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192: Addressing Criticality for Rare Earth Elements in Permanent Magnets Supply Chain: A Focus on the EV sector

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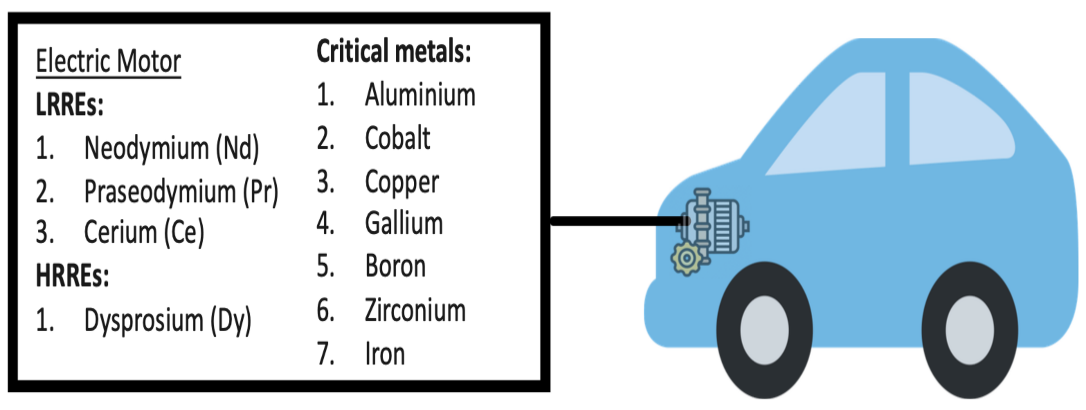
Goal

To show that individual **REE** used in PM have unique **supply risks** and economic importance and therefore different levels of **criticality**

To understand how much REEs can potentially be obtained from **recycling PMs** during the 2020–2050 period

Motivation

•**Rare earth elements** (REEs) are the essential components of **permanent magnets** (PM) that are employed in **electric vehicles** (EV).[1]



•REE are considered **critical metals** and ensuring the **sustainability of their supply chain** has become an important issue for the European Commission and other international counterparts.[2]

•**High projected demand** have been extensively documented for REE by various studies.[3,4]

•**Recycling of PMs** emerges as a viable strategy to help mitigate the supply risks associated with REEs and to fulfill the **EU's future REEs' needs**.

•This study assesses:

- The **criticality of the supply risk associated with REEs** used in PM.
- The **potential coverage of future EU demand for rare earth magnets through the recycling** of PM from end-of-life EVs.

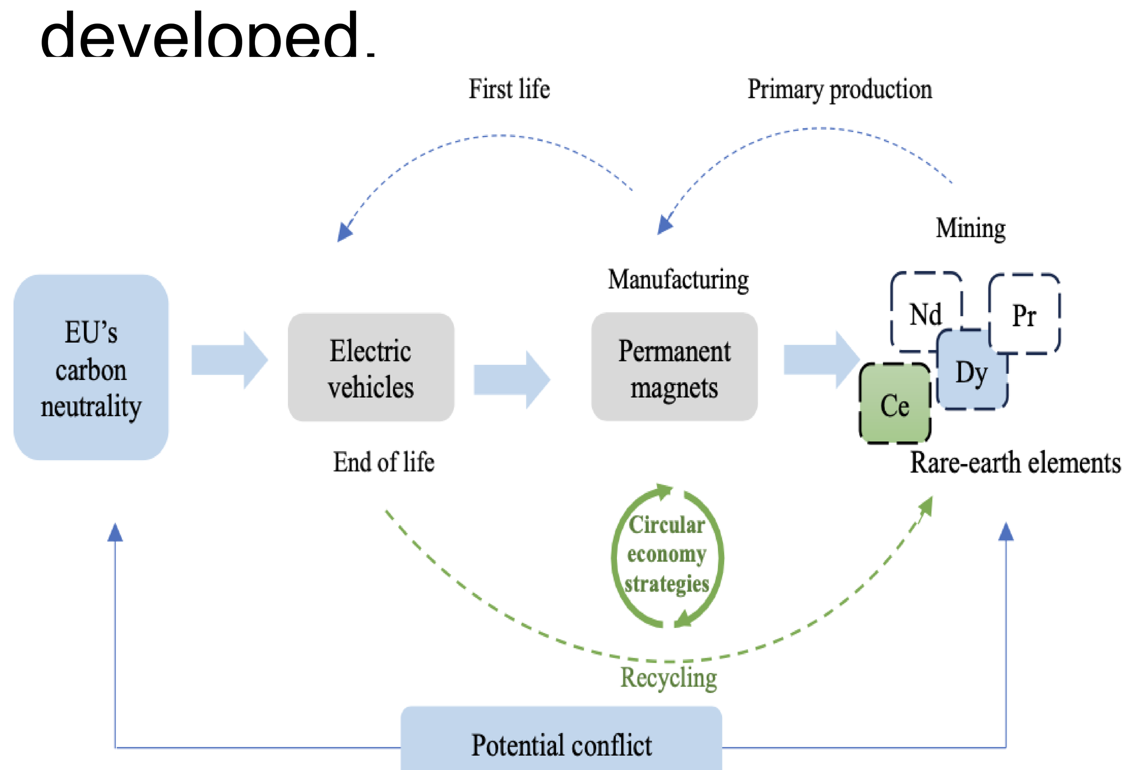
Approach

•Supply risk factor was determined for each component including:

- REEs: **Neodymium, Neodymium, Cerium and Dysprosium**
- Other critical metals: **Aluminium, Cobalt, Copper, Gallium, Boron and Zirconium**

•The analysis involved a **two-stage supply risk assessment**, including **the extraction stage** and **the processing stage**.

•To assess **the potential of recycling of REEs PM** to meet future demand for PM in the EU, a **scenario analysis** was developed.



- Data have been collected
  - on **overall demand for REE magnets used in EVs** for the **years 2024-2050**
  - on **the EU scrap availability of REEs PM** was collected for the years 2024-2050.

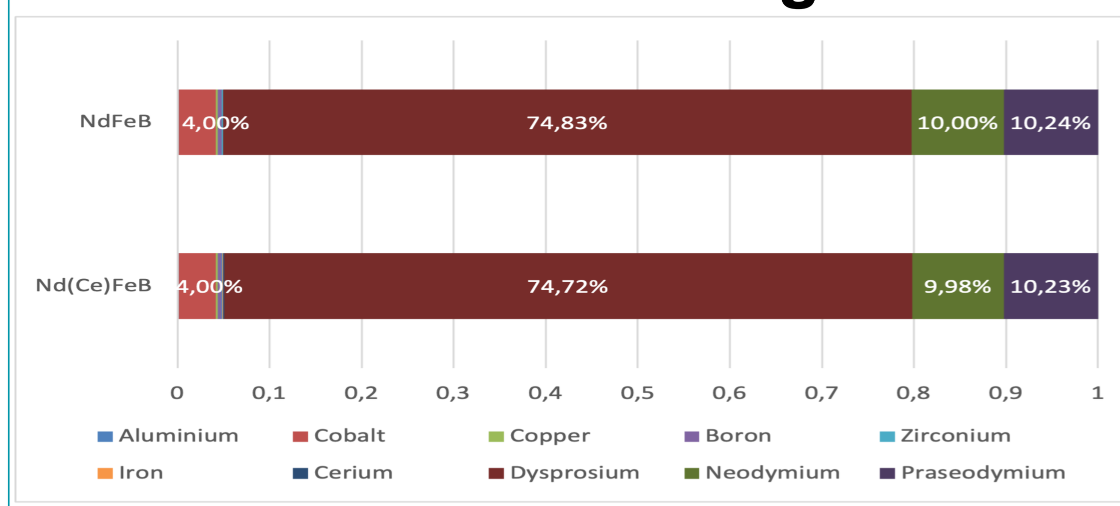
•**Two alternative scenarios**, namely scenario 1 and scenario 2, were developed based on three key variables: **collection rates of EoL EVs for recycling in the EU**, **efficiency rates of product disassembly** and **recycling efficiency rate**.

Application	Collection rate (%)		Disassembly efficiency rate (%)		Recycling efficiency rates (%)	
	Sc.1	Sc.2	Sc.1	Sc.2	Sc.1	Sc.2
EVs	50	90	85	95	85	99

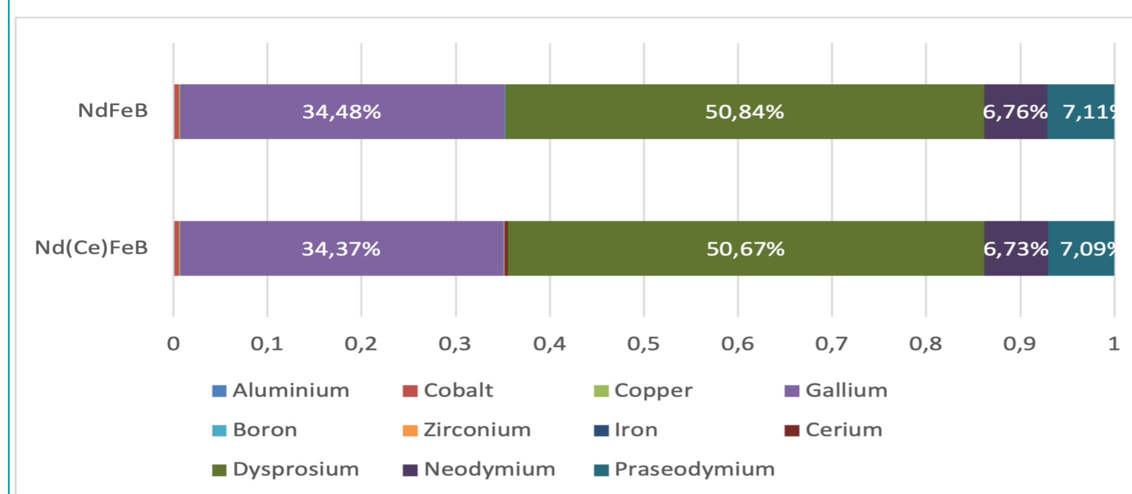
Results

•The results of the criticality assessment for NdFeBand and Nd(Ce)FeB magnets.

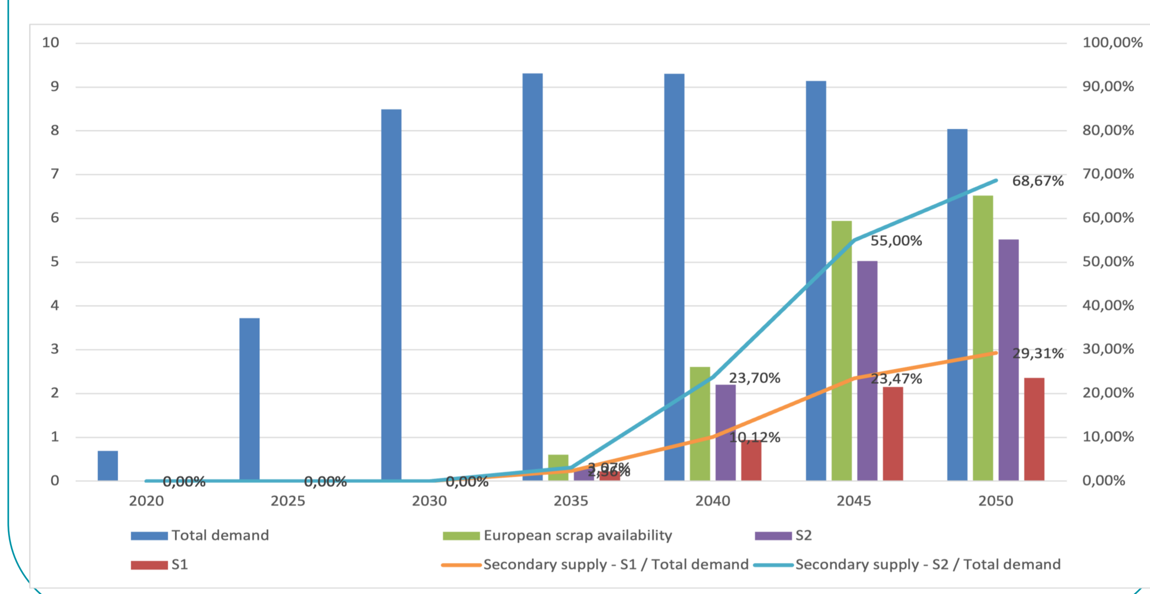
Extraction stage



Processing stage



•The comparison between **the total REEs PM demand in the EU and secondary supply over time.**



Key take-aways

•Among the critical metals used in PM production, **Dysprosium has the highest probability of supply disruption** and imposes risk on the product system.

•The **establishment of an EV PM recycling chain within the EU contributes an estimated 29-69% to the overall demand** between 2025 and 2030.

Further reading

1. Cheema, H.A., et al. (2023). Assessment and Mitigation of Environmental Footprints for Energy-Critical Metals Used in Permanent Magnets. In: Pathak, P., Srivastava, R.R., Ilyas, S. (eds) Anthropogenic Environmental Hazards. Springer, Cham.
2. Filippas, A., et al. (2021). Critical rare earths: The future of Nd & Dy and prospects of end-of-life product recycling, Materials Today: Proceedings, 37 (4), 4058-4063.
3. KU Leuven (2022), Metals for Clean Energy: Pathways to Solving Europe's Raw Materials Challenge, Report Commissioned by Eurometaux.
4. Hund, K., et al. (2020), Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition, World Bank Group.

Acknowledgement

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