PASSENGER
FOR SUSTAINABLE AND EFFICIENT RE-FREE MAGNETS

Pilot Action for Securing a Sustainable European Next Generation of Efficient RE-free magnets

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INTELLIGENCE BULLETIN #10

Strategic Intelligence Bulletins aim to enrich strategic and managerial decisions and to engage stakeholders based on partners networks.

CRITICAL RAW MATERIALS TRENDS

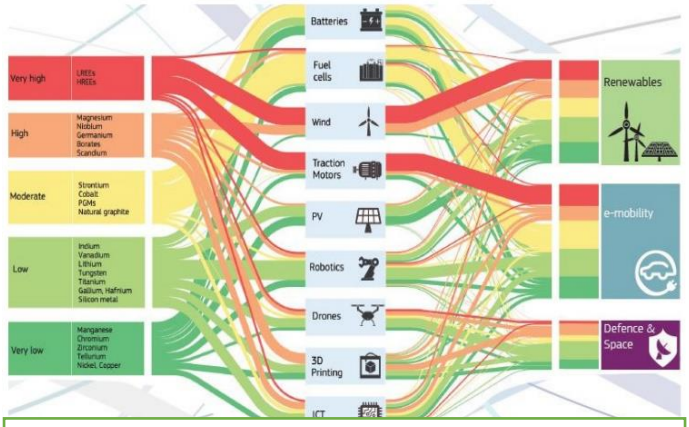

Figure 1: Critical Raw Materials for Strategic Technologies and Sectors in the EU, Source: European Commission

Ensuring sustainable access to raw materials is crucial for promoting sustainable development and boosting the competitiveness of the contemporary EU economy. These resources play a fundamental role in driving advancments in key technological fields, such as construction, engineering, chemical, automotive, aerospace, and other strategic industries. They are used in almost all modern high-tech sectors, including lithium-ion battery production, in electric vehicles and green energy. The EU minerals and non-energy extractive industries estimate that a total of 30 million people are employed in these technological areas, which provides an additional value-added of around €1.324 billion[1]. Since June 2010[2], the EU Commission has been monitoring and continuously updating a list of selected raw materials named as *critical* due to the EU's dependency on these minerals/ metals in high-tech [3] applications. (Fig. 1).

Presently, the EU is striving to reduce its dependency on Critical Raw Materials (CRMs) by exploring alternatives or increasing the number of CRM resources within the EU.

CRMs List Overview

To address the challenge of CRMs, the European Commission (EC) has started to establish a list of CRMs, combining the high importance of CRMs to the EU economy with the substantial risk linked to their supply. The economic importance aspect provides an overview of materials in the EU in terms of end-use applications and value-added, whilst the supply risk element considers the potential for EU supply disruption, depending on the

[1] https://single-market-economy.ec.europa.eu/sectors/raw-materials/related-industries/minerals-and-non-energy-extractive-industries_en
[2] https://ec.europa.eu/commission/presscorner/detail/en/MEMO_10_263
[3] https://rmis.jrc.ec.europa.eu/uploads/CRMs_for_Strategic_Technologies_and_Sectors_in_the_EU_2020.pdf

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EU's import reliance.. Starting from these considerations, the EC started publishing the CRMs lists:

- The first list was published in 2011[4] and included 14 CRMs.
- The second list was released in 2014[5] including 20 CRMs.
- The third list covered 27 CRMs and was published in 2017[6].
- The fourth list was released in 2020[7] with 30 CRMs included.
- The fifth and last list was published in 2023 [8]and covering now 34 CRMs.

2023 CRMs List

The list published in 2023 was the latest one and has considered 87 raw materials candidates. In this case, raw materials have been divided into three categories:

- Strategic
- Critical
- Non-Critical

Among the strategic actions to clarify the size of the available resources of critical raw materials resources, and to achieve sustainable raw material diversification or substitution, the EC continuously finances innovative research and technology projects within several EU funding programmes, such as Horizon Europe, Euratom Research and Training Programme, ITER and others[9]. Several EU-funded strategic projects have conducted accurate and comprehensive studies and analyses to assess supply risks and the economic ecosystem, determining the importance of particular raw materials. For instance, examples include the EU-funded SCRREEN1[10]and SCRREEN2.

Compared to the list of 2020, the new 2023 has not lost any element and at the same time gained 4 new ones, namely *arsenic, feldspar, helium, and manganese*. This indicates that the measures taken to reduce dependence on Critical Raw Materials in the period 2020-2023 did not lead to a shortening of the list, but, on the contrary, to an increase. The presence of manganese also deserves special attention Ukraine occupies one of the leading positions in terms of manganese reserves and is a significant supplier to the EU countries, primarily to the Czech Republic and Poland.

[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0025
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0297
[6] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0490
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[8] https://ec.europa.eu/docsroom/documents/54114/attachments/1/translations/en/renditions/native
[9] https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes_en
[10] https://scrreen.eu

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As shown in Figure 2, in addition to individual elements, there are two groups - the platinum group metals (PGM) and the rare earth elements (REE), the latter being divided into three more groups: *REE (magnets)* (those used in permanent magnets such as neodymium and dysprosium), *LREE (rest)* (light REE) and *HREE (rest)* (heavy REE). The materials are listed in the table in descending order of supply risk. As can be seen in the chart, *REE (magnets)* assumed a high supply risk, behind Gallium and Magnesium only. Aluminum also deserves attention, as it has been on the CRM list since 2020, despite the relatively low supply risks A characteristic feature of Aluminum is that its use is critical for every EU strategic technologies and industries[11].

Supply Risk	Raw material
4.8	Gallium
4.1	Magnesium
4.0	REE (magnets)
3.8	Boron
2.7	PGM
1.9	Lithium
1.9	Bismuth
1.8	Germanium
1.8	Natural graphite
1.7	Cobalt
1.6	Titanium metal
1.4	Silicon metal
1.2	Tungsten
1.2	Manganese
0.5	Nickel
0.1	Copper
5.3	HREE (rest)
4.4	Niobium
3.5	LREE (rest)
3.3	Phosphorus
2.6	Strontium
2.4	Scandium
2.3	Vanadium
1.8	Antimony
1.8	Beryllium
1.6	Arsenic
1.5	Feldspar
1.5	Hafnium
1.3	Baryte
1.3	Tantalum
1.2	Aluminium
1.2	Helium
1.1	Fluorspar
1.0	Phosphate rock

[11] https://eitrawmaterials.eu/aluminium-the-critical-raw-material-acts-blind-spot/

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The next important aspect is shown in Figure 3 and concerns technologies and industries dependent on critical raw materials.

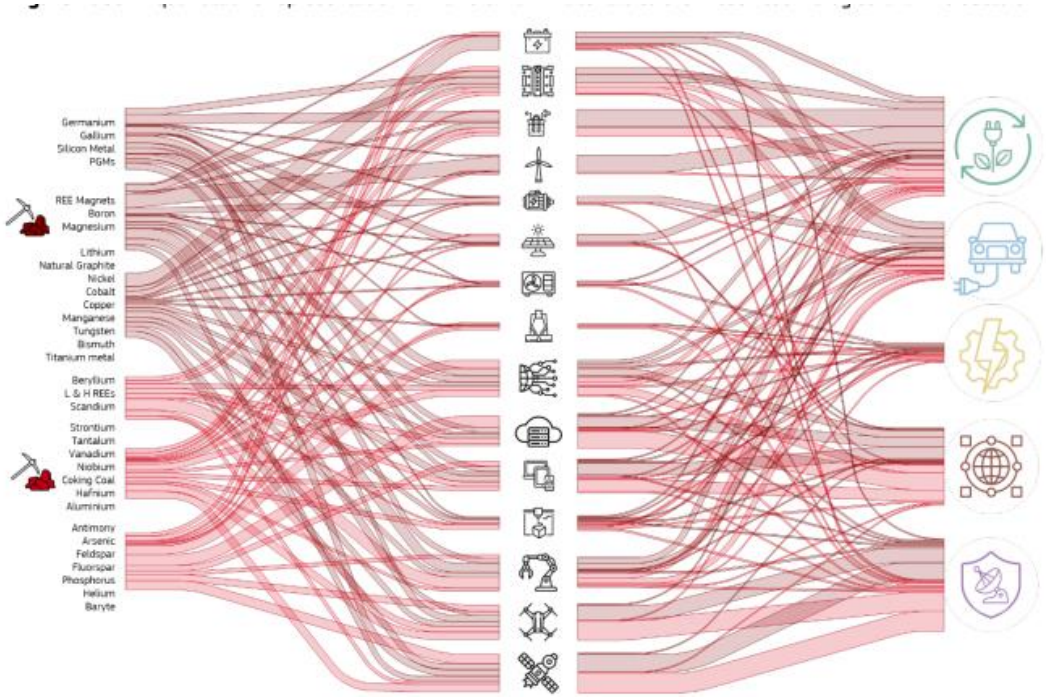

Figure 3. Raw Materials flow to the fifty's technologies and five sectors, Source: EU report

REE Comparison with previous and future assessments

Comparing the 2020 list with the 2023 list in terms of REE, a significant increase in economic importance can be seen, for example for neodymium from 4.8 to 7.2.[12] due to the evolution of end-uses shares towards permament magnet (PM) production sector.

Figure 4 shows that the demand of neodymium and dysprosium (key materials in permanent magnets) will increase by 5-6 times by 2030 and 6-7 times by 2050 in the EU compared to the current demand. [13] The study also shows that the relative growth in demand for REE is more pronounced in the e-mobility sector, which is still largely at an early stage. This means that REE are one of the most vulnerable categories due to their use in some of the most critical technologies for the EU (such as e-mobility). This issue, together with the current low recycling capacity of this material, makes it important to find alternative solution to the use of REE.

[12] European Comission (EC) Study on the Critical Raw Materials for the EU, 2023
[13] European Comission (EC) Study on the Critical Raw Materials for the EU, 2023

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The key EU target is to ensure uninterrupted supplies of raw materials for the European

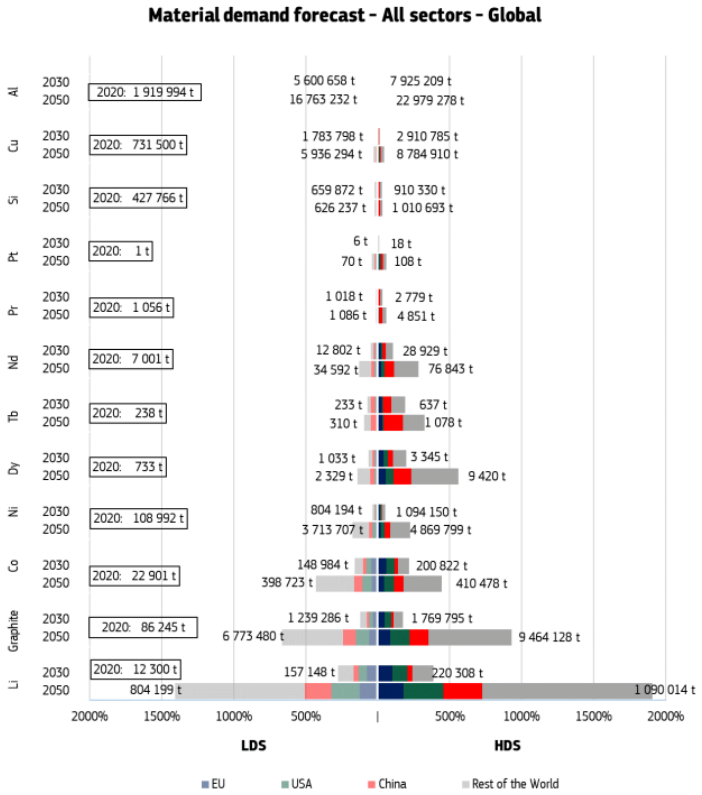

Fig 4: Future material forecast, Source: EU report

industry through the launching of different national public and governmental initiatives, for example, the Technology Platform on Sustainable Mineral Resources (ETP SMR)[14]. This platform was created on a share basis by combining science and its potential and the largest European industrial producers at a wide scale in coal, metal ores, industrial minerals, and different sectors along the value chain, from exploration to extraction, processing, and recycling. In addition, the EU Commission has launched a strategic partnership within the European innovation partnership (EIP) framework on raw materials[15]. Thus, in 2021 EU set up a strategic partnership on raw materials with Canada and Ukraine[16] focused on

[14] https://www.etpsmr.org/?page_id=6#:~:text=The%20European%20Technology%20Platform%20on,and%20engineering%20companies)%20in%20different
[15] https://single-market-economy.ec.europa.eu/sectors/raw-materials/eip_en
[16] https://eitrawmaterials.eu/the-start-of-long-standing-cooperation-eu-and-ukraine-sign-a-strategic-partnership-on-raw-materials-and-welcome-a-new-member-of-erma/

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diversification activities along the entire value chain of both primary and secondary critical raw materials security of supply chains for minerals and metals[17].

Fig 5: Strategic partnership with Canada and Ukraine, Source: EUCCAN, European Commission, EIT RawMaterials and ERMA

REE solution: PASSENGER contribution

PASSENGER project seeks a solution to the EU's REE dependency in PM production by replacing traditional REE-based PMs with magnets based on improved Sr-ferrites and MnAlC alloys. This approach provides a sustainable permanent magnet solution, eliminating the most critical raw materials, and using elements readily available in the EU. The selection of these PMs has been made based on realistic results and patents:

- Improved Sr-Ferrite: One of the advantages of these PMs is that they are chemically inert, easy to process and offer high coercivity at a very cheap cost, as well as showing a stable improvement in properties with increasing operating temperature.
- MnAlC alloy: magnetic tau-phase shows a lower density (and therefore less weight) in comparison with the traditional PMs.
- Both Sr-Ferrite and MnAlC alloy production can be scaled-up at industrial level.

Sources :

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2. European Comission (EC) Study on the Critical Raw Materials for the EU, 2023

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[17] https://www.international.gc.ca/world-monde/international_relations-relations_internationales/can-eu_agreement-accord_can-ue-2022.aspx?lang=eng

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