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Securing Europe's Supply of Rare Earths

The supply chain for rare earths needed for green technologies is dominated by China. To mitigate supply risks, European countries must invest in domestic mining, processing, and recycling capacities as well as international cooperation.

By Julian Kamasa

The discovery of Europe's so far largest deposit of Rare Earth Elements (REEs) in Kiruna, Sweden in January 2023 has raised hopes for more European self-sufficiency to meet climate targets and reduce dependencies on Russian fossil fuels and REEs from China. The supply risk for REEs is high due to China's dominant position across the supply chain. China has a global market share of 94 per cent in magnet making, 87 per cent for REE processing, and 60 per cent for REE mining. Ebba Busch, Sweden's deputy prime minister, said in this context, that "the dependence that the EU has had on Russian gas will seem like a nice summer breeze compared with the lock-ins on the green transition."[1]

Indeed, wind turbines, solar panels, or advanced battery systems in electric vehicles (EVs) all require raw materials that are largely mined, processed, and manufactured outside Europe. Since 2011, the EU has evaluated a wide range of raw materials, categorizing them as either critical or non-critical depending on the assessed supply risk and the significance for the European economy. In the EU's latest assessment in 2023, REEs are once again considered the most critical raw material. This is because strategically important sectors such as transportation, energy, and defense rely on critical REE components such as permanent magnets. Given that Europe has been facing energy supply uncertainty and needs to diversify and decarbonize its energy mix, it is not surprising that the Kiruna discovery gained so much attention. Switzerland's position regarding potential supply risks of REEs is not different from that of the EU. Hence, efforts by the EU to diversify the REE supply chain as foreseen by the recently proposed European Critical Raw Materials Act (ECRMA) should be followed closely by both policymakers and the high-tech industry in Switzerland.

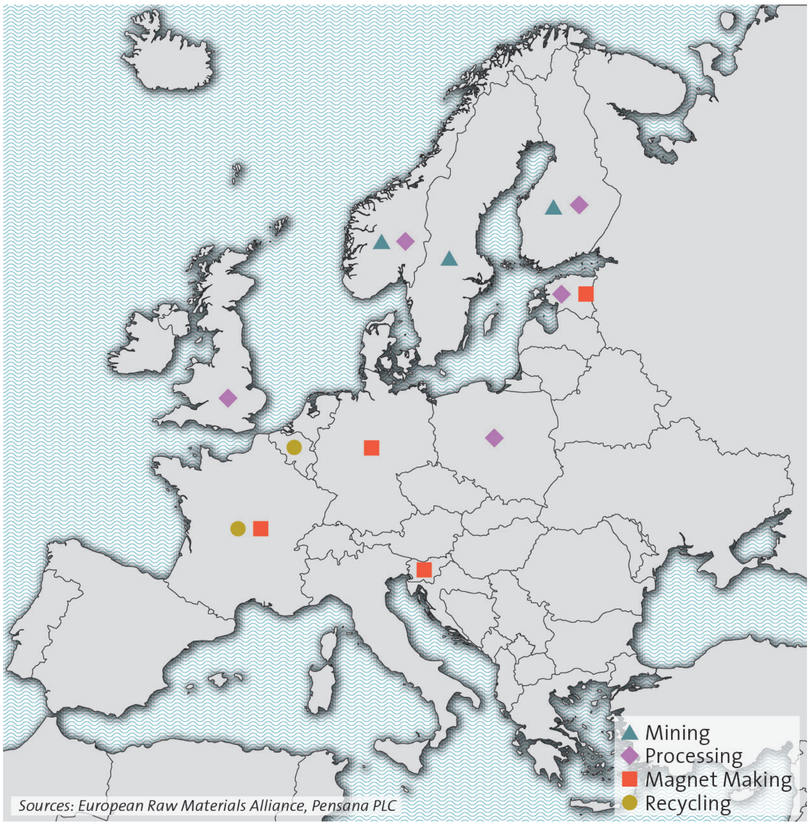
Key Points

- In its ambitions to accelerate the transition from fossil fuels to renewable energy sources, European countries should not deepen existing dependencies on authoritarian countries.
- It is important to invest more in the diversification of the REE supply chain both in and outside Europe to set up a politically reliable and economically resilient supply of REEs needed for the energy, transportation, and defense sectors.
- This effort can help European countries to reduce its energy dependence on authoritarian states, meet its climate ambitions, and create new jobs.

REEs: Not Rare, but Unequal in Demand

REEs are a group of 17 chemical elements. They are all metals. Based on atomic weight, REEs are divided into light (LREEs) and heavy (HREEs) ones. This distinction matters as HREEs occur in lower concentrations than LREEs and are often more valuable. REEs can be found in the earth's crust in normal abundance. The "rarity" of REEs is its insufficient concentration of highly demanded elements which need to be separated from less demanded ones. Three aspects deserve closer attention.

First, REEs are in unequal demand and market value. Offshore wind turbines require and EVs commonly use permanent magnets. The strongest type of permanent magnets is composed of the REE Neodymium, Iron, and Boron (NdFeB magnet) and can also be found in health applications (magnetic resonance imaging), computers and smartphones (hard disk drives, headphones, speakers), and defense applications (weapons systems, radar and sonar systems, satellite communications). It is possible to substitute NdFeB magnets both in power generators in onshore wind turbines and in traction motors in EVs, but substitutes are much heavier and less energy-efficient. Apart from Neodymium, other REEs such as Praseodymium, Dysprosium, or Terbium are also used for magnet making. Their market price is 100 times higher than the price for Cerium, which is used in catalytic converters and oil refining processes. 90 per cent of the revenue of all REE end-products is generated by magnets.[2] The International Energy Agency expects that by 2040, due to a large-scale rollout of wind turbines and EVs, demand for Neodymium, Praseodymium, and Dysprosium may double, or even triple.



Overview of a potential European REE supply chain including the existing processing facility in Estonia as well as the magnet making factories in Germany and Slovenia.

Second, increased demand for certain REEs can cause supply shortages. China plays a key role here, because it is the only country processing HREEs such as Dysprosium or Terbium, and it has significant pricing power for magnet making. The only non-Chinese processing facilities, albeit of LREEs, are in Malaysia and Estonia. This monopoly could lead to two scenarios with resulting export restrictions. On the one hand, China might be in a position in which it cannot supply the global market with sufficient REEs due to increased external (the US and the EU go green) and/or internal (China goes green) demand. On the other hand, China could use its monopoly on REEs as a geopolitical instrument. In 2010, a collision between a Chinese fishing boat and the Japanese coast guard in Japanese territory resulted in export restrictions on REEs by China and caused price increases of up to 700 per cent. It is not unrealistic to assume that Beijing might politicize REEs in response to US weapons exports to Taiwan, further US export controls on chips, or Western sanctions for human rights violations in Xinjiang.

Third, avoiding supply shortages is a complex long-term matter. What 2022 was for the gas supply in large parts of Europe, 2010 was for the global supply of REEs. However, more than ten years after China politicized its monopoly in the market, affected Western states have still not managed to set up a non-Chinese supply chain. Responsible mining and processing of REEs require time, skills, and financial resources to comply with the higher environmental standards of Western countries. Even under best conditions, it takes up to 15 years for a mine to operate at full capacity. This is a realistic time horizon for diversification efforts of the Chinese-dominated REE supply chain.

The Cost of Supply Risk

The complex matter of both mining and processing REEs as well as projected demand increases and associated supply risks help to explain why the EU Commission came up with a proposal like the ECRMA in March 2023. Aiming to become less dependent on market-dominating suppliers like China comes at a cost worth taking for two reasons.

First, the reliance on a single supplier of REEs runs the risk of costly vulnerabilities. Europe's import dependence on Chinese REE products is as high as 98 per cent and cannot be reduced overnight. Strategic sectors such as cleantech, high-tech, automotive, and defense need components with REEs. Regardless of geopolitics, this degree of dependence is an inherent supply risk. Adding the geopolitical component of China being a so-called "systemic rival" of the EU to the equation, the European economy can be subject to political vulnerabilities. Recent insecurities regarding the European supply with gas have shown that lock-in effects can be costly. This mistake should not be repeated for the green energy transition. Hence, more self-reliance is in the EU's best interest.

Second, mining and processing of REEs comes with negative environmental side-effects. This is particularly true for the Bayan Obo mine in Inner Mongolia, China. This mine generates not only the world's largest quantities of highly demanded REEs, but also acidic wastewater, radioactive waste residue, and wasteful gas. For European countries eager to meet their ambitious climate targets, a less environmentally harmful way to mine and process REEs is crucial and not impossible. Both mining residues and acidic wastewater can be contained when mining and processing are carried out responsibly. This comes at higher financial cost, but also at low pollution levels and, thereby, low environmental costs. It would be in Europe's best interest to come up with a competitive and responsible approach towards mining and processing the metals needed for the energy transition.

European Options

There are four options for the EU to consider in the quest for more supply security.

First, addressing a complex challenge requires interdisciplinary solutions instead of silo-thinking. The supply risks of REEs need instruments at the intersection of education, innovation, research and development, environmental and industrial policy, energy security, and geopolitics. Recycling of REEs is a good case in point here. Regaining rare earth metals from electronic waste, wind turbines, or EVs requires expertise from all above-mentioned policy fields. Education, Innovation, Research and Development can help to define new ways to extract these precious metals for second-use applications. Industrial and environmental policy can set incentives and targets for scientists to find such solutions. The role of wind turbines and EVs as potential electricity storage devices for households still needs to be defined by energy experts. The EU's foreign and security policy must cooperate with like-minded partners such as the US, Canada, Australia, Japan, the UK, Norway, or Switzerland to exchange know-how and capabilities.

Second, the EU's targets must be achievable. The ECRMA's aim is that the dependency from one single third country should not be above 65 per cent on an annual consumption level at any stage (mining, processing, recycling) by 2030 for each of the 16 raw materials listed as "strategic". For all strategic raw materials, the EU's average footprint in its annual consumption should be 10 per cent for mining, 40 per cent for processing, and 15 per cent for recycling. The 65 per cent target will be hard to reach for permanent magnets. Currently, the EU is 100 per cent import reliant on HREEs and 85 per cent on LREEs processed in China. Apart from a processing facility in Estonia and magnet making factories in Germany and Slovenia with global market shares at 1 per cent, there is very little that the EU can leverage. Capacity-building takes time and to, a skilled workforce with expertise in mining and recycling of REEs is crucial. Mining needs at least one decade until becoming fully operational. Recycling is hard to implement due to the lifecycles of EVs (<10 years) and wind turbines (25–30 years), which in larger quantities will most likely outdate the EU's target year of 2030. Thus, it is unclear where these recycled REEs should be coming from by 2030. In addition, given that the demand for REEs is estimated to grow substantially due to a wide-scale rollout of wind turbines and EVs, the EU's catch-up work on the supply side coincides with a fast-moving target on the demand side.

Third, "ally-shoring" will help to achieve some of the EU's targets more effectively than full "EU-shoring." The European Raw Materials Alliance estimates that a 1.7 billion EUR investment into a European REE supply chain including mining, processing, magnet making, and recycling (see graph) could meet 20 per cent of European demand for permanent magnets by 2030.[3] Even for this 20 per cent the EU needs strong cooperation with third states and foreign investment to achieve even parts of its ambitious goals. One of the few non-Chinese LREE processing

Further Reading

European Commission, ***Study on the Critical Raw Materials for the EU,*** 2023. Shows an in-depth criticality assessment of raw materials.

European Commission, ***Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study,*** 2023. Presents a future-oriented evaluation of potential supply risks.

Alessandra Hool, Luis Tercero, Patrick Wäger, **"Kritische Rohstoffe: ein Thema für die Schweiz der Zukunft,"** in: *swissfuture* 02 (2022). Explains why the topic of critical raw materials is important for Switzerland.

plants located in Estonia is a good case in point here. It is owned by the Canadian company, Neo Performance Materials (NPM), and run by an Estonian subsidiary. The lion's share of raw materials is mined in and imported from a Russian company which is so far not sanctioned by either the EU or Canada. NPM is also investing 81 million EUR in a magnet making factory in the processing plants' vicinity, creating 1,000 new jobs.[4] Other projects under development are heavily dependent on cooperation with third countries, too. In Poland, the chemicals company Grupa Azoty partnered with the Canadian Mkango Group to develop a processing plant for the LREEs Neodymium and Praseodymium as well as the HREEs Dysprosium and Terbium. Mkango will mine the raw materials in a sustainable way in Malawi. In the UK, a non-EU country, a processing plant of Neodymium and Praseodymium is supposed to become operational in 2024. Pensana, the company in charge of the 195 million USD investment, will import the raw materials from a sustainably operated mine in Angola run by a local subsidiary. Existing and planned operations show that the EU must cooperate with international partners in parallel to developing more mining capabilities in its own backyard.

Fourth, the EU should emphasize Environmental, Social and Governance (ESG) standards to level the playing field in competition with Chinese companies. Brussels has considerable regulating power and can leverage on it even when not having a lot of industrial clout. A lack of REE mining capabilities is not an obstacle to a strong ESG profile applied to the entire supply chain of REEs and other critical and strategic raw materials. This policy must ensure that European companies complying with high ESG standards would not have a cost disadvantage in competition with Chinese companies whose price advantages often reflect low environmental and labor standards.

Swiss Options

Finally, Switzerland is equally affected by potential supply risks and should play its part in addressing them. The EU and the US are by far the most important trading partners for Switzerland. Since the Russian attempt to politicize gas supplies, Switzerland is eager to expand its share of renewable energy sources to increase supply security. Supply risks identified by the EU apply for Switzerland, too. Such an evaluation of potential supply risks would make a lot of sense, but so far, the Federal Administration has not carried out comprehensive risk assessments. Rather, a joint effort from the Swiss Federal Laboratories for Materials Science and Technology, the Association for Mechanical and Electrical Engineering Industries, and the Development Foundation of Rare Metals has developed into a tool that companies can use voluntarily to assess their respective supply risks in raw materials. This might not be enough, because it is anything but certain if and to what extent Swiss companies will benefit from the ECRMA.

Bern should follow developments both in the EU and in the US closely. The same applies to the EU-US Trade and Technology Council, where Brussels and Washington highlight closer cooperation on the diversification of REE supply chains quite explicitly. Should this transatlantic cooperation become more substantial, Switzerland as a non-EU country may run the risk of being excluded. Norway and the UK are not EU countries as well, but the first has a lot of critical minerals to offer, while the latter will offer processed REEs soon. Switzerland is not rich in raw materials. But the country is innovative and said to be a global pioneer in the recycling of e-waste. However, recycling permanent magnets from electronics is not done systematically.[5] This potential is yet to be unlocked, and it could lead to knowhow that Switzerland could bring to the table at a time when the ECRMA is emphasizing the development of European recycling capabilities.

Selected sources

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2. REIA, "Rare Earth Elements: Small Market, Big Necessity," global-reia.org.
3. Roland Gauss et al., *Rare Earth Magnets and Motors: A European Call for Action,* 2021.
4. Rudolf Hermann, "Europe wants to become less dependent on China for strategic raw materials – this path begins in the small EU state of Estonia," *NZZ,* 10.03.2023.
5. Baudirektion Kanton Zürich, "Factsheet Seltenerdmetalle," zh.ch, 2014.

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