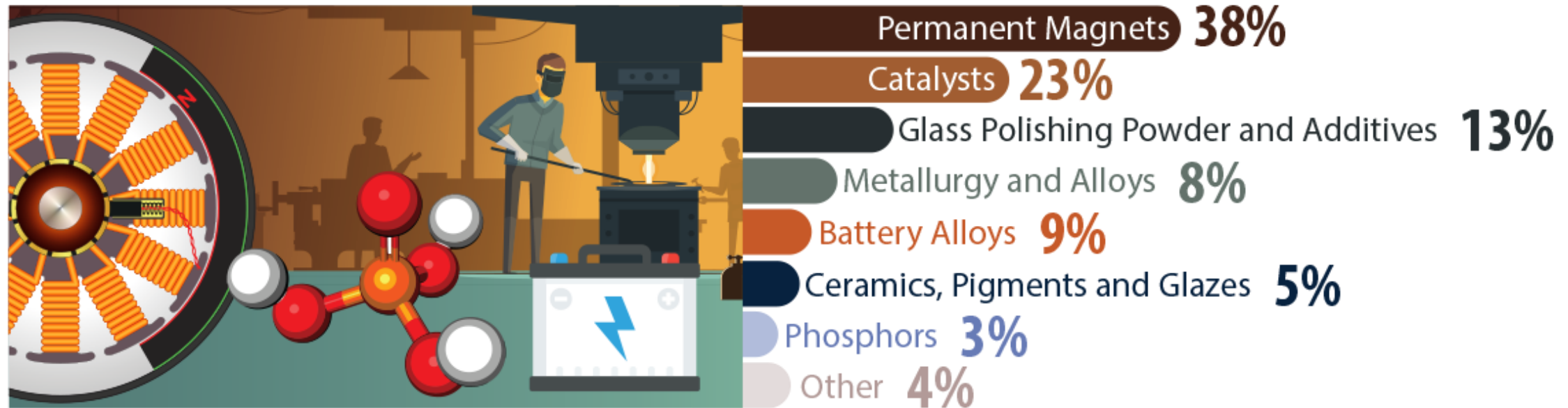
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2. An overview of VALOMAG project
3. LCA in VALOMAG of primary and secondary Nd magnets



Rare earth elements (REE)

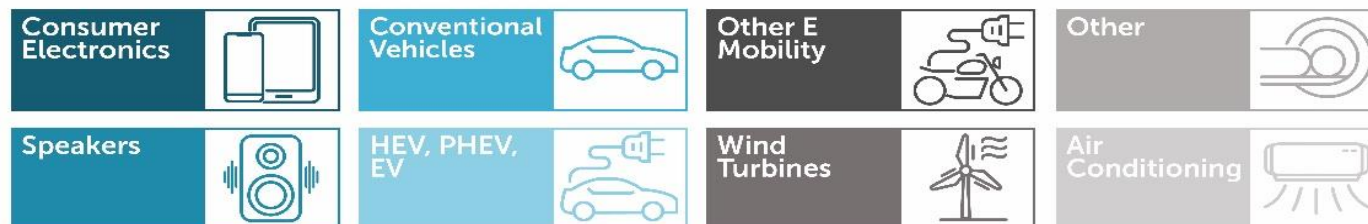
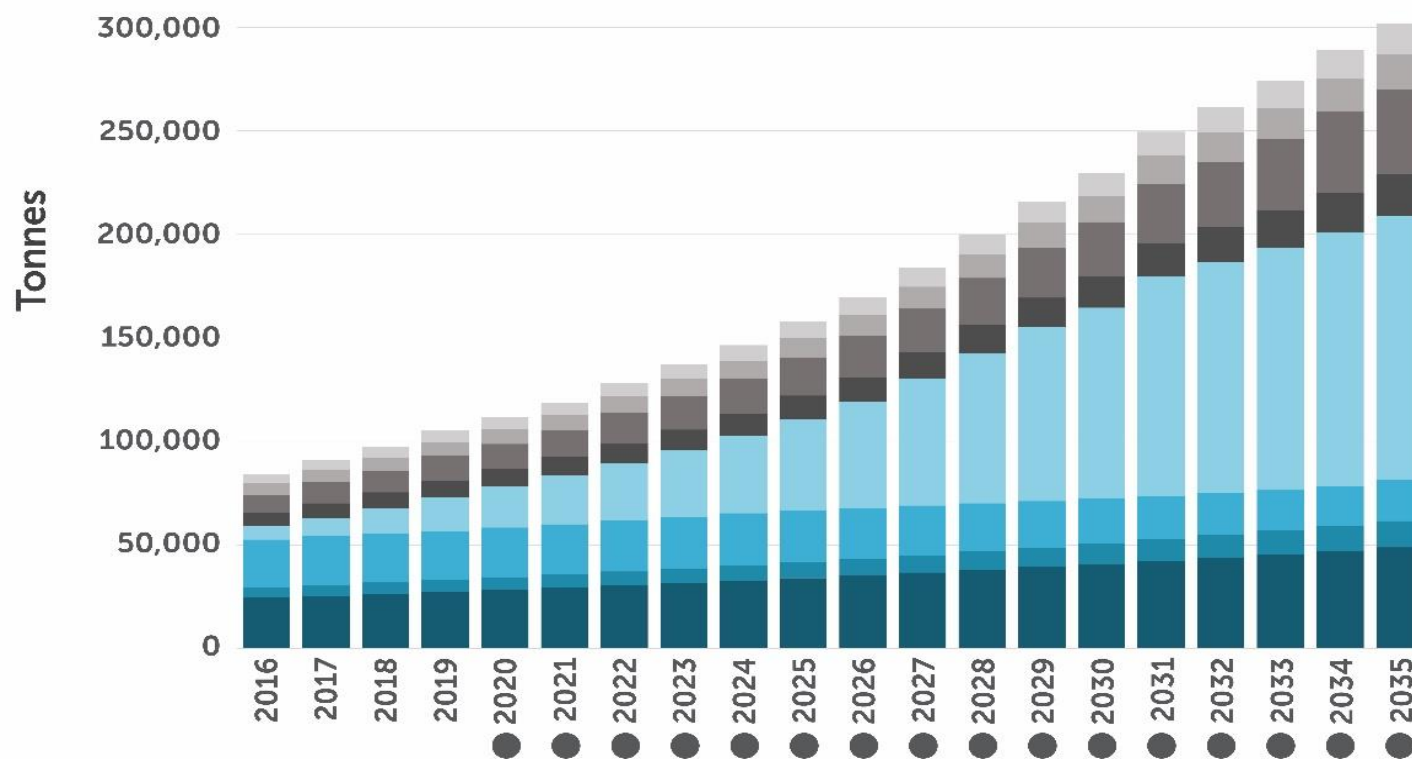
- REE = set of 17 metallic elements including:
 - 15 lanthanides
 - Scandium and Yttrium



Increasing demand of rare earth magnets

- Permanent magnets: alloys of Neodymium-Iron-Boron (NdFeB)
- Clean energy applications
- Electromobility
- New technologies

Forecast NdFeB Magnet Consumption

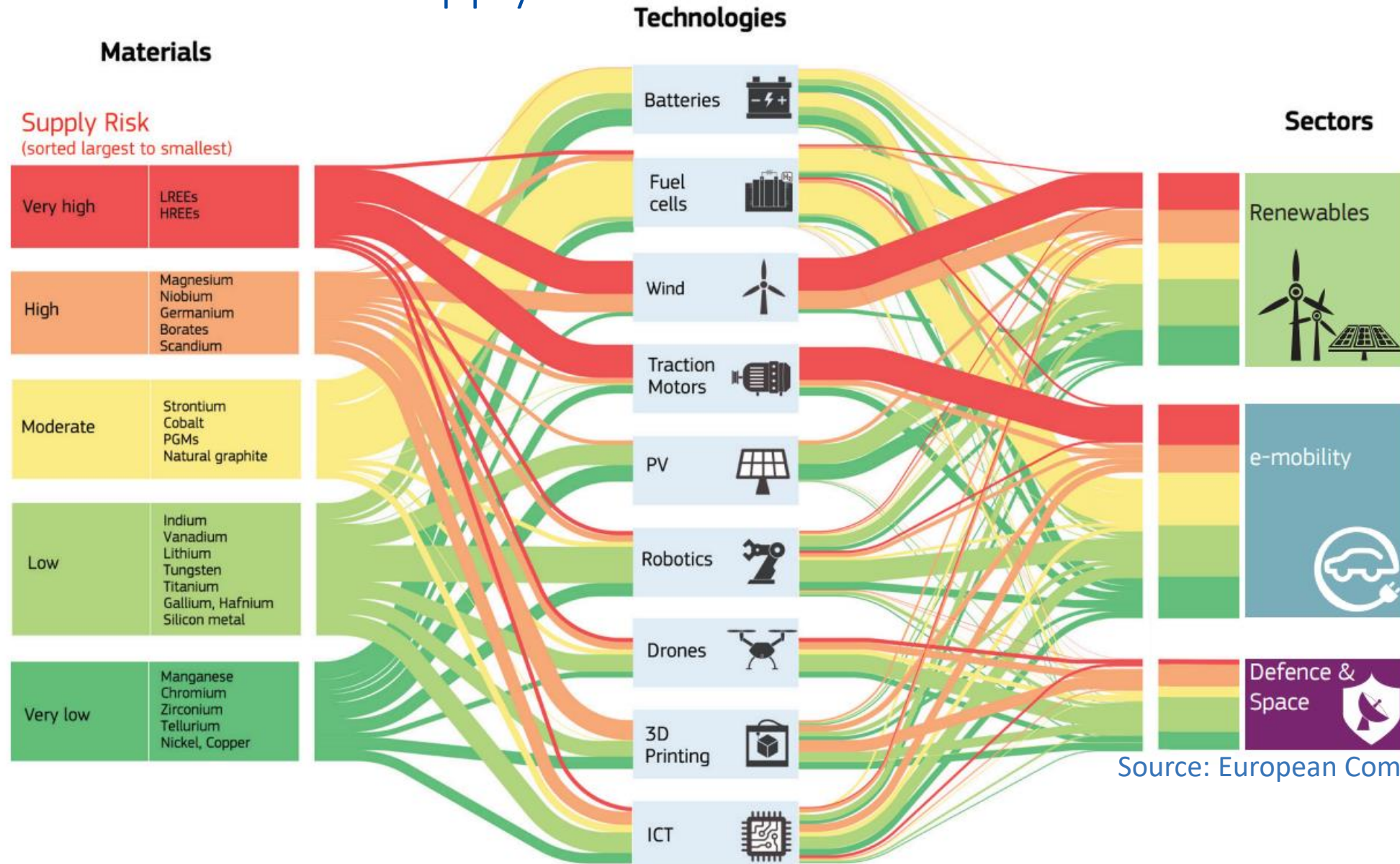


Other includes MRI, elevator motor, magnetic separator, robotics and industrial applications.
Source: CRU – Rare Earth Report 2020

● Forecast

Challenges in rare earth magnets:

Vulnerable supply of critical metals



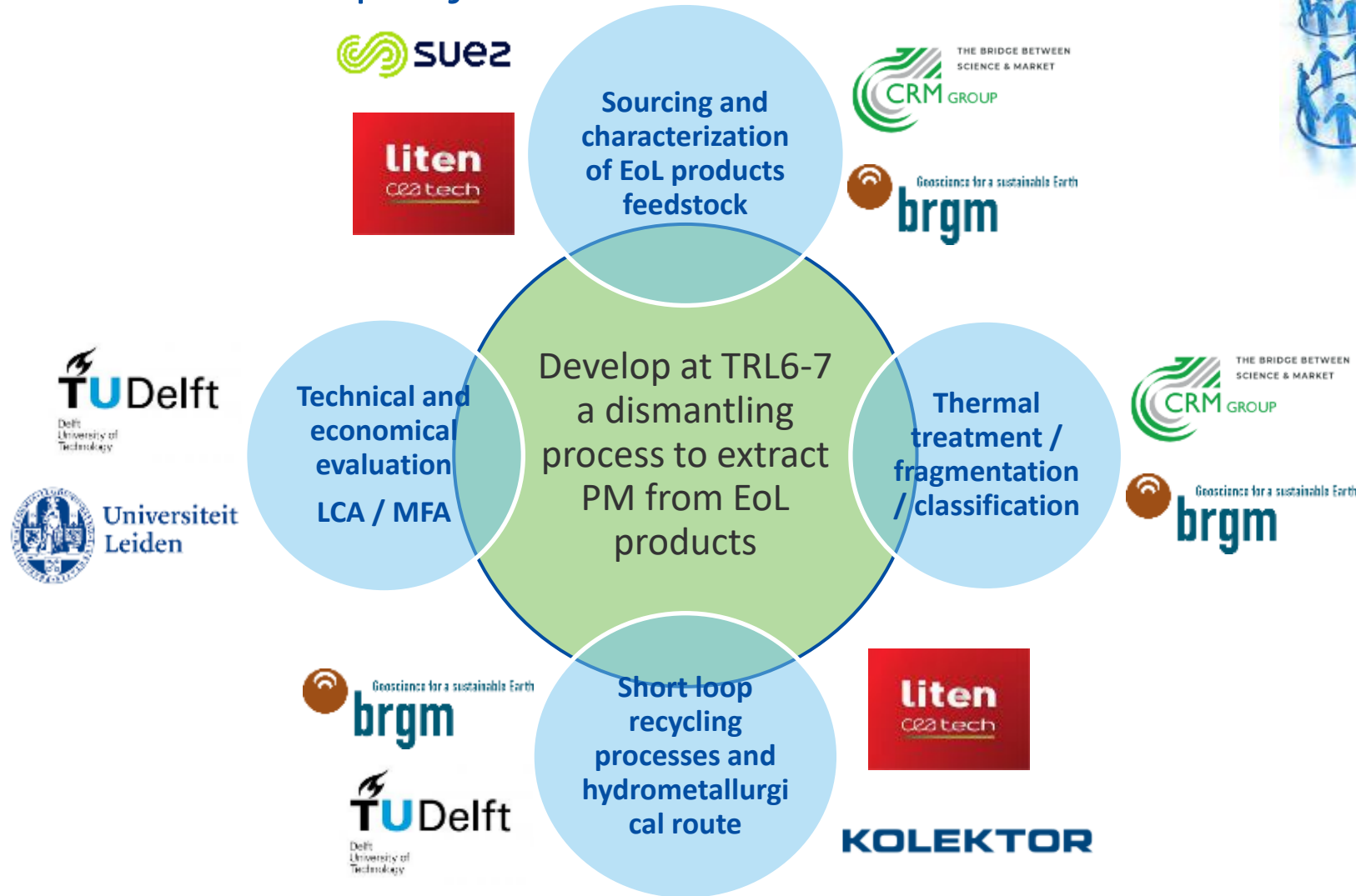
Source: European Commission, 2018.

Challenges in rare earth magnets:

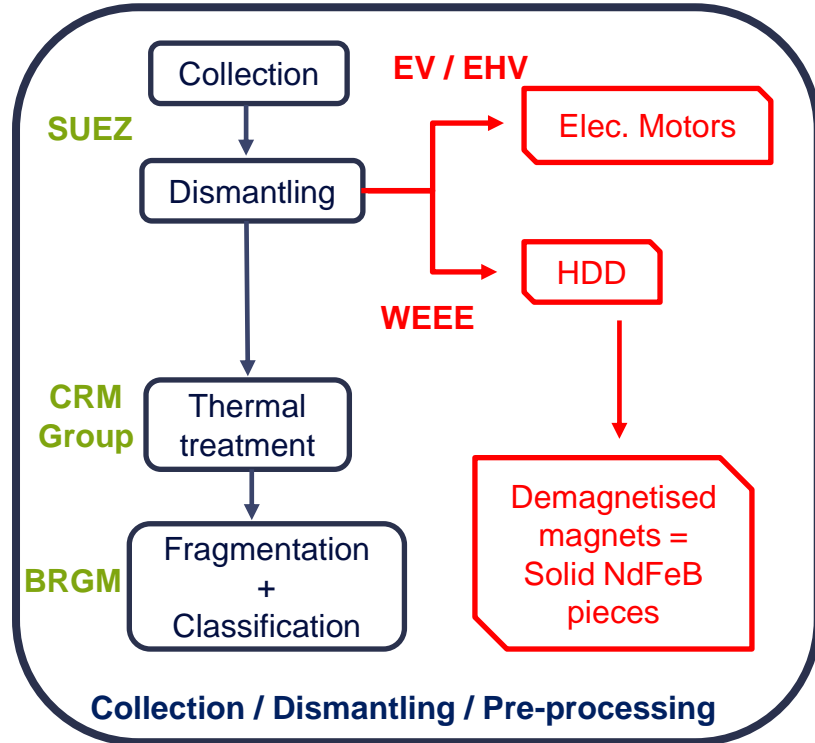
Environmental concern about rare earth mining and manufacturing



Objective of VALOMAG project



VALOMAG process chart: from the dismantling of EoL products

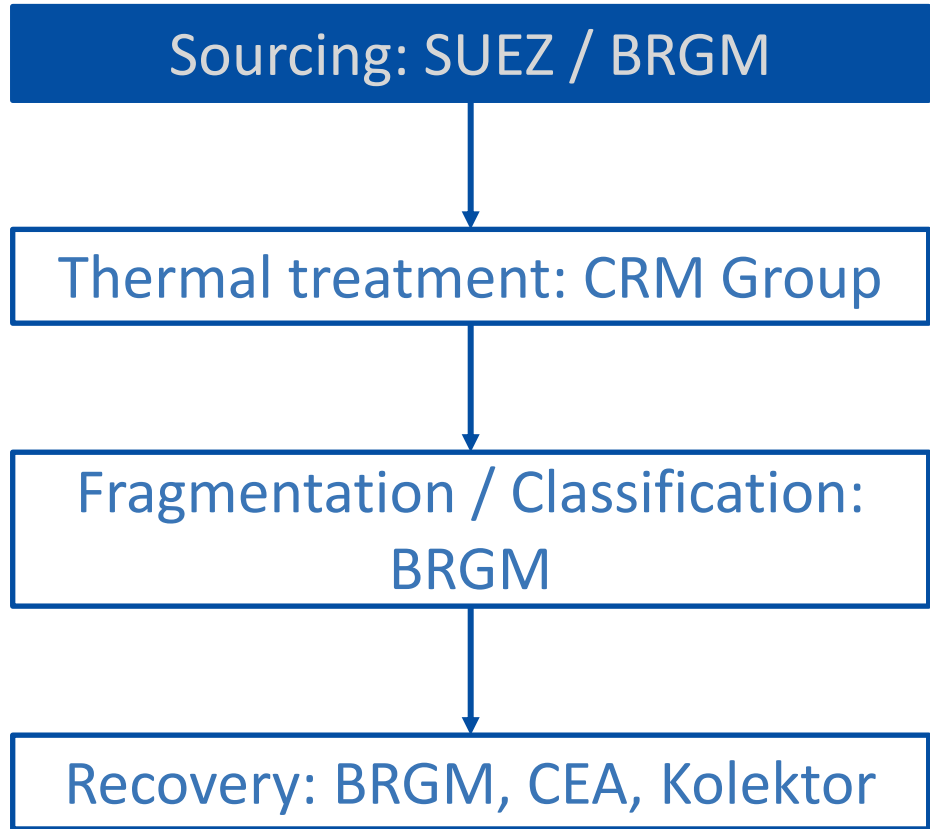


Legend: Partner involved

Materials

Process step

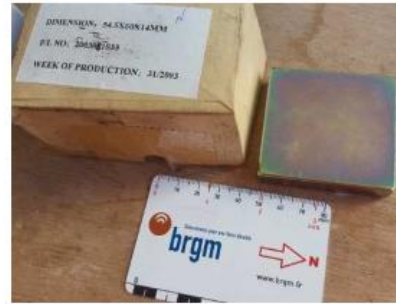
Sourcing of EoL products



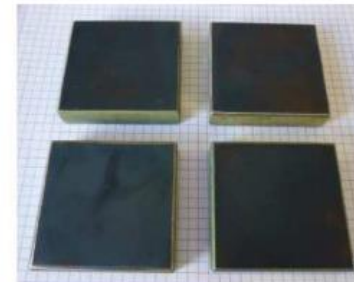
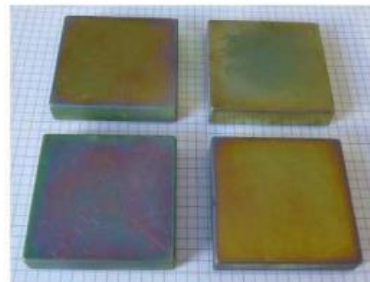
1 600kg HDD delivered to CRM



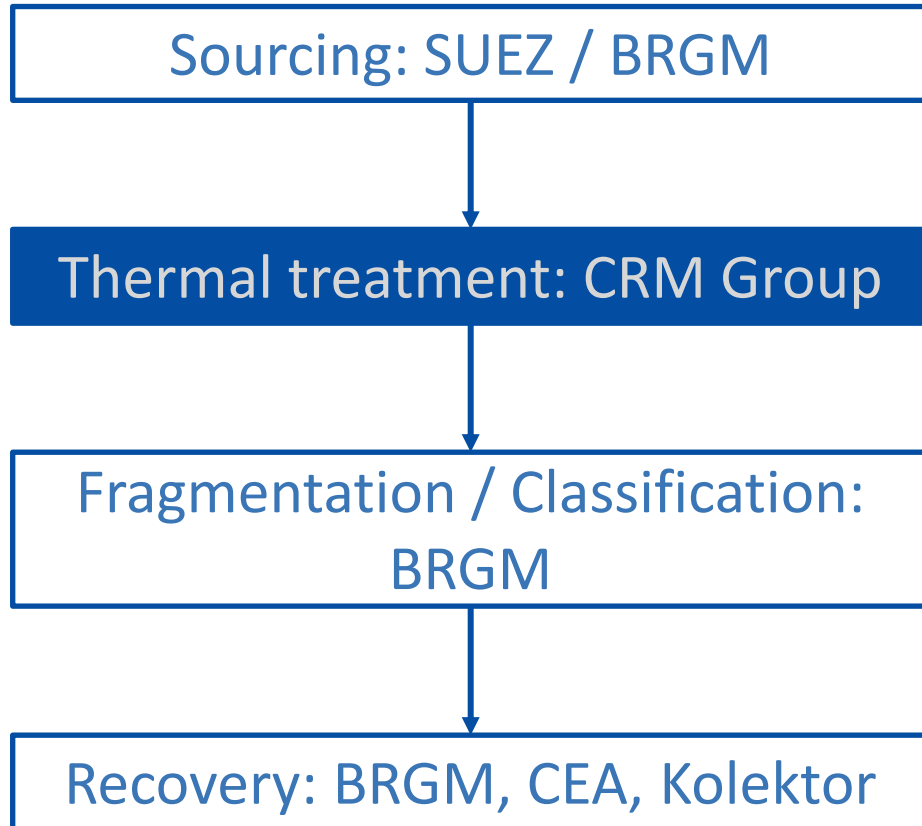
980kg Wind Turbines' magnets sourced by BRGM



2 types: with and without Zn coating



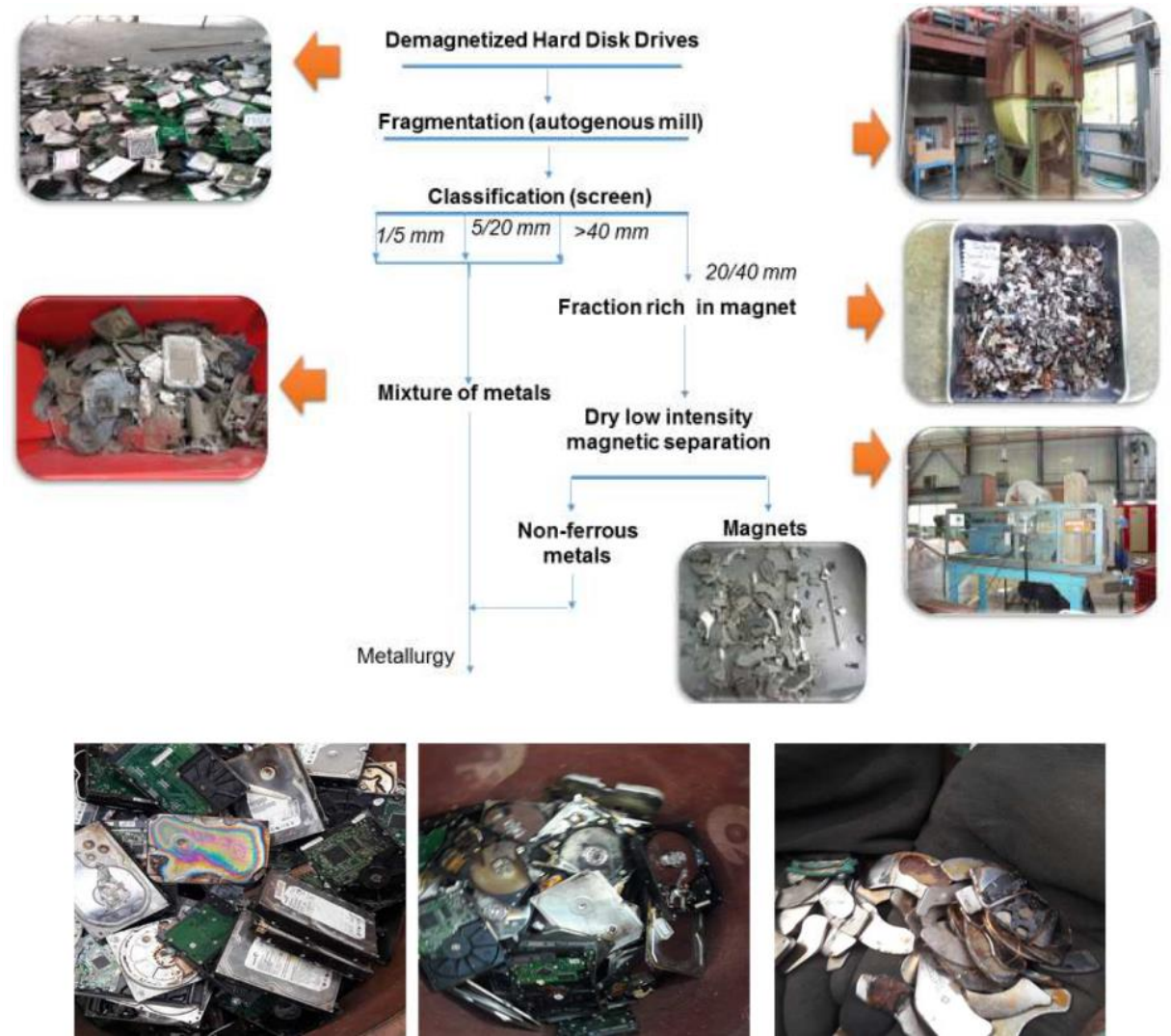
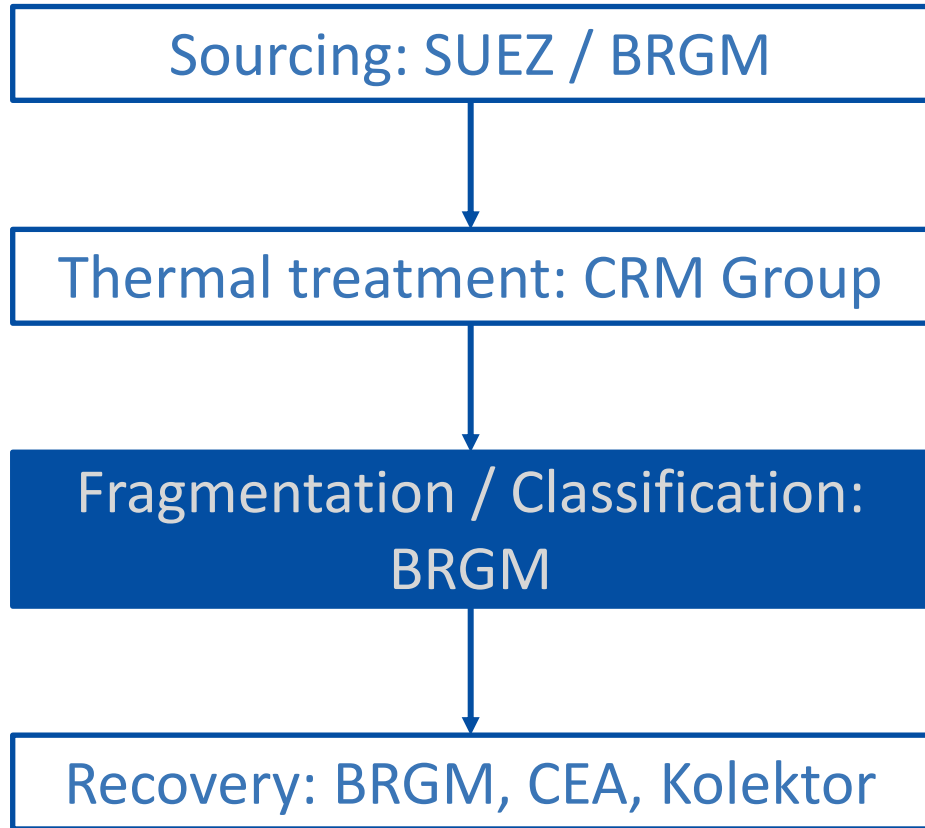
Dismantling process → Thermal treatment



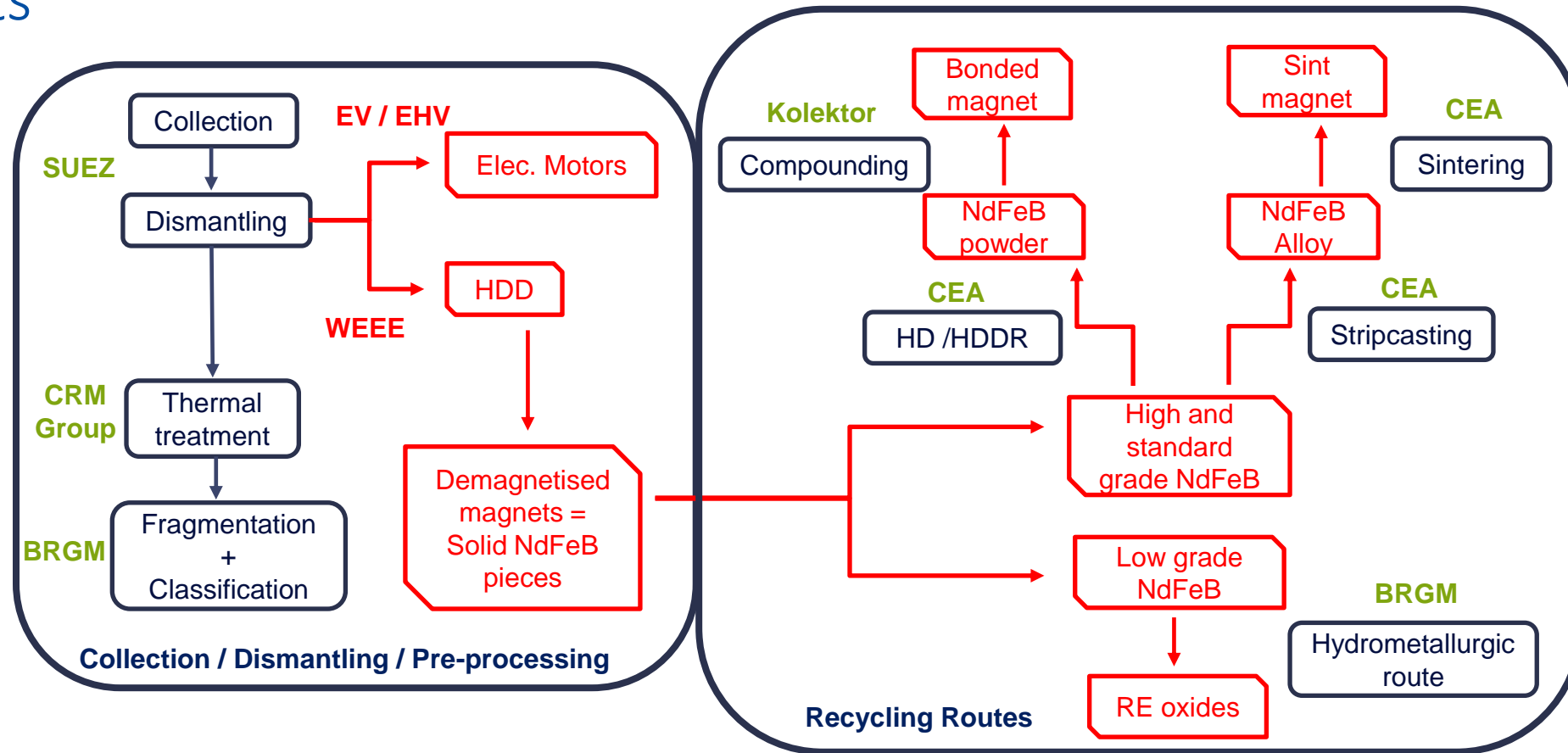
“Design for recycling”



Dismantling process → Fragmentation and classification

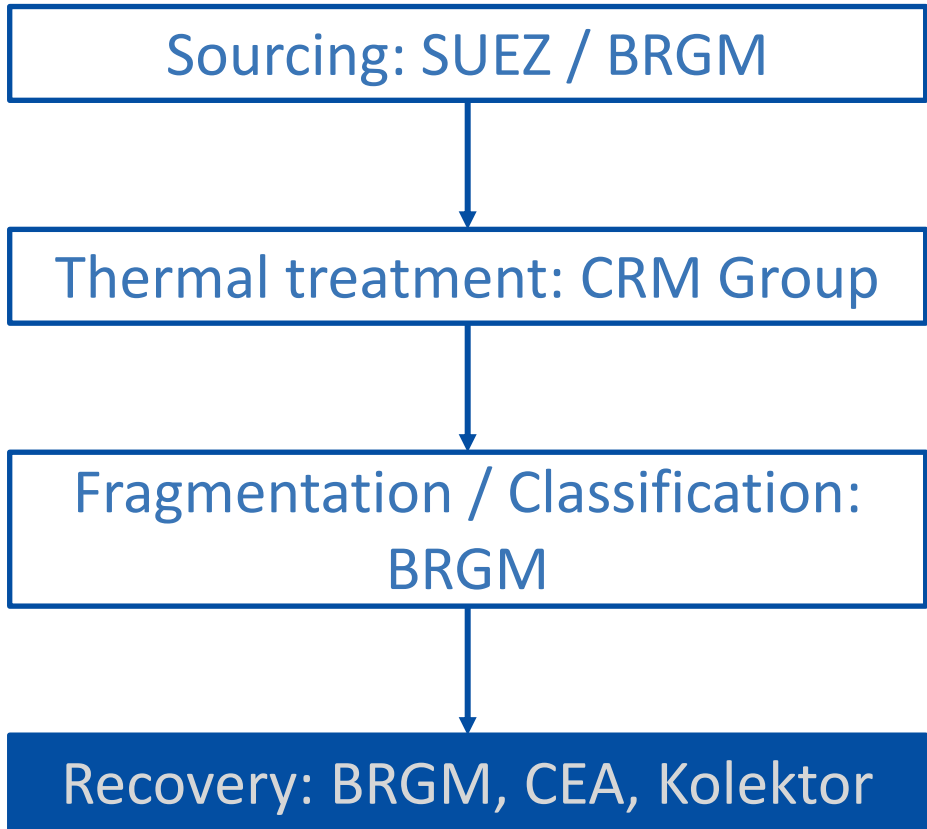


VALOMAG process chart: to the recovery of REE oxides and recycling of magnets

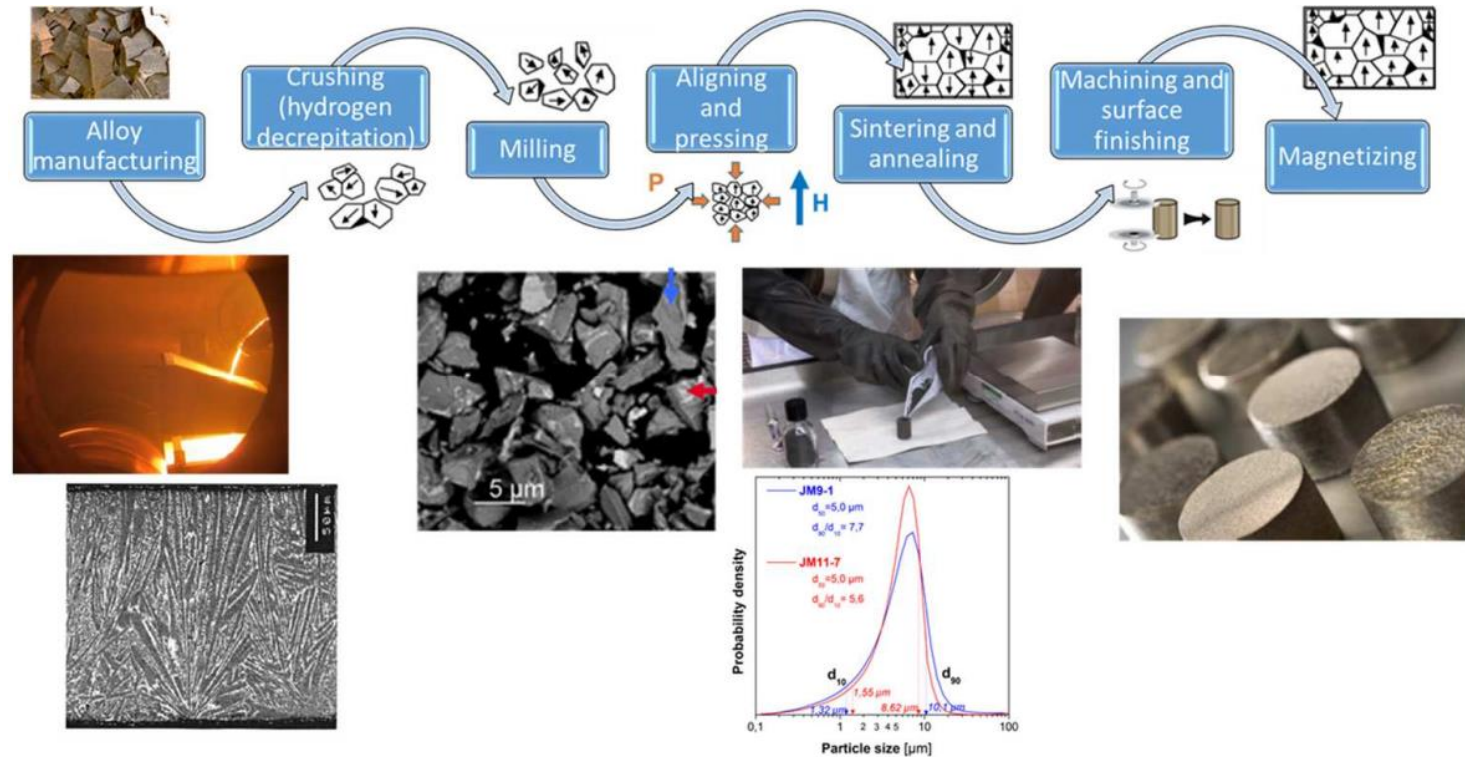


Legend: Partner involved (green text), Materials (red box), Process step (black box)

Recovery and recycling routes

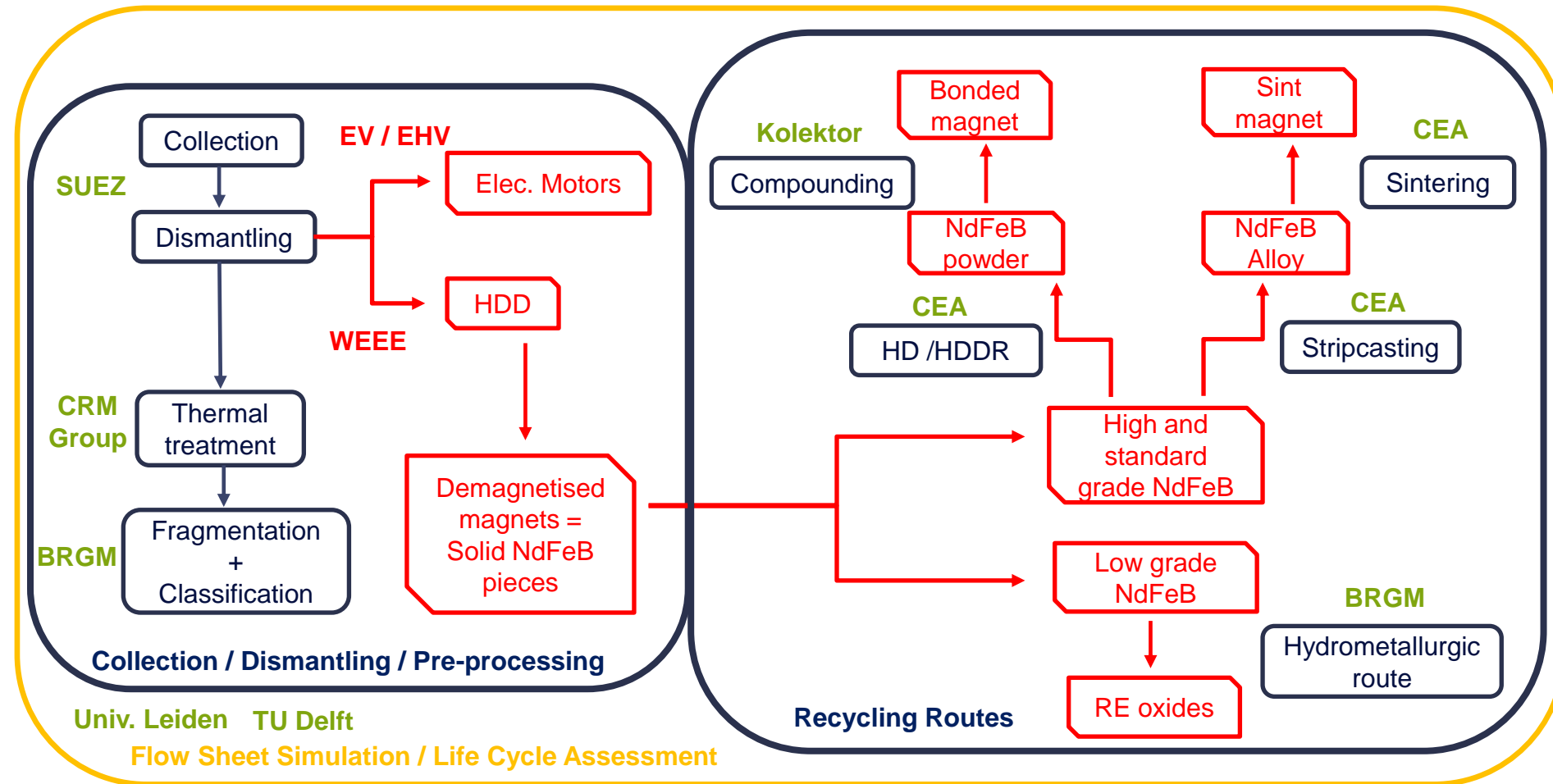


From raw materials to functional magnets



Short Loop Recycling with CEA and Kolektor

VALOMAG process chart: supported by LCA and MFA



Legend: Partner involved (green text), Materials (red box), Process step (black box)

LCA methodology

- “Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle”



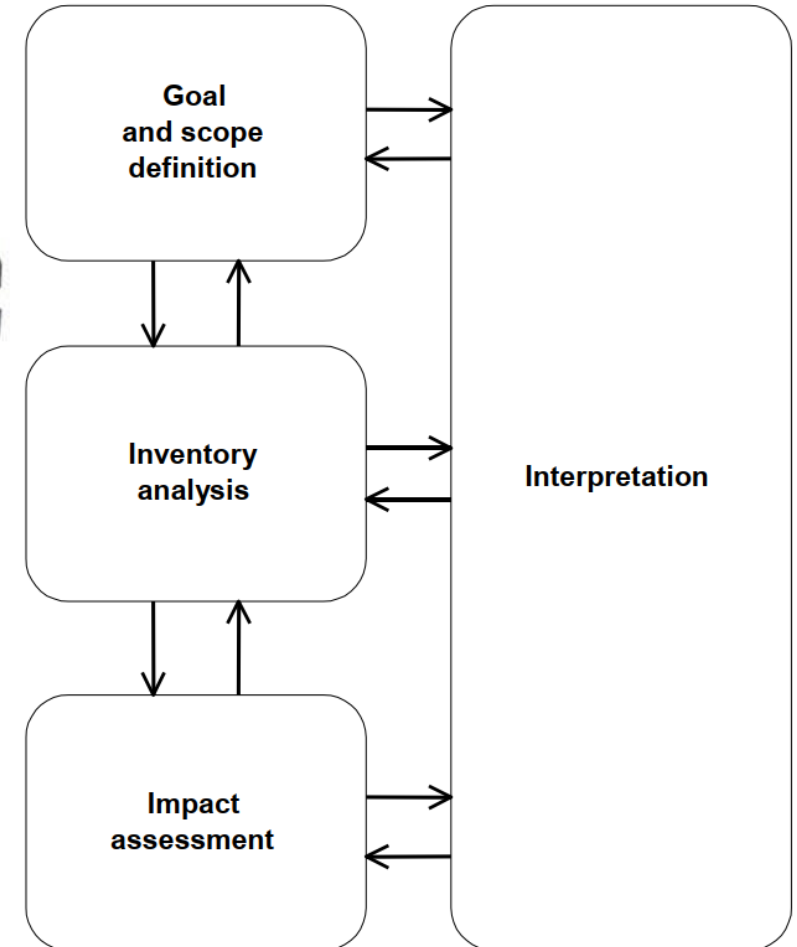
- Research question:

What is the environmental impacts of producing 1kg primary NdFeB magnets

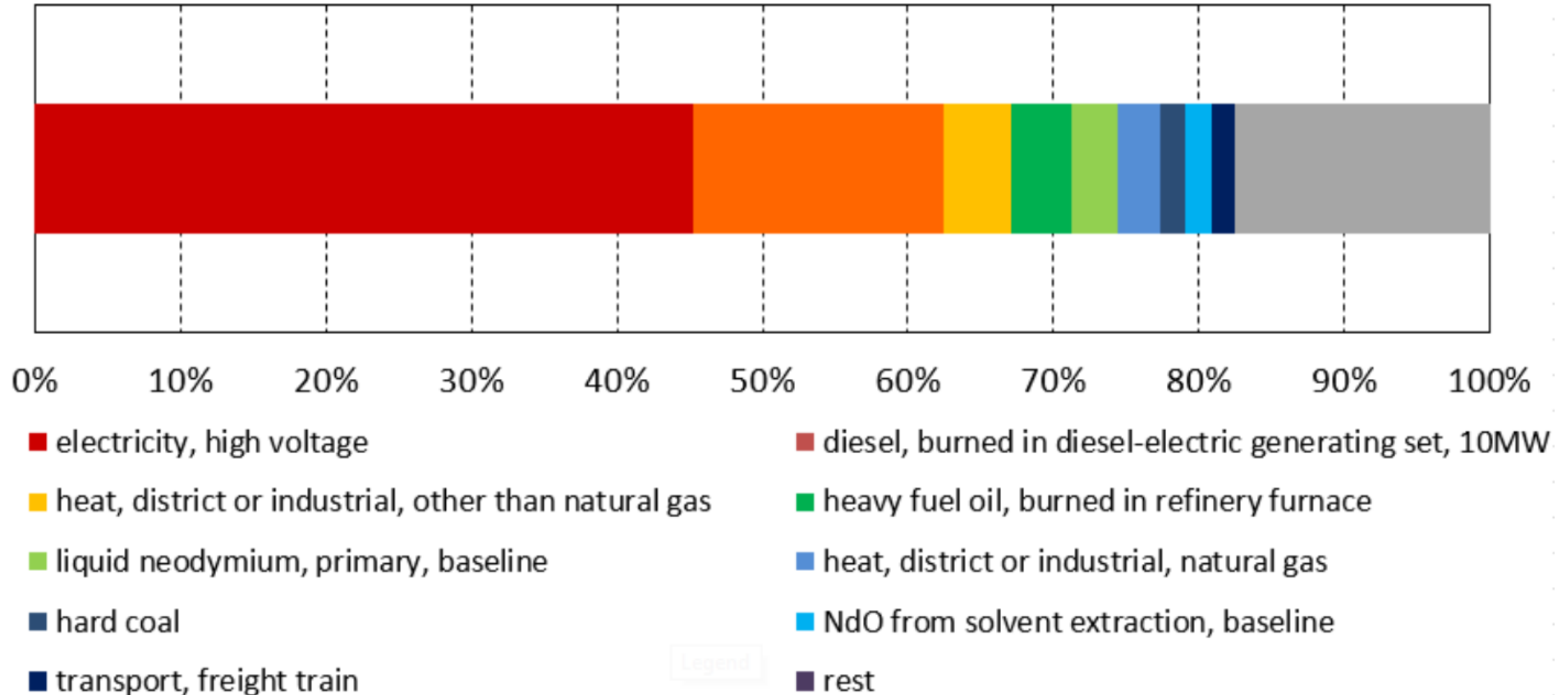
compared to

1kg of equivalent secondary Nd magnets from different VALOMAG recycling routes?

Life cycle assessment framework

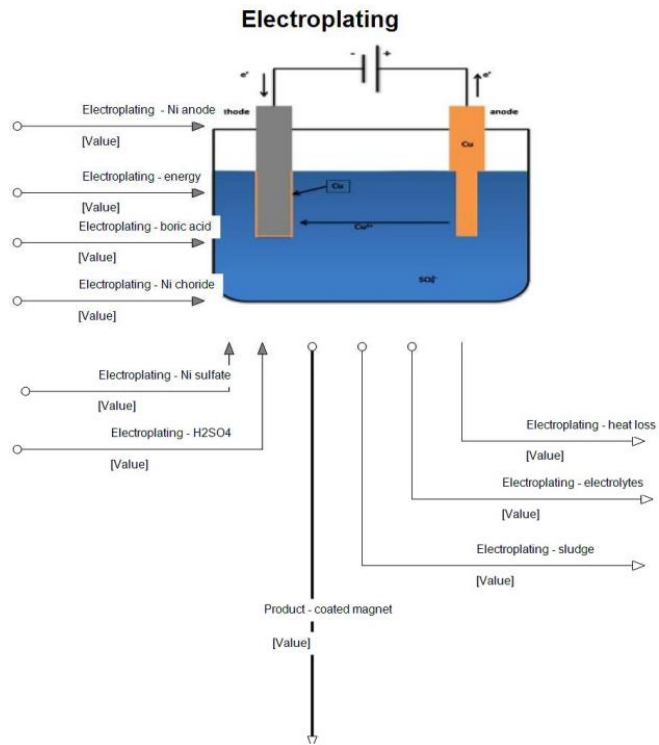


LCA results of primary magnets: process contributions to climate change



Flowsheet simulation to LCA

HSC Sim Model



Welcome to the Activity Browser!

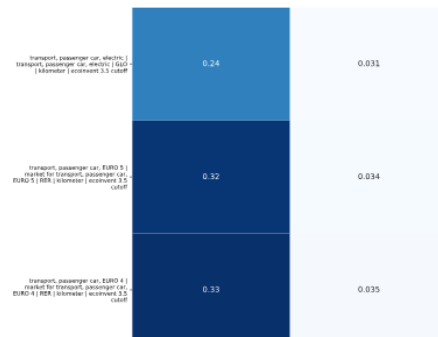
The [Activity Browser](#) is an open source graphical user interface designed to increase the productivity when working with the [Brightway2](#) advanced life cycle assessment framework.

Key features:

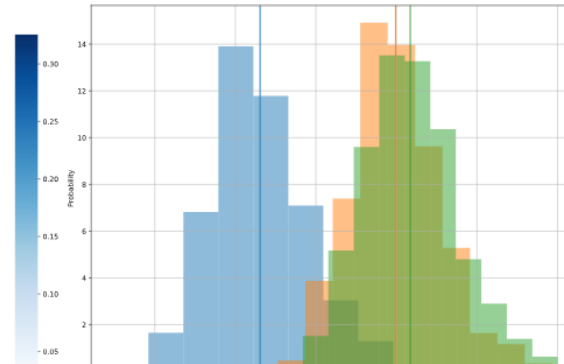
- Manage brightway2 projects, databases and activities (increasing your productivity with brightway)
- Calculate fast LCA results (use "calculation setups" to calculate LCA results for several reference flow and impact categories at once)
- Easily plot and export your LCA results (contribution analyses, Monte Carlo simulations)
- Visualize your results in Sankey diagrams or explore your database with the Graph Explorer

Examples

LCA results overview



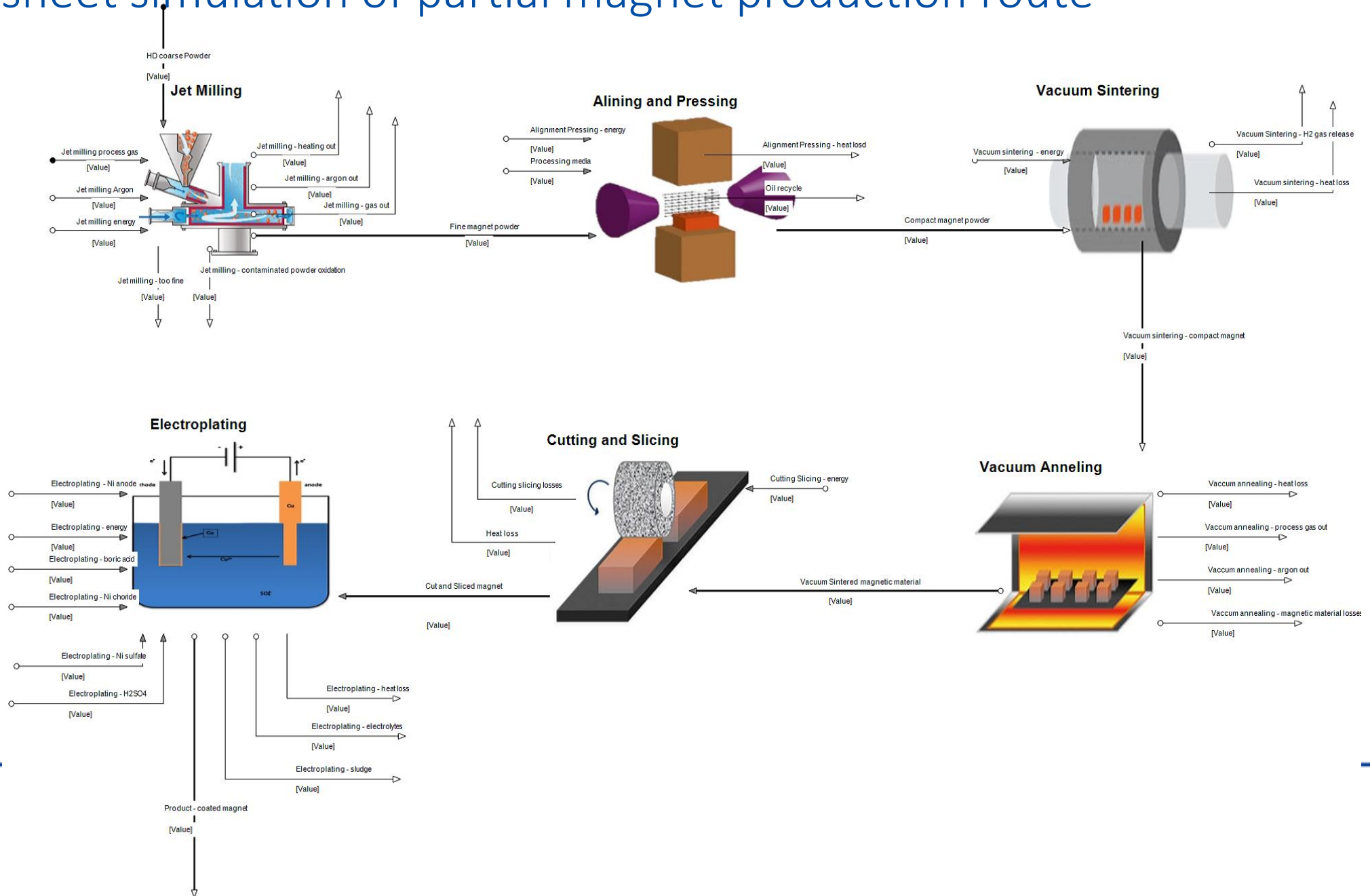
Monte Carlo simulation



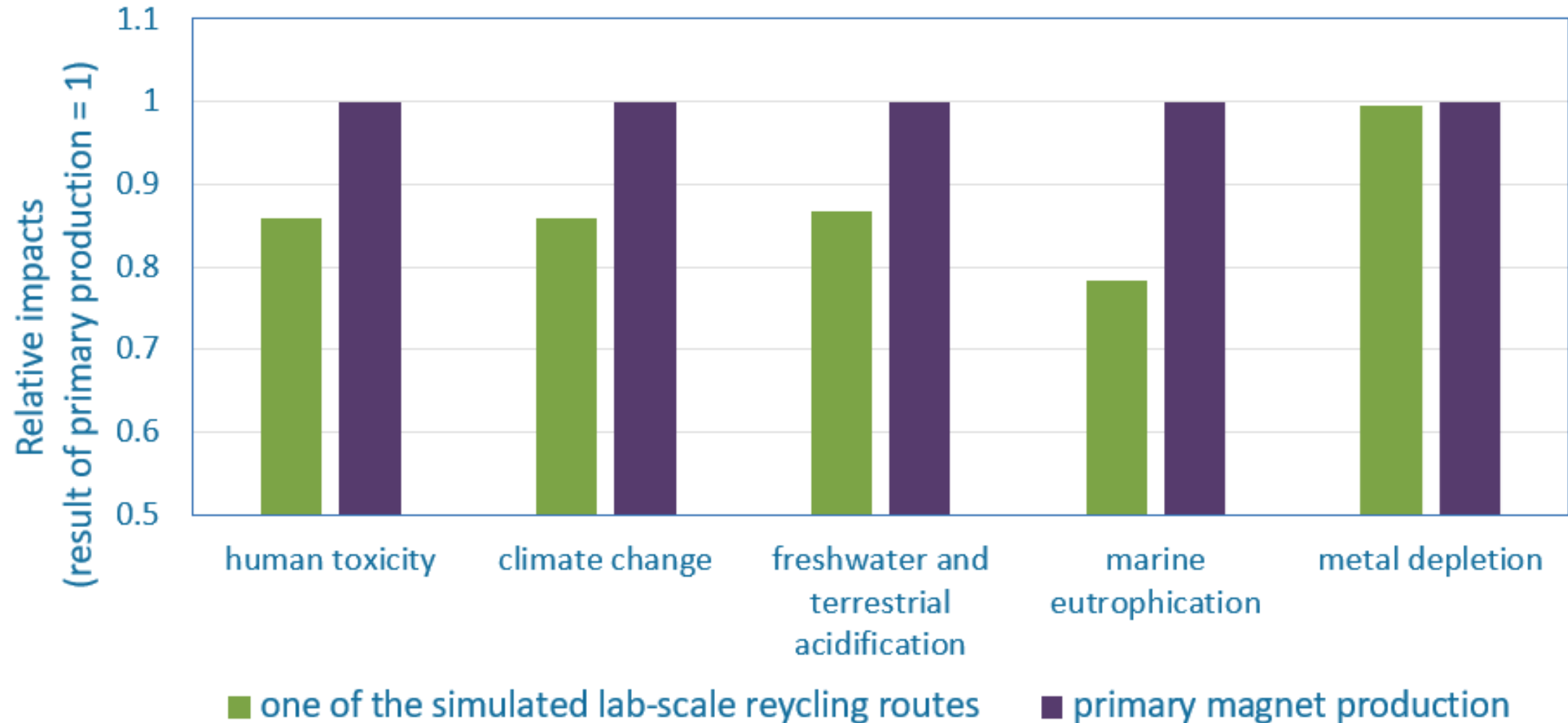
Sankey diagrams



Flowsheet simulation of partial magnet production route



Relative environmental impacts of simulated recycling technology



Future recycling of rare earth magnets

- RE products call for more attention to “design for recycling”.
- Recycling helps
 - strengthen the RE supply chain resilience.
 - lower the potential environmental impacts of primary RE magnet production
- Combining LCA with other methods offers more potential to impact technology development.



THANKS FOR YOUR ATTENTION!