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The EU's Quest for Strategic Raw Materials: What Role for Mining and Recycling?

In her State of the Union address in September 2022, European Commission President Ursula von der Leyen recognised how raw materials like lithium and rare earths are increasingly "replacing gas and oil at the heart of our economy" and that the EU, faced with growing demand and high market concentration, should avoid "falling into the same dependency as with oil and gas" (European Commission, 2022).

EU concerns over raw materials supply are well grounded, and certainly not new. The first calls for action in this domain can be traced back to the Council's 2nd Environment Action Programme, which noted the Community's dependence on raw materials from countries beyond its borders (Council of the European Communities, 1977). Two decades on, the European Commission adopted the Raw Material Initiative, the first integrated strategy aimed at improving access to raw materials (European Commission, 2008). This led to the establishment of a first list of critical raw materials (CRMs), defined as such because of the combination of high economic importance, high supply risk and general lack of available substitutes. While the need to secure access to raw materials has been highlighted by several EU high-level strategies since then (European Commission, 2020), supply chain disruptions caused by the COVID-19 crisis coupled with the war in Ukraine have added new dimensions to the challenge (Rizos and Righetti, 2022).

Ultimately, achieving the EU's green and digital transitions will also depend on the secure and reliable access to a number of raw materials. CRMs like lithium and rare earths, but also base metals such as aluminum, copper and zinc are indispensable ingredients for a wide range of digital and clean technologies, as well as for the power grid infrastructure, the aerospace and defence sectors (Girardi et al., 2023) and a number of other industrial value chains. Available studies indicate that with the progressive decarbonisation and digitalisation of modern economies, the demand for these raw materials is projected to massively increase in the coming decades. For example, in the EU alone, the European Commission's Joint Research Centre expects lithium consumption to increase 9 to 12 times by 2030, and up to almost 21 times by 2050, driven almost entirely by the uptake of e-mobility (Carrara et al., 2023). In the case of graphite, overall EU consumption is expected to increase to 14 times its current levels by 2030, and 26 times by 2050 (Carrara et al., 2023). With similar trends recorded in other world regions – notably China and the US – an increased pressure on global markets for materials can be foreseen, bringing the risk of possible shortages or supply disruptions.

While in theory there are enough resources across the globe available to sustain even the most ambitious climate mitigation scenario (Wang et al., 2023), geological distribution, economic specialisation and geopolitical drivers have led raw materials value chains – from mineral extraction to processing and recycling – to become highly concentrated in a handful of countries. China is a key player in this domain. For example, the country controls 100% of the global heavy rare earths elements[1] (HREEs) supply, 91% of global magnesium supply and 76% of global silicon metal supply. Heavy market concentration also exists for cobalt – with the the Democratic Republic of the Congo controlling over 60% of the global market – platinum (71% controlled by South Africa) and palladium (40% controlled by Russia), among others. In such a quasi-monopolistic scenario, the EU today is heavily reliant on imports to meet its domestic raw materials needs; for instance, it sources 100% of its HREEs, 85% of its light rare earths elements[2] (LREEs) and 97% of its magnesium supply from China, as well as 99% of its boron supply from Turkey and 79% of its lithium supply from Chile (European Commission, 2023a).

Amidst rapidly increasing demand and intensifying geopolitical tensions, this market structure leads to significant supply risks for the EU. The fragility of the global supply chain, which became quite evident with the supply disruptions during the COVID-19 pandemic and even more with the recent gas shortages triggered by the Russian invasion of Ukraine, highlights even more the need for greater security in CRMs supply, and calls the EU to boost its strategic autonomy in this field.

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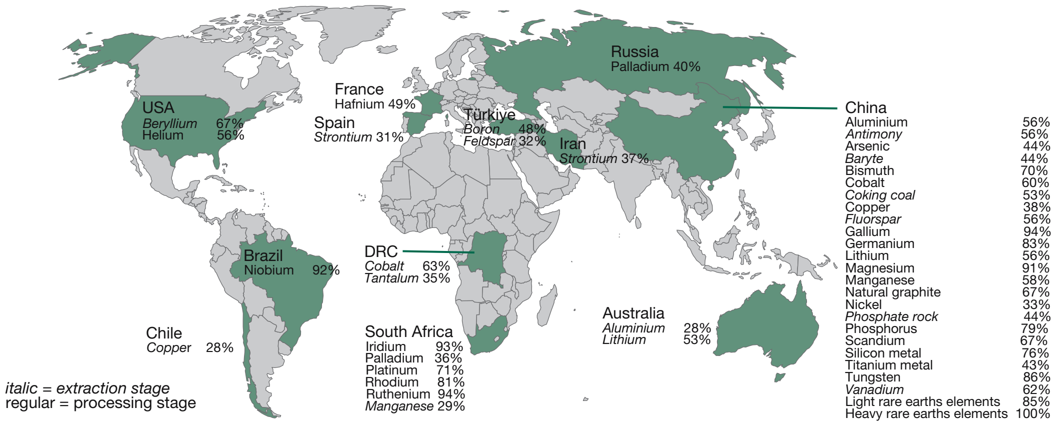
1 These include dysprosium, erbium europium, gadolinium, holmium, lutetium, terbium, thulium, ytterbium, yttrium.

2 Cerium, lanthanum, neodymium, praseodymium and samarium.

Figure 1
Global distribution of critical raw materials supply



Source: European Commission (2023).

In the wake of such risks and as announced President von der Leyen's 2022 State of the Union speech, in March 2023 the Commission published a proposal for establishing a framework to ensure a secure and sustainable supply of CRMs, the so-called Critical Raw Materials Act (European Commission, 2023b). Alongside the proposal for a regulation, setting conditions and benchmarks for the development of domestic mining and recycling capacity in the EU, the Act was accompanied by a Communication outlining a strategy to diversify supply chains and strengthen global engagement with reliable, resource-rich countries. Notably, besides updating the list of CRMs, the Act further identifies a subgroup of so-called strategic raw materials (SRMs), i.e. CRM that are strategically important for green, digital, space and defence applications and subject to future supply risks. In the regulation proposal, significant attention is placed on creating the enabling conditions for critical raw materials projects to scale, by e.g. streamlining permitting procedures and facilitating access to finance. Added to this, it sets requirements on the mapping of resources, as well as on the monitoring and mitigation of supply risk at the member state and industry level.

These recent developments in EU policy action suggest that upscaling mining and recycling capacity have been identified as primary avenues for boosting EU strategic autonomy in the raw materials sphere. But while targets are being set, uncertainty remains as to what the actual contribution of these sectors might be in the future, when a significant contribution could realistically be achieved, and how to make it happen.

The potential contribution and limits of mining

The first obvious reaction to raw materials supply pressures is to look at potentially unexploited domestic resources. In the CRMs Act, there is a (non-binding) 10% target for EU SRMs consumption to be mined in the EU.

The European continent is well endowed with – at least part of – these materials. Recent assessments and discoveries seem to suggest that indigenous deposits might have been underestimated and could – if systematically exploited – potentially serve a non-negligible share of EU raw materials demand. Notably, significant untapped potential has emerged for the so-called battery raw materials – i.e. lithium, cobalt, nickel, graphite and manganese. France and Portugal, for instance, are widely known for their large lithium resources, with the former set to launch one of the largest European lithium mining sites[3] and the latter already ranked sixth worldwide in terms of lithium mining production (United States Geological Service, 2023). For cobalt – another important material for modern lithium-ion batteries – substantial unexploited resources have recently been identified throughout the continent (Horn et al., 2021). European deposits of rare earths elements (REEs) – key materials for the manufacturing of high-performance permanent magnets used in e.g. electric vehicle (EV) motors or wind turbines generators – have also been documented (see for instance Goodenough et al., 2016) with large discoveries announced recently.[4]

But while similar findings appear promising, the overall picture of mineral endowments in the EU remains today rather blurred, as a comprehensive and reliable assessment of EU geological potential is largely missing. This is partly because of insufficient monitoring in the EU over the past few years, but also due to technical or geological constraints still preventing accurate measurements. Although further improvements in mining and exploration technologies – for which the EU is

3 In October 2022, the French mining company Imerys announced the launch of a major mining project in Echassières (Allier, France). The site has the potential to produce 34,000 tonnes per year of lithium for over 25 years – enough to equip 700,000 electric vehicles. Production is expected to start in 2028 (Vif, 2022).

4 In Sweden, LKAB has announced the discovery of a large REEs deposit in the Kiruna site (LKAB, 2023).

global leader – and coordinated efforts in the monitoring and exploration of geological occurrences – to which the CRMs Act gives great emphasis – will likely allow for greater clarity in the years to come, uncertainty still remains as to the actual untapped mining potential in the EU.

Aside from this, the question it comes down to is to what extent, and within which timeframe, this mining potential can be realistically converted into mining production. The technical and economic feasibility of the extraction of identified resources are key open questions. On top of this, lengthy and complex permitting procedures still represent a major constraint for upscaling mining capacity in the EU. Today, the time horizon for a mining project to set off in the EU is typically between 10 to 15 years, which per se excludes any substantial contribution of new EU mining production for meeting increasing EU raw materials requirements by 2030. Although the space for EU intervention in this context is rather limited (mining regulations largely fall within member state competences), the CRMs Act regulation proposal aims to address this via the implementation of strategic projects, i.e. raw materials extraction (or recycling) projects that – provided they meet certain criteria in terms of expected contribution, technical feasibility and sustainability – can be considered as of “overriding public interest” and therefore benefit from streamlined permitting and facilitated access to finance. Under such a framework, strategic projects would have to receive a permit within two years. This provision has received mixed responses from different stakeholders; while some consider it to be a step in the right direction, others argue that the current timeframe will not be realistic, and risk weakening social and environmental safeguards (Noyan, 2023; Friends of the Earth Europe, n.d.).

A second major challenge is the rooted public opposition to mining projects across the EU, which often further delays (if not blocks altogether) the take-off of extractive operations. As shown by the case of the Barroso mine in northeastern Portugal (Fleming et al., 2022), the lack of acceptance from local communities motivated by environmental concerns can be a detrimental element for the successful opening of new mines. In this respect, while “the meaningful engagement of local communities” is included as a prerequisite for a raw materials project to be considered as strategic, and the requirement for a plan “containing measures to facilitate public acceptance” is included in the CRM Act regulation proposal, no further specific provisions have been put forward.

In addition, being able to attract investments is an important prerequisite for scaling up mining capacities in the EU. However, due to the above-mentioned structural deficiencies, as well as other impediments such as the high energy cost of the mining process, uncertain economics due to volatile commodity prices or the possible shortage of a skilled workforce, extractive projects are often considered highly risky, and therefore not attractive for international investors. To tackle this, in the regulatory framework put forward by the CRMs Act, facilitated access to public (both at the EU and member state level) and private financing opportunities is provided for strategic projects.[5]

The potential contribution and limits of recycling

With the potential contribution of the mining industry being fairly limited in the short term, fostering circularity and upscaling recycling capacities in the EU will be key options to be explored.

The CRM Act provides for a target of at least 15% of EU annual consumption of each SRM to be covered by the Union recycling capacity by 2030. For some materials, recycling already provides inputs to EU supply well beyond that threshold. In the case of copper, for example, which is widely used in construction or power transmission and distribution grids, recycled feedstock already covers over half of the overall EU supply, thanks to high availability and favourable physical properties (Copper Alliance, 2022).[6] Still, for the majority of SMRs – and indeed for most of the whole CRMs group – the contribution of secondary sources to overall supply remains either negligible or completely absent. Crucially, this is the case for three battery raw materials – lithium, manganese and natural graphite – as well as all rare earth elements required for permanent magnets manufacturing.

Recycling technologies and processes for most CRMs-containing products or components already exist. While some are still at lab scale, others already have good prospects for rapid commercialisation and scale up. Spurred by the increasingly ambitious targets set by EU regulations (Council of the European Union, 2023)[7] and supported through EU funding, there are various ongoing recycling projects for EVs batteries across the EU. Similarly, recycling operations for rare earths permanent magnets are also being developed or planned. While scaling up EU recycling capacity to the point where it will provide a meaningful contribution will also take some time (possibly a few years), the time horizon is realistically lower than the expansion of mining production. Still, beyond the readiness of recycling technologies themselves, the extent to

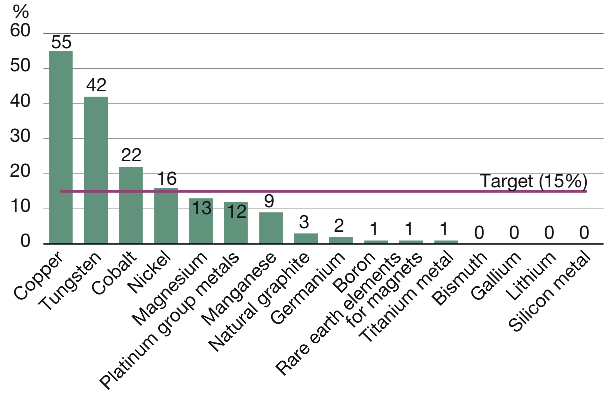
5 This section on mining is based on insights and qualitative data collected by the authors as part of an ongoing study by CEPS on ways to achieve strategic autonomy of the EU in the economic field.

6 Copper can be recycled an infinite number of times without performance losses.

7 The proposed new Battery Regulation provides that minimum levels of recovered cobalt (16%), lead (85%), lithium (6%) and nickel (6%) from manufacturing and consumer waste must be reused in new batteries from eight years after the entry into force of the regulation, to be increased from the 13th year (26% for cobalt, 85% for lead, 12% for lithium and 15% for nickel). The agreed text is available at https://data.consilium.europa.eu/doc/document/ST-5469-2023-INIT/en/pdf.

Figure 2

Current end-of-life recycling input rates for strategic raw materials and Critical Raw Materials Act target



Notes: The actual list of strategic raw materials as reported by European Commission (2023b) is: copper, tungsten, cobalt, nickel – battery grade, magnesium metal, platinum group metals, manganese – battery grade, natural graphite – battery grade, germanium, boron – metallurgy grade, rare earth elements for magnets, titanium metal, bismuth, gallium, lithium – battery grade, silicon metal. Platinum group metals include iridium, palladium, platinum, rhodium and ruthenium. Rare earth elements for magnets include neodymium, praseodymium, terbium, dysprosium, gadolinium, samarium and cerium.

Sources: European Commission (2023a; 2023b)

which the recycling industry will be able to cover an increasing EU raw materials consumption will also largely depend upon the efficiency of the entire recycling systems, on the one hand, and on the actual amount of end-of-life (EOL) products ready for recycling, on the other.

To date, multiple issues or bottlenecks exist throughout the various steps of the recycling chain, i.e. from product design up to the collection of disposed products and the actual recycling process. Systematic collection of some products containing CRMs is often lacking,[8] mostly due to inefficient waste management systems, lack of collection infrastructures and limited economic incentives for the recycling of some CRMs.[9] In the case of end-of-life electric vehicles, for instance, it has been shown that over a third are currently either not properly collected or exported outside the EU (Mehlhart, 2017). For waste electric and electronic equipment, the current collection rate in the EU as a whole stands at 46% (although with significant variations across member states), leaving large quantities of potentially valuable material out of the production cycle (Eurostat, 2023).

Notwithstanding the fundamental importance of efficient recycling systems, the theoretical contribution of recycling in meeting the future demand for critical raw materials – especially those employed in rapidly expanding applications such as electric mobility and renewable energy – will also largely depend on the actual availability of products to be recycled. For most low-carbon applications, material consumption is projected to increase exponentially up to the early 2030s, and only gradually stabilise thereafter. With average lifetimes of these applications ranging from about 12 years for EVs to over 30 for wind turbines, the number of products reaching the EOL stage in the near term will be relatively small compared to production volumes. Hence, a significant share of production will inevitably have to rely on primary materials in the short term, and the possible contribution of recycling will significantly grow only in the longer term.

Despite this caveat, previous assessments have shown that – with fairly efficient recycling systems in place, secondary materials could still provide a non-negligible input to EU material demand, even in the short term. For instance, Rizos and Righetti (2022) have estimated that in a best-case scenario – that is, assuming high recycling efficiencies and collection rates for recycling in the EU – up to 21% of lithium, 18% of cobalt and 14% of nickel requirements for EVs battery manufacturing could be obtained by EoL batteries recycling in 2030. In the same year, the recycling of wind turbines could help meet 22% of nickel, 10% of neodymium and 11% of dysprosium requirements for new wind power installations (Rizos and Righetti, 2022). Similarly, systematic recycling of spent rare earth permanent magnets could contribute to sourcing up to 19% of the materials required for the manufacturing of new magnets in 2030, including rare earths (Rizos et al., 2022).

The above figures seem to suggest that the 2030 recycling target for SRMs set by the CRM Act is, overall, realistic. However, it is worth emphasising that these result from fairly optimistic assumptions on the evolution of EU recycling capacity, and that significant efforts in terms of e.g. improving collection rates, establishing eco-design requirements or creating the enabling conditions for recycling projects to be profitable will be required for such rates to be achieved. Moreover, it should be noted that there is significant heterogeneity in the supply context of different materials, and that a 15% target might be much more challenging for some SMRs than others to achieve. While establishing material-specific targets may be complex in practice, recognising the existence of such heterogeneity and prioritising recycling efforts among technologies employing materials with the higher supply risk – notably lithium rare earths elements – should be the way forward.

Conclusions

Faced with an expected massive increase in demand and high import dependency, the EU future supply of critical raw ma-

8 In the case of mobile phones, for instance, Rizos et al. (2019) have estimated that up to 700 million unused devices across the EU remain uncollected.

9 The recycling of rare earths from permanent magnets represents one example where the economic incentives are currently very limited, see Rizos et al. (2022).

terials is exposed to risks. This is particularly relevant in the context of what the new Critical Raw Materials Act proposal defines as strategic raw materials for green, digital, space and defence applications.

While the EU has long recognised the issue and has already put forward several initiatives, the COVID-19 crisis and the recent turmoil in gas markets have further exposed the EU's systemic vulnerabilities. The need for a supportive regulatory framework, particularly for domestic mining and recycling, has emerged as a precondition for the EU to achieve enough security of supply. The newly published CRM Act marks a change of pace in this regard.

The CRM Act proposal sets targets for the first time for the supply of strategic and critical raw materials through EU sources, even though they have a non-binding status. It also puts forward a number of actions to support the scaling up of the primary and secondary supply of raw materials in the EU. Still, the actual potential of mining and recycling to contribute to future EU demand needs to be properly assessed, along with the constraints that might prevent such potential from being exploited.

In the short term, the contribution of additional mining production in the EU will likely be limited. This is largely due to long permitting processes, which together with other structural deficiencies – e.g. low public acceptance and difficulty in attracting investments – make it unrealistic that substantial capacity additions will happen before 2030, even with the new EU legal framework for raw materials in place.

With recycling facilities already opening, recycling might need a shorter time horizon to scale and provide significant inputs. Still a number of challenges, including a lack of sufficient collection infrastructures and limited economic incentives, need to be addressed in order to put an efficient EU recycling value chain in place. One key question in this regard is how fast substantial volumes of CRM-containing products will reach the end-of-life stage in order to be recycled.

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