Recycling REE in the EU

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Executive summary

The increasing demand for Rare Earth Elements (REE) in recent years has raised the question of their availability and thus production and recycling. In this publication, we present a synthesis of the drivers and opportunities of recycling REE in the European Union (EU), focusing on four minerals that are used within permanent magnets, and which drive most of the REE demand.

Wind energy and electric vehicles (EV) are the most REE-intensive sectors in the EU, driving 85% of the European demand for permanent magnets.
Forecasts of REE demand for wind energy vary widely, depending on the evolution of both the technology mix and the local production of turbines. EV-related forecasts are more accurate, but this market remains threatened by a potential decrease of the European share in the global production of electric motors.

One of the main challenges to recycling REE in the EU is the lack of actors along the value chain. Although recycling REE has been identified as a priority, there is still a long way to go to establish a robust and sustainable recycling sector.

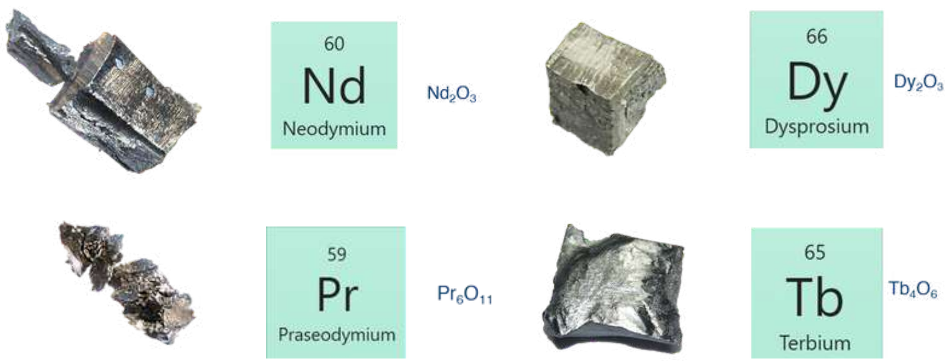
However, advances in materials science and recycling technology are likely to make the recycling process more efficient and cost-effective over time.

Recycling Rare Earth Elements in the European Union: An Overview

1. Introduction

REE are chemical elements that are crucial components in a vast range of modern technologies, including home appliances, wind turbines, electric vehicles, industrial applications, etc.

Out of the seventeen elements, four (Neodymium, Praseodymium, Dysprosium and Terbium) represent more than 61% of the REE market value, their demand being mainly driven by NdFeB permanent magnets. These magnets are widely used in various everyday products. REE are not abundant with most of the world's supply coming from a few countries, including almost 60% from China.



This motivates many countries to explore ways to increase their domestic supply of REE. One of the key ways to do this is by recycling REE. It also leads to reduced environmental impact by promoting a circular economy through reusing valuable resources instead of extracting them from the ground.

2. Analysis of REE demand by 2035

Based on the demand of permanent magnets in each sector, benchmarks of demand forecasts by 2035 and by defining the appropriate indicators, the top two sectors driving REE's demand are wind energy and EV, making it a strategic recycling market.

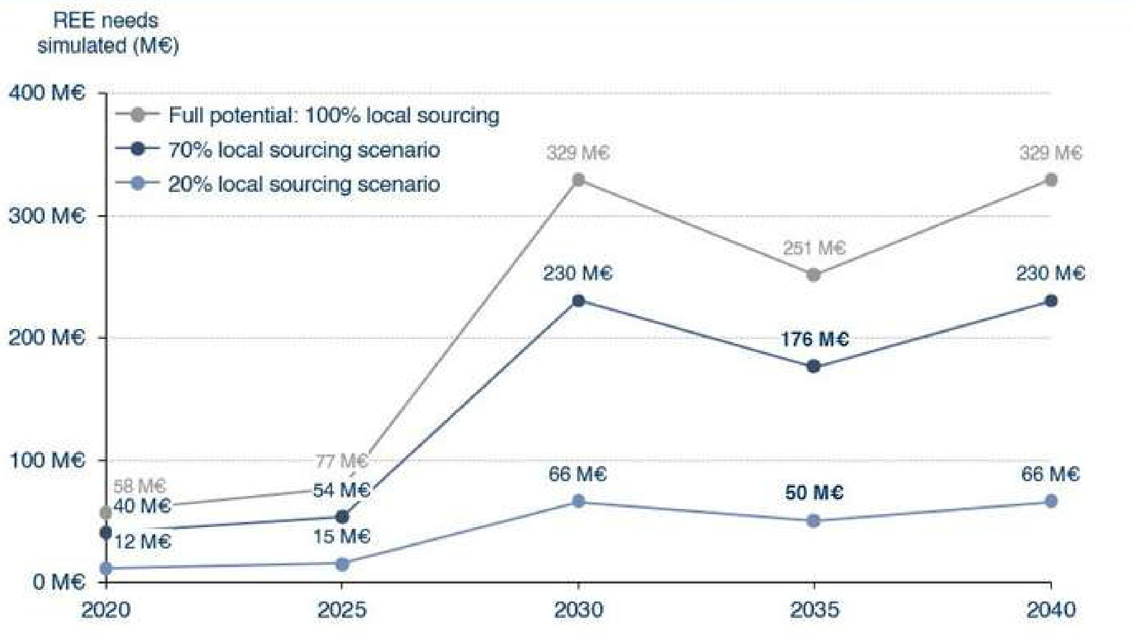
Electric vehicles

Wind energy

Focus on wind turbines: a demand that will quadruple, but forecasts are uncertain due to 3 factors

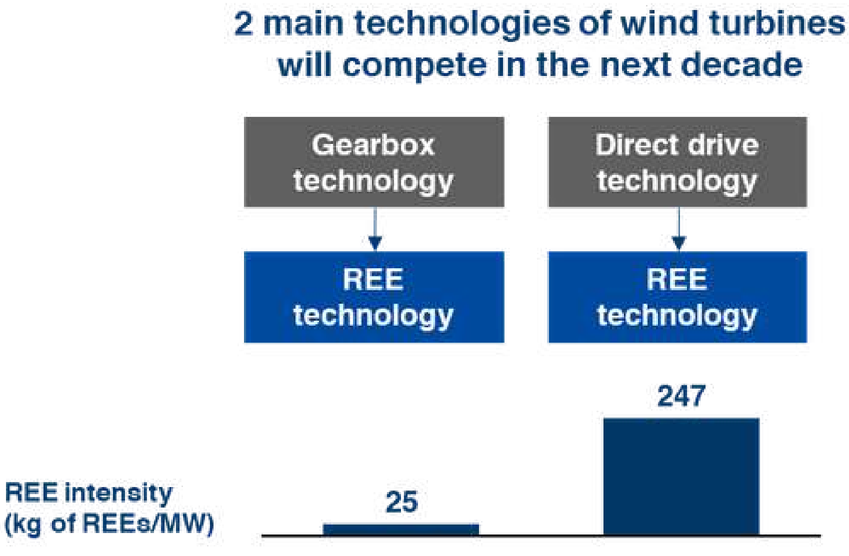
According to installed capacity projections and hypotheses on the share of domestic production, forecasts suggest that the value of REE contained in permanent magnets required for production of wind turbines will reach between 50 and 176 million euros by 2035. There are various factors impacting the demand, such as the production location of elements of wind turbines (EU or China). The most likely scenario is 70% of wind turbine production in Europe, which requires the availability of REE locally.

European REE needs following 3 possible wind turbines deployment scenarios (M€)



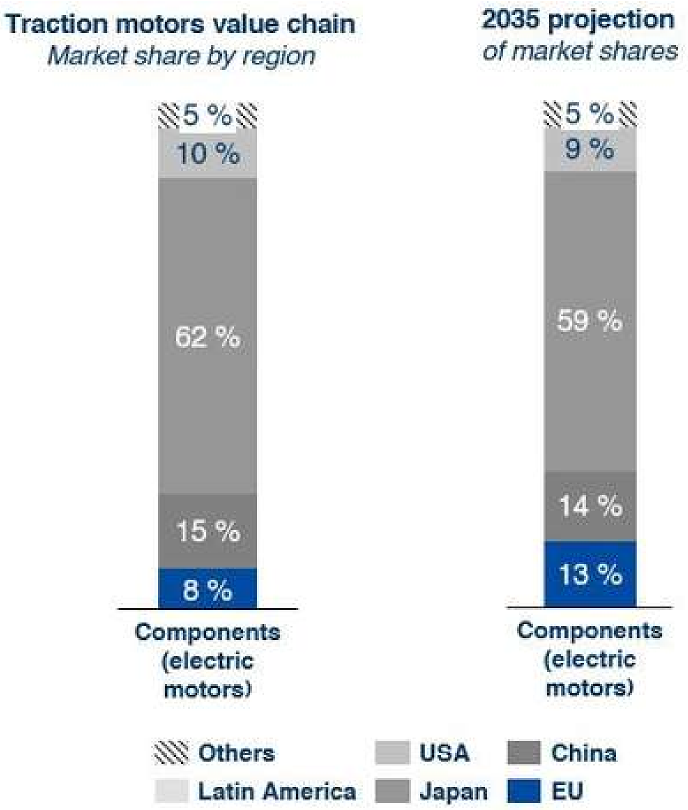
The technology mix also makes forecasts uncertain. There are two competing wind system technologies: Direct Drive and Gearbox. Although Direct Drive (primarily offshore) is ten times more demanding in REE than Gearbox (primarily onshore), Gearbox is the more likely technology to prevail in the future.

What reinforces the uncertainty of the evolution of the REE demand is the development of REE-free technologies, alternatives that are more sustainable to facilitate global energy transition. The increase of the share of gearbox-based turbines in offshore projects could also decrease the demand for REE.



Focus on electric vehicle (EV): a gain in visibility on forecasts but a strong dependence on Asian companies

As for the electric vehicle sector, in 2035, the European Union (EU) will manufacture 13% of the global EV's sales. This represents a 70 million euros market in REE's for permanent magnets in traction motors.

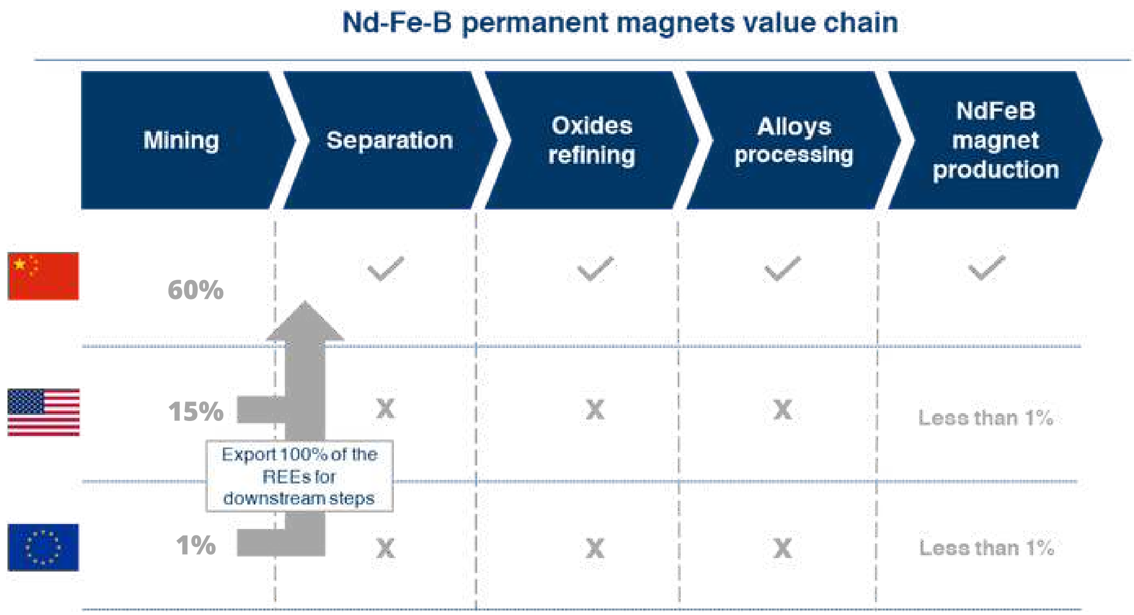


Compared to the forecasts made for the wind energy sector, the visibility on the developments in demand for permanent magnets used in the electric vehicle sector is clearer. However only a small share of electric motors is manufactured in Europe with the rest dominated by China. This will make local demand for REE smaller than its full potential on the EV market.

3. Analysis of REE product chain

Challenges

The major problem with recycling REE in the EU is that the EU has no control over the production chain. Currently, the EU only produces a small amount of locally mined REE (less than 1% of the global REE mining market), which is then exported to China for refining. The EU imports 98% of its demand from China. Developing recycling capabilities for REE is one way for the EU to secure the supply for its future demand of REE.



Still, there are 2 major challenges that remain to be faced.

REE are not directly available in the EU for recycling, as most of the e-waste containing them is currently exported out of the continent for end-of-life treatment.

The recycling process for REE is complex. REE are used in a wide variety of products and separating them from the other materials in these products can be difficult and time-consuming. Indeed, REE are most of the time a small subset of a component, which is why it is necessary to target them precisely in order to optimize their recycling.

Opportunities

Despite these challenges, there are many reasons to be optimistic for the future development of recycling in EU. The lack of presence of European stakeholders in the production chain and the increasing demand for REE show that European recycling is an opportunity to be seized for a variety of actors – from.

Furthermore, recent announcements of large REE deposit discoveries and mining projects will lead to the emergence of local actors and know-how on all intermediary steps.

There are four possible ways to recycle rare earth magnets, which all have the potential to contribute to the EU's net-zero transition strategy.

The first one is the recycling of production waste, an opportunity that is limited to China and other existing REE producers.

However, the other three options are likely to present opportunities for European companies.

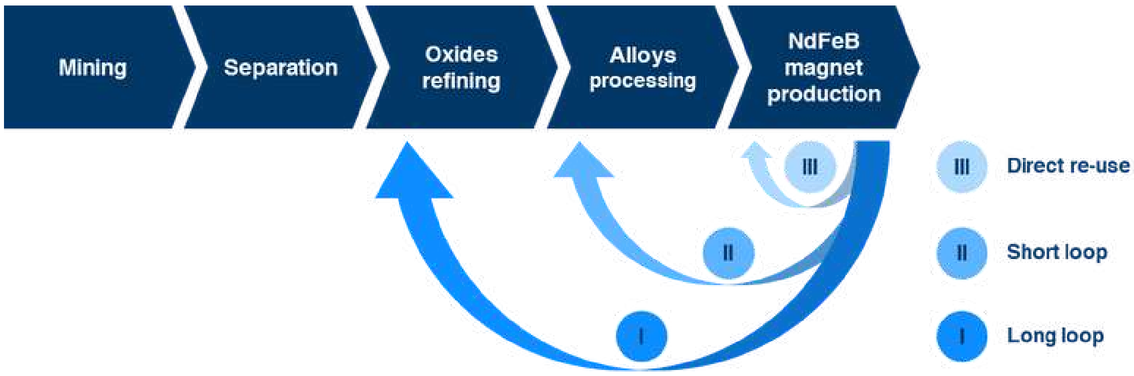
Long loop recycling is the process of grinding rare-earth magnets then separating out the pure rare earth element oxides. This process enables adaption to changes in magnet design, but it also depends on the EU's magnet manufacturing capabilities.

Short loop recycling is about grinding rare-earth magnets into a powder to be used in forming new rare-earth magnets. This short loop process can lead to potential losses of performance.

Industrial projects on long-loop recycling and short-loop recycling are already launched.

The final promising option is the direct re-use of rare-earth magnets from end-of-life products. This option is still in the early investigation phase at CEA and Fraunhofer. What differentiates this option is the signification reduction in the number of steps, and that it allows direct access to the final step of the value chain (the magnets themselves). However, it requires the usage of existing technologies (design or alloy), which does not leave room for innovation.

These three options rely on existing actors and are expected to help reduce the EU's dependence on China for REE. The EU must use this potential and make it a priority.



Conclusion: a potential to be exploited

In conclusion, the recycling of REE in the EU has the potential to play a key role in ensuring a secure and sustainable supply of these critical raw materials. As the EU continues to prioritize recycling of e-waste and the development of new technologies, it is likely that the recycling of REE will become a critical part of the European REE supply chain in the coming years.