



Challenges and opportunities of the European Critical Raw Materials Act

Alessandra Hool¹ · Christoph Helbig² · Gijsbert Wierink³

Received: 19 July 2023 / Accepted: 7 September 2023
© The Author(s) 2023

Abstract

The Critical Raw Materials Act (CRMA) is an essential regulatory framework designed to address the pressing challenges faced by the European Union (EU) in the strategic sectors of decarbonization, digitalization, and aerospace and defense. It aims to tackle the lack of secure and sustainable access to critical raw materials (CRMs) by increasing anticipation and mitigation of supply risks, fostering domestic CRM potential, and promoting sustainable sourcing practices. Part of a broader “Green Industrial Plan” and aligned with the “Net-Zero Industry Act” (NZIA), the CRMA strives to position the EU as a leading hub for clean tech industries. The NZIA and CRMA packages respond to international trends of protecting clean energy technology and resources, akin to the US Inflation Reduction Act. Defining materials as “strategic” based on their relevance and expected demand for strategic technologies, the CRMA regulation establishes benchmarks for minimum shares of EU demand to be covered by domestically sourced and processed as well as recycled raw materials and aims at reducing dependencies on single third country suppliers in all steps of the supply chain. A communication complements the regulation by focusing on increasing CRM supply security and sustainability through circularity, standardization efforts, skill development, and strategic actions for research and innovation. Establishing a “CRM Club” and partnerships with like-minded countries intend to strengthen international partnerships to safeguard CRM supply security and facilitate sustainable investment in resource-rich nations. Challenges arise concerning the concept of “strategic raw materials” and meeting benchmarks, particularly in materials availability, recycling targets, diversification, and the establishment of necessary skills. Data gaps, potential national differences, coherence with national legislation, long-term economic viability, and potential fuelling of international tensions also pose significant challenges to the effective implementation of the CRMA. Addressing these challenges and embracing the opportunities presented by the CRMA are crucial steps toward achieving sustainable resource management and advancing the EU’s clean tech industries.

Keywords Critical raw materials · Critical minerals · Resource management · Strategic projects · Mineral policies · Strategic raw materials

Intention and context

The European Commission proposed the Critical Raw Materials Act (CRMA) on March 16, 2023, as part of its broader “Green Industrial Plan” and in conjunction with a “Net-Zero Industry Act” (NZIA), with the intent to reduce the EU’s dependence on critical raw materials (CRMs) and foster a sustainable level playing field for the EU’s CRM value chains (European Commission 2023a). With a proposal for a regulation on many aspects concerning the EU’s management of CRMs (European Commission 2023b), accompanied by a communication (European Commission 2023c), the CRMA aims to address the EU’s pertinent supply risks of raw materials and in parallel increase their sustainability.

✉ Christoph Helbig
christoph.helbig@uni-bayreuth.de

Alessandra Hool
alessandra.hool@esmfoundation.org

Gijsbert Wierink
gw@plutonic-rma.com

¹ ESM Foundation, Junkerngasse 56, 3011 Bern, Switzerland

² Ecological Resource Technology, University of Bayreuth, Universitätsstr. 30, 95447 Bayreuth, Germany

³ Plutonic Raw Materials Advisory, Rue Belliard 40, 1040 Brussels, Belgium

The CRMA and the NZIA are part of a global trend towards increased protectionism on technological developments and resources for the clean energy transition. Among others, the US Inflation Reduction Act, passed in August 2022, subsidizes domestically produced energy technologies and provides tax reductions for products containing locally sourced raw materials. Korea announced benchmarks for domestic sourcing and recycling of strategic raw materials in February 2023 (MOTIE 2023). Industrial policies on raw materials are thus currently proliferating internationally.

While critical raw materials were a topic of concern in the USA already in the Second World War, the Commission of the European Communities has discussed issues of third-country supplier cluster risks since the mid-1970s. However, economic ties to supplying countries — often including those countries' dependency on development aid — seemed stable enough not to take any major action. Also, for some raw materials, proven existing EU reserves (e.g. in the case of magnesium) and substitution possibilities (e.g. in the case of cobalt) led policy-makers to believe that supply would not pose a major problem for the future (Commission of the European Communities 1975). While potential hurdles to domestic extraction such as environmental concerns were acknowledged, this did not change the overall assessment, and not much attention was paid to changing demand considering technological change.

A new take on critical raw materials emerged in the early 2000s, when industrialized countries around the world started to screen their supply risks not primarily based on potential geological availability, but on the factual origin of raw material used in the respective economy and the potential instabilities of supply from third countries; especially if this supply is concentrated on only a few players (Graedel and Reck 2016; Schrijvers et al. 2020). In the EU, a working group on critical raw materials was established in 2005, followed by the Raw Materials Initiative (RMI) in 2008 (European Commission 2008). The first list of critical raw materials for the EU was issued in 2011 and has since been updated regularly (European Commission 2011). New initiatives such as the knowledge and innovation community *EIT RawMaterials* and the *European Raw Material Alliance* have emerged on EU level, and several national agencies dealing with raw material risks were founded. Increasingly, “open strategic autonomy” and “technological sovereignty” have become influential principles guiding the current policy and funding endeavours of the European Union in civil-military and technological initiatives, emphasizing the importance of self-reliance and control over key areas while aiming at balancing collaboration and independence.

However, while previous raw material initiatives on EU level tried to increase supply security by supporting research and development (R&D) in mining, recycling, and substitution via public funding for joint projects and provided

guidance by openly available risk assessments, these were rather generic incentives that left the raw materials sector mostly open to be regulated by international market mechanisms. Accordingly, these incentives did not lead to significant changes in supply dependencies for many critical value chains where imports were the most cost-effective option and did not require large capital investment. The CRMA is thus the first comprehensive attempt to regulate critical raw materials management and steer related industry practices.

Summary of the CRMA

The CRMA targets the raw material basis for strategic sectors of decarbonization, digitalization, defense, and raw materials critical for the European economy overall (European Commission. Joint Research Centre 2023). It attempts to ensure secure and sustainable access to such raw materials relating to three subproblems: insufficient anticipation and mitigation of supply risks, underutilization of domestic CRM potential, and unsustainable sourcing of CRMs. The proposed regulation aims at specific objectives of increasing the EU industry's awareness and mitigation of CRM-related risks in supply chains, increasing the EU's domestic capacity for extraction, processing, and recycling, and reducing the environmental footprint of the EU's CRM consumption (European Commission 2023b).

The CRMA consists of several documents, with the main elements being a communication (European Commission 2023c), a regulation (see Fig. 1), and annexes to the regulation (European Commission 2023b). Additional delegated acts will have to be added later to specify some of the not-yet-defined terms and procedures introduced in the regulation. The regulation in its current form as a Commission proposal targets the goal of EU domestic production capacities in extraction, processing, and recycling stages capable of providing the benchmarks of 10%, 40%, and 15% of the EU's demand for strategic raw materials, respectively (*Art. 1*). Simultaneously, the EU aims to no longer source more than 65% of each strategic raw material from a single third country (*Art. 1*). These benchmarks refer to a 2030 time horizon.

The regulation defines both the term strategic raw material (SRM) and critical raw material in annexes I and II, whereby SRMs are raw materials that “score the highest in terms of strategic importance, forecasted demand growth and difficulty of increasing production” (*Art. 3*), and CRMs are these strategic raw materials together with all raw materials that exceed certain thresholds for both economic importance and supply risks (*Art. 4*). While three criteria for classifying a material as strategic are named — referring to their relevance for strategic technologies and the demand growth for these technologies (*Annex I*)

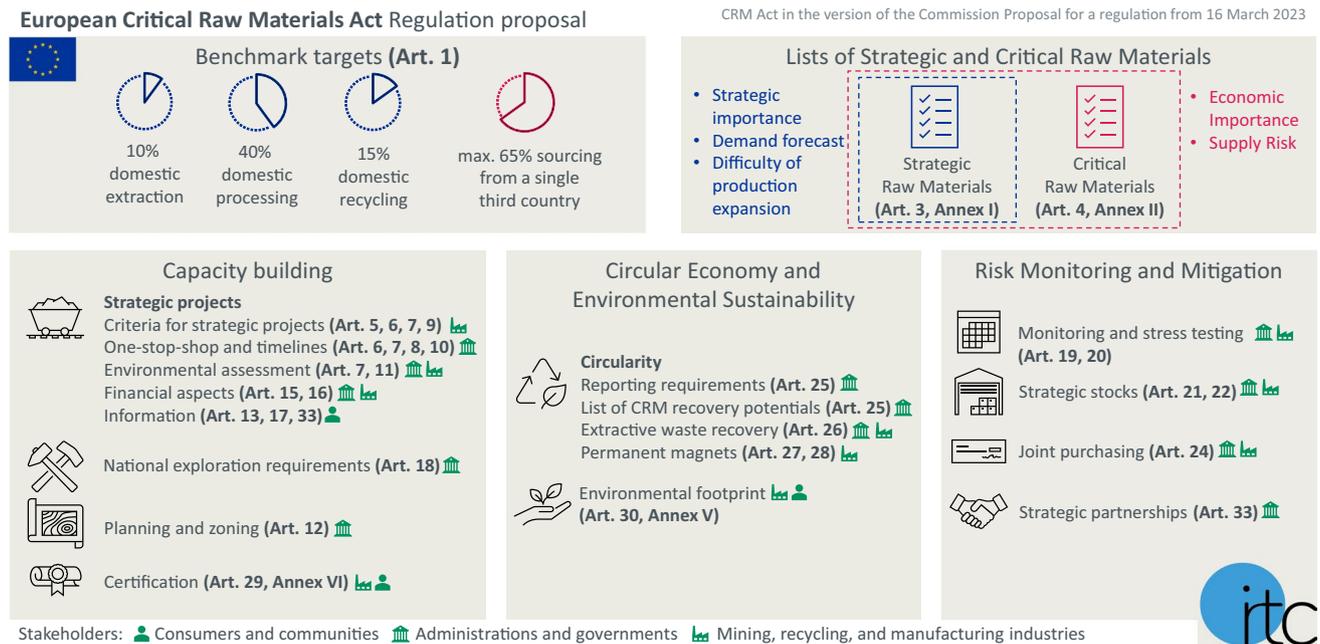


Fig. 1 A thematic overview of the CRMA regulation proposal from March 16, 2023, and affected stakeholders

— no concrete methodology or further explanation is provided (*Annex I*). In contrast, the underlying methodology for the criticality assessment is publicly available and has remained the same since 2017 (*Annex II*) (Blengini et al. 2017). In 2023, 70 candidate raw materials comprising 67 individual elements and the material groups of heavy rare earth elements, light rare earth elements, and platinum group elements were assessed. Of these, 16 are considered SRMs, and 32 raw materials are above the economic importance and supply risk thresholds. In total, 34 raw materials are considered CRMs, because copper and nickel do not meet the CRM thresholds but are classified as strategic and are thus included in the CRM list.

Another core component of the regulation is the introduction of *strategic projects*, which are required to make a meaningful contribution to the EU's supply of strategic raw materials (Art. 5-7). The regulation aims to support these strategic projects by ensuring that member states provide a one-stop-shop for their permitting process, thus prioritizing these projects and ensuring a timely permitting of a maximum of 24 months for extraction and 12 months for processing and recycling (Art. 9-10). Strategic projects require a sustainable implementation and compliance with broader ESG standards (Art. 5). Nevertheless, the public consultation period on the environmental impact assessment is limited to 90 days (Art. 11) since strategic projects are considered to be of "overriding public interest" (Art. 7). The regulation furthermore mandates member states to take possible critical raw materials projects into account in planning and zoning (Art. 12).

Strategic projects are further supported by coordinated financing, off-take agreements, and online accessibility of key information (Art. 15-17). Mandatory national exploration programmes targeted at Critical Raw Materials are meant to reduce the financial risk of exploration and facilitate the development of extraction projects (Art. 18). In addition, the regulation addresses better risk monitoring and mitigation by performing regularly updated stress tests for CRM supply chains, reporting and coordination of strategic stocks, supply chain auditing for large companies in strategic sectors, and joint purchasing of strategic raw materials (Art. 19-24).

Member states of the EU are called upon to increase the circularity of CRMs on different levels, whereby particular attention is given to permanent magnets (Art. 25-28). Strategic projects are fostered by certification schemes, and specific CRMs may be declared to have mandatory environmental footprint declarations (Art. 29-30). Furthermore, collaboration with selected third countries declared as *strategic partnerships* is another key strategy towards achieving the benchmarks (Art. 33). Partnerships are also emphasized in the CRMA's communication by the introduction of a "CRM club" of like-minded countries (European Commission 2023d).

Impacts on stakeholders

One of the key impacts of the CRMA is the establishment of benchmarks for domestic extraction, processing, and recycling of SRMs. The regulation sets benchmarks for

minimum shares of EU demand to be covered by domestically sourced, processed, and recycled raw materials. This requirement places increased pressure on the mining and processing industry to ramp up their domestic production capabilities. While this presents an opportunity for job creation and economic development in these sectors, it also brings challenges in meeting the benchmarks, securing investment, finding a skilled workforce, and ensuring compliance with the new regulations.

A critical question is how the benchmarks are defined: will there be single targets per raw material or for a certain aggregate of SRMs? If the latter, how will this aggregate be composed: as the mean of the 16 strategic raw materials, with each having the same impact, as an average based on weight, value-added, or other factors? Will member states have differing benchmarks for different raw materials, accounting for their reserves or mining capacities, therefore impacting mining companies differently according to the location of their operations? The answers to these questions will unfold in the upcoming legislative procedure and implementation process. While they are quite technical, they will significantly impact the involved stakeholder groups, and especially the mining industry.

The CRMA regulation emphasizes the importance of circularity and sets targets for the domestic recycling of SRMs, driving the need for increased investments in recycling facilities and technologies. It also creates incentives for developing more efficient and effective recycling processes. However, the industry may face challenges in meeting the recycling targets, particularly for certain materials with complex recycling requirements. Additionally, opposition to establishing new recycling facilities and potential conflicts over extractive waste management may arise in local communities. Here, the final version of the regulation and its implementation can also significantly influence impacts. The current proposal does not specify whether recycled raw materials have to come from end-of-life products or could also be manufacturing waste; it is not said whether they must originate from the EU (or, possibly, strategic partners). In its current generic form, it might be easier for OEMs to import manufacturing waste from China than to look for EU recycled end-of-life materials, especially for materials where the amount of available end-of-life products in the coming years will be marginal in comparison to the steeply increasing demand — such as EV batteries. Furthermore, it is not specified whether raw materials recycled in the EU can also count as “mined in Europe” and thus can contribute to meeting the mining benchmark. Depending on how the regulation develops, incentives, opportunities, and challenges to develop and report mining and recycling projects can differ substantially.

Also, the manufacturing industry and final producers will face the impact of increased demand for domestically sourced and recycled raw materials. They will need to adapt

their supply chains and sourcing strategies to align with the CRMA's requirements. The increased monitoring and reporting requirements could lead to increased costs and potential disruptions in the supply chain, particularly for those companies relying heavily on imported raw materials and may raise issues of company confidentiality. However, the CRMA also presents opportunities for market advantages by rewarding compliance with sustainability standards, thus allowing companies to tap into the growing demand for sustainably sourced materials and products.

Local communities, particularly those in mining regions, will experience both positive and negative impacts from the CRMA. On the one hand, increased domestic mining activities driven by the CRMA can contribute to job creation and economic growth in these areas. On the other hand, concerns about environmental impacts and social welfare may arise, requiring careful planning and engagement with local stakeholders to ensure sustainable development and minimize adverse effects. The proposed regulation could become especially controversial regarding the shortened timeframes for permitting and the strict time limits for public consultation on environmental impacts.

The CRMA impacts EU consumers through potential changes in the availability and pricing of products. The CRMA's focus on sustainable sourcing and circularity may lead to increased transparency and labelling of products, enabling consumers to make more informed choices. However, there is also the possibility of price increases for certain products due to the higher costs associated with complying with the CRMA's provisions.

National governments play a crucial role in implementing the CRMA and ensuring compliance with its requirements. They must coordinate efforts, provide regulatory frameworks, and allocate resources to support domestic production, processing, and recycling of raw materials. National governments also face challenges in balancing economic development objectives with environmental and social considerations and ensuring coordination with other EU member states to maintain a level playing field. Again, challenges and opportunities will strongly depend on how the proposed benchmarks are measured and implemented. Another critical factor to consider is the financing of the increased workload associated with monitoring and implementation. If the Member States bear these costs themselves, economically weaker regions might be disadvantaged, and the Act runs the risk of further increasing economic imbalances within the Union. Moreover, EU, Member State, and regional governments need the skills and capacity to process strategic project applications and speed up the permitting process without increasing unreasonable environmental impacts.

Non-EU actors and countries supplying raw materials to the EU are impacted by the CRMA through requirements for diversification and reduced dependencies on single

third-country suppliers, which may lead to changes in trade dynamics and potential tensions between the EU and non-EU actors. Strategic partnerships with like-minded countries can open up opportunities for collaboration but may also result in potential disadvantages for non-partner countries.

Lastly, the CRMA has far-reaching implications for both EU and non-EU investors. On the one hand, investment opportunities in projects related to raw material extraction, processing, and recycling will likely increase. On the other hand, investors must navigate potential market volatility and manage risks associated with regulatory compliance and sustainability considerations. ESG factors will play a significant role in investment decisions, aligning with the CRMA's focus on sustainable resource management. Increased compliance and reporting costs will likely weigh on investment decisions in the EU. Clarity on supply chain transparency and reporting requirements are especially challenging for the complex and relatively opaque supply chains in the raw materials sector.

Further, for industry, investors, and governments to execute timely on the CRMA, certification of sustainable extraction, processing, and supply needs to be simplified and unified. Access to financing will be crucial for companies to meet the CRMA's requirements and for strategic projects to realize. Market competition will intensify, driving companies to differentiate themselves based on compliance and sustainability practices. The CRMA drives an enormous economic and industrial shift for the EU Single Market. As such, partnerships between investors, companies, and governments and the close involvement of citizens will be vital to advancing responsible investment practices and ensuring a resilient raw materials supply chain. Table 1 summarizes selected opportunities, challenges, and open questions for the main stakeholders.

Conclusion

The CRMA represents an important step by the European Union to address the challenges of secure and sustainable access to critical raw materials (CRMs), aiming at significantly reducing the EU's dependence on single third-country suppliers and promoting circularity and sustainable sourcing practices. The CRMA's provisions are transformative by utilizing industrial policy instruments and can be seen as a result of two decades of EU efforts and policy dialogue to actively mitigate supply risks.

The regulation has wide-ranging impacts on stakeholders, including the mining and processing industries, manufacturing companies, local communities, consumers, national governments, non-EU actors, and investors. While the CRMA presents opportunities for job creation, economic development, and market advantages for companies that comply with its provisions, it also brings forth challenges. The mining, processing, and recycling industry will face the task of

meeting the benchmarks and securing investments, which will necessitate careful planning, skilled workforce development, and compliance with new regulations. The manufacturing industry and OEMs will need to adapt their supply chains and sourcing strategies, potentially facing increased costs and disruptions. Mitigating negative impacts on local communities will require sustainable development practices and stakeholder engagement. European consumers may see changes in product availability, pricing, and transparency. National governments will have to balance economic development objectives with environmental and social considerations and ensure coordination with other EU member states. Non-EU actors supplying raw materials to the EU may face changes in trade dynamics and potential tensions, while strategic partnerships can offer collaboration opportunities. Investors will encounter novel opportunities but also new risks, with ESG factors becoming crucial in investment decisions.

The CRMA is a unique policy instrument to bolster the European green transition and open strategic autonomy while requiring the necessary capacity to execute the legislation at member state, local community, and EU levels, which may lead to an increased need for administrative support from public officials, consultants, and other personnel. A lacking workforce in implementation may hamper tangible progress. The definition of benchmarks, implementation details, and harmonization across member states will impact the outcomes of the CRMA's implementation. Clarity, simplification, and unification of certification and reporting requirements are necessary for transparency and compliance. Access to financing and collaboration between investors, companies, and governments will be essential, and close involvement of citizens is crucial for responsible investment practices and a resilient raw materials supply chain. By navigating these challenges and seizing opportunities, the CRMA can contribute to sustainable resource management and advancing the EU's clean tech industries.

Future considerations

During the legislative progress, several issues may arise, such as how to measure progress on the benchmarks, implement new suggested practices like stockpiling and joint purchasing, and not least on financing the necessary activities. New industry dynamics will emerge by introducing strategic raw materials as a sub-category of critical raw materials and making them subject to specific regulations, which could entail industries lobbying for specific raw materials to be classified as strategic and putting more resources into SRM projects, possibly in parallel reducing efforts towards other (critical) raw materials.

For the regulatory framework around the CRMA to reach its ambitions, close collaboration between policymakers,

Table 1 Selected opportunities, challenges, and open questions for the main stakeholders of the Critical Raw Materials Act

Stakeholder group	Selected opportunities	Selected challenges	Selected open questions
Mining and processing industry	Increased demand for domestically mined and processed SRMs; increased visibility & political support	Pressure to meet benchmarks and securing investments; pressure to meet compliance requirements; possible knowledge and skill gaps	How will benchmarks be measured and composed (e.g., benchmark for each SRM versus total of all SRMs)?
Manufacturing industry and OEMs	Reduced supply risk due to domestic production and strategic partnerships; transparency requirements might increase reputation and thus demand (also internationally)	Pressure to meet transparency requirements; additional costs for compliance	How quickly and effectively will new information systems, transparency standards, and labelling be implemented?
Recycling industry	Increased and secured demand for domestically recycled SRMs; visibility & political support	Potential difficulties to reach benchmarks due to lacking end-of-life products and processing waste	Will recycling benchmark refer to domestically recycled material only, or recycled materials in general (such as processing waste from China)?
Local communities	Job creation and economic development, including in downstream regional industry	Potential environmental damages and natural habitat destruction due to shortened permitting times; potential relocation of communities	Will there be a successful dialogue, co-creation, and trust between policymakers, industries, and affected communities?
Consumers	Higher transparency; possibility for informed consumer choices regarding material origin and environmental footprint; possible more stable long-term product availability	Possibly increased prices through compliance costs; due to possibly increased trade tensions, unexpected changes in product availability are possible	How will raw material origin and environmental footprint be communicated? Will consumers see it as an added value?
National governments	Job creation and economic development, including downstream regional industry; bolstering of green transition and increased autonomy on EU level	Need to balance economic development objectives with environmental and social considerations and ensure coordination with other EU member states; might disadvantage economically weaker regions; increased workload associated with monitoring and implementation	Will there be EU level financial and personnel support to meet requirements and workload?
Non-EU actors	Market advantages for strategic partners	Changes in trade dynamics and potential tensions; pressure to meet transparency requirements	How strict will the division between strategic partners and non-partner countries be, and might benchmarks extend to strategic partners (like the US Inflation Reduction Act)?
Investors	New investment opportunities in strategic projects; increased R&D activities may help long-term innovation and market growth, also in other sectors	Need to navigate potential market volatility and manage risks associated with regulatory compliance and sustainability considerations; need to adapt decision-making and investment criteria, especially regarding ESG; longer time horizon for Return on Investment due to technical and regulatory complexity	How will sustainability or supply chain resilience be defined and measured? How will compliance be monitored? How will it affect competitiveness and economic growth?

industry, and research is essential. For stakeholders working in the field of materials and the green transition, the addition of the category of strategic raw materials politicizes the analysis of mineral criticality. This politicization makes the field more volatile, moving away from static methodological approaches to raw material criticality.

With industrial policies on securing the basis for low-carbon technologies emerging not only in the EU but in countries around the world, the competition for critical raw materials is growing fiercer. Notions of strategic partnerships and new forms of collaboration with like-minded countries are likely to intensify tendencies of global block-building, which might change the political landscape substantially, with the political and economic consequences yet to emerge.

By July 2023, several Member States, including France, Germany, and Italy, have already expressed their intentions to enhance collaboration to achieve the objectives outlined in the CRMA. By the end of June 2023, the European Council took a significant step forward by adopting its negotiating position. The Council of the European Union proposed raising the benchmarks even higher than before, suggesting an increase in the share of EU-domestic processing and recycling for EU-consumed materials to rise from 40 to 50% and from 15 to 20%, respectively. In addition to emphasizing facilitating more efficient permitting procedures for strategic projects, the Council recommended including bauxite and aluminium in the strategic raw materials list and reinforcing measures to increase circularity and sustainability.

Making substantial progress in the implementation process of the CRMA requires ongoing efforts and constructive dialogue among the member states and engagement and negotiation among stakeholders to effectively navigate the complexities involved. Despite the challenges posed by addressing these complexities in a democratic process, intensifying political tensions surrounding critical raw materials present a possibility that the Act may be fully adopted before the 2024 European elections.

Author contributions All authors contributed to the study conception and design, analysis, first draft and reviews and edits of the manuscript. All authors read and approved the final manuscript.

Funding Open Access funding enabled and organized by Projekt DEAL. The authors are members of the project IRTC, “International Round Table on Materials Criticality”. The IRTC project receives funding from EIT RawMaterials, supported by the Institute of Innovation and Technology (EIT), a body of the European Union, under Horizon Europe, the EU Framework Programme for Research and Innovation.

Data availability Not applicable

Declarations

Ethics approval and consent to participate Not applicable

Consent for publication Not applicable

Competing interests The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Blengini GA, Nuss P, Dewulf J et al (2017) EU methodology for critical raw materials assessment: policy needs and proposed solutions for incremental improvements. *Resour Policy* 53:12–19. <https://doi.org/10.1016/j.resourpol.2017.05.008>
- Commission of the European Communities (1975) The Community's Supplies of Raw Materials. Communication from the Commission to the Council. COM (75) 50 final. *Bulletin of the European Communities Commission* 1975 Supplement 1/75
- European Commission (2008) Communication from the Commission to the European Parliament and the Council - The raw materials initiative : meeting our critical needs for growth and jobs in Europe {SEC(2008) 2741} COM/2008/0699 final. <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52008DC0699>
- European Commission (2011) Critical Raw Materials for the EU. Report of the Ad-hoc Working Group on defining critical raw materials. <https://ec.europa.eu/docsroom/documents/5662/>
- European Commission (2023a) European Critical Raw Materials Act. In: European Commission - European Commission. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1661. Accessed 11 Jul 2023
- European Commission (2023b) Proposal for a regulation of the European parliament and of the council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020, COM/2023/160 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023PC0160>
- European Commission (2023c) COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A secure and sustainable supply of critical raw materials in support of the twin transition
- European Commission (2023d) Commission Staff Working Document Impact Assessment Report Accompanying the document Proposal for a Regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020, SWD/2023/161 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023SC0161>
- European Commission. Joint Research Centre (2023) Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU : a foresight study. Publications Office, LU

- Graedel TE, Reck BK (2016) Six years of criticality assessments: what have we learned so far?: six years of criticality assessments. *J Indust Ecol* 20:692–699. <https://doi.org/10.1111/jiec.12305>
- MOTIE (2023) Strategies to secure core minerals to become a global powerhouse in high-tech industries [국가 핵심광물 공급위기 대응 및 공급망 안정화 대책 발표]. <https://www.korea.kr/briefing/pressReleaseView.do?newsId=156554864>. Accessed 10 Jul 2023
- Schrijvers D, Hool A, Blengini GA et al (2020) A review of methods and data to determine raw material criticality. *Resour , Conserv Recycling* 155:104617. <https://doi.org/10.1016/j.resconrec.2019.104617>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.