

THE ROLE OF INTERNATIONAL PARTNERSHIPS AND GLOBAL ALLIANCES FOR SECURING CRITICAL RAW MINERAL SUPPLY CHAINS

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Abstract: The global energy and digital transitions have significantly increased the demand for critical raw materials (CRMs) and exposed vulnerabilities in current supply chains. This paper investigates the geopolitical, economic, and environmental risks associated with the high concentration of CRM production and reserves in a limited number of countries and regions. The purpose of this study is to assess how international strategic partnerships can mitigate these systemic risks and ensure more secure, diversified, and sustainable access to key mineral resources. The objectives pursued include: mapping the global distribution of CRM reserves and production capacities; identifying key geopolitical and structural risks that threaten supply chain resilience; and analysing the most relevant international initiatives and bilateral or multilateral agreements aimed at cooperation on CRM. The study focuses in particular on the European Union's strategic partnerships with countries such as Canada, Namibia, Australia, and Japan, as well as transatlantic and Indo-Pacific alliances involving the United States, Canada, Japan, and Ukraine.

Keywords: critical raw materials, supply chain, international partnerships, geopolitical and structural risks.

1 Introduction

Critical minerals are essential resources for economic development and the global energy transition. They are indispensable for modern technologies, including batteries for electric vehicles, wind turbines, solar panels, and digital infrastructure (IEA, 2022). According to the European Commission (2023), dependence on a limited number of supplier countries leads to significant vulnerabilities both in developed and emerging economies. In this context, international partnerships have become a strategic component in securing supply chains.

This paper addresses the critical challenge of securing supply chains for CRMs by analysing the strategic role of international partnerships and global alliances. The issue is of paramount importance due to the concentration of CRM production and processing in a limited number of geopolitically sensitive regions such as China, the Democratic Republic of Congo, South America, and Indonesia. Such concentration exposes global supply chains to systemic vulnerabilities arising from geopolitical risks, export restrictions, resource nationalism, political instability, and various external shocks such as natural disasters and armed conflicts (IRENA, 2023). These factors threaten the stability and reliability of supply that are essential for the green and digital transitions.

To explore this issue comprehensively, the paper includes an analysis of quantitative data on global CRM reserves and production (USGS, 2024), which provides a detailed understanding of supply capacities and dependencies. The study investigates the responses of key actors, in particular the European Union, the United States (U.S.), Canada, Australia, Japan and Ukraine, through strategic partnerships and multilateral frameworks aimed at enhancing diversification, transparency and resilience of supply chains. These include policy instruments such as the European Raw Materials Alliance, and the Critical Raw Materials Act as well as bilateral and multilateral agreements to promote cooperation on sustainable mining practices, technology transfer, and capacity building.

By integrating recent empirical data and policy developments, this paper contributes to the existing literature by providing an updated assessment of risks in the CRM supply chain and mitigation strategies. It builds on previous research and reports from authoritative institutions such as the International Renewable Energy Agency (IRENA), the Organisation for Economic Co-operation and Development (OECD), the International Energy Agency (IEA), and the European Commission, while offering new insights into the evolving geopolitical dynamics and collaborative initiatives shaping the future of critical minerals supply security.

2 Literature review

The proliferation of emerging technologies – from renewable energy systems to electric vehicles – has led to a growing demand for critical mineral resources (CMRs). These materials are essential for the development and deployment of such technologies. However, their supply chains are often vulnerable to disruption, geopolitical tensions, and concerns over social and environmental sustainability (Althaf & Babbitt, 2020; Bhuwalka et al., 2021; Kramarz, Park & Johnson, 2021).

Addressing the challenges associated with critical mineral resources requires a collaborative approach involving governments, industry, and academia. Partnerships can play a pivotal role in developing comprehensive strategies to mitigate risks in the supply chain, diversify sources, and promote sustainable and ethical extraction and processing practices. A large number of researchers and practitioners are working to ensure a stable supply of these materials, which are critical to the transition to renewable energy technologies. The COVID-19 pandemic has further exacerbated the fragility of these supply chains, as disruptions in production and transport have contributed to increased uncertainty in the global economy (Giese, 2022). In this context, international actors have initiated partnerships aimed at mitigating the risks and addressing the challenges associated with critical mineral resources.

According to studies and policy reports (IRENA, 2023; Månberger & Johansson, 2019; OECD, 2016), CMRs' supply chains are exposed to a variety of geopolitical risks that jeopardise their stability and reliability. These risks include external shocks such as natural disasters, pandemics, armed conflicts, and mining accidents, which can significantly disrupt production and transport routes. In addition, the increasing trend towards export restrictions and resource nationalism, including the formation of mineral cartels that coordinate production volumes, pricing strategies, or market access, poses strategic challenges for consumer countries. Political instability and social unrest in resource-rich regions, manifested in strikes, violence, or corruption, further complicate the predictability of supply flows. Furthermore, market manipulation by dominant actors can distort global prices and restrict access for weak economies. In this context, international partnerships and global alliances are some of the most effective measures to mitigate these types of risks by promoting diversification, transparency, and collective resilience.

3 Research Methodology

The research methodology used in this paper is primarily qualitative and involves a comprehensive review and analysis of international literature, policy reports, and official documents published by key stakeholders, including international non-governmental organisations (NGOs) and European institutions. This analysis enabled a critical assessment of the current state of CRM supply chains, geopolitical risks, and policy responses.

In addition, the study examines and compares data on global CRM reserves and production in different regions and shows a significant concentration of these resources in a limited number of geographical areas. This geographical concentration emphasises the structural vulnerabilities of the global supply system, as dependence on a few key regions increases the risk of disruption. The analysis also included the mapping and assessment of existing strategic partnerships and international alliances to secure and diversify CRM supply. Particular attention was given to bilateral and multilateral agreements involving major actors such as the European Union, the United States, Canada, Australia, Japan, and Ukraine.

4 The Distribution of Reserves, Global Production, and Utilization of CMRs

Critical raw materials are naturally occurring elements and compounds that are economically important but whose supply is associated with a high risk due to geopolitical, geological, or market factors. These materials

are essential to the functioning of key industries such as renewable energy, digital infrastructure, aerospace, and defence. Their “criticality” arises from a combination of factors including their economic importance, the concentration of supply in a small number of countries, and the lack of viable substitutes or recycling technologies (European Commission, 2023).

The categorisation of a mineral as “critical” is not static, but evolves with technological advances and geopolitical dynamics. For example, the IEA points out that the energy transition will significantly increase demand for minerals such as nickel, copper, and manganese, creating new vulnerabilities in global supply chains (IEA, 2022). In addition, the concept of critical raw materials is increasingly linked to sustainability considerations, including the environmental and social costs of extraction, the carbon footprint of supply chains, and the ethical dimension of sourcing from conflict-affected regions (OECD, 2016). Effective governance frameworks and international partnerships are therefore crucial to ensure safe, responsible, and equitable access to these strategic resources.

CRM's classification reflects the strategic priorities of major global actors and their assessments of supply chain vulnerabilities. In 2024, the European Union (EU) enacted the Critical Raw Materials Act (CRMA) with Regulation (EU) 2024/1252, which identifies 34 CRMs, 17 of which are designated as strategic raw materials (SRMs). These SRMs are seen as critical to the EU's green and digital transitions and the regulation sets specific targets for extraction (10%), processing (40%), and recycling (25%) by 2030. The EU's SRM strategy emphasises resilience, sustainability, and reduced dependence on third-country suppliers, particularly in the context of increasing geopolitical tensions and supply disruptions (European Commission, 2024a).

In March 2025, the European Commission selected 47 Strategic Projects “to secure and diversify access to raw materials in the EU”. All of them are located across 13 EU Member States: Belgium, France, Italy, Germany, Spain, Estonia, Czechia, Greece, Sweden, Finland, Portugal, Poland and Romania. The Strategic Projects cover 14 of the 17 SRMs listed in the CRMA (European Commission, 2025).

Also, in the United States, the USGS Mineral Commodity Summaries 2024 contain an updated list of 50 critical minerals considered essential to national economic security and defence. These include lithium, cobalt, rare earths, and other commodities needed for batteries, renewable energy infrastructure, and military technologies. The US strategy focuses on assessing supply chain risks and expanding domestic production and processing capabilities to reduce dependence on geopolitical rivals (USGS, 2024).

On the other hand, although China does not publish an official CRM list, it retains global dominance over the processing of 19 of the 20 most strategically important minerals, such as rare earths, graphite, and lithium. In 2024, the Chinese government revised its Mineral Resources Law to strengthen strategic reserves and incentivise increased production of key materials (Xinhua, 2024).

Meanwhile, the IEA warns of extreme market concentration in its Global Critical Minerals Outlook 2025: the three largest producing countries will control more than 75% of the supply for many key CRMs such as copper, nickel, and cobalt by 2035. The IEA calls for international cooperation and robust investment in diversified, resilient, and transparent value chains to support the global energy transition (IEA, 2025). These minerals are the foundation for strategic sectors of the global economy, from green energy and e-mobility to communications, robotics, and defence. Demand is continuously rising, increasing trade tensions and pressure on natural resources.

Table 1: Global Reserves and Production of Key Critical Raw Materials

Critical Raw Material	Global Reserves (metric tons)	Global Production (metric tons, 2023)	Used for
Lithium	28,000,000	180,000	EV batteries, energy storage
Cobalt	11,000,000	230,000	Batteries, super alloys
Nickel	>130,000,000	3,600,000	Stainless steel, batteries
Rare Earth Elements	110,000,000	350,000	Magnets, electronics, defence
Graphite (natural)	280,000,000	1,600,000	Batteries, lubricants
Copper	>1,000,000,000	22,000,000	Electrical wiring, electronics
Tantalum	>450,000	2,400	Capacitors, electronics
Niobium	>17,000,000	83,000	Steel alloys, superconductors
Tungsten	4,400,000	78,000	Metalworking, electronics

Source: USGS, 2024.

Table 1 provides a brief overview of global reserves, production volumes (estimated for 2023), and the main applications of the most important CRMs, which are essential for modern industrial and technological processes. The data illustrates the significant disparity in reserves and production volumes of the various minerals, reflecting their varying geological availability and market demand.

Lithium, with global reserves estimated at 28 million metric tons and production of 180,000 metric tons, is primarily used in batteries for electric vehicles and energy storage systems, underlining its central role in the ongoing energy transition. Cobalt, with reserves of around 11 million metric tons but a similar production level to lithium, is mainly used in the production of batteries and superalloys, which are essential for high-performance applications.

Nickel and copper are characterised by large reserves – more than 130 million and 1 billion metric tons respectively – and substantial production volumes. Their broad industrial use in stainless steel, batteries, electrical wiring, and electronics highlights their fundamental status in global manufacturing and infrastructure.

Although rare earths have smaller reserves, they occupy a crucial position due to their special applications in magnets, electronics, and defence technologies. Natural graphite, tantalum, niobium, and tungsten are less rich in reserves than copper and nickel, but play an indispensable role in niche applications such as battery anodes, capacitors, steel alloys, and metal processing. Although their production volumes are modest, they reflect targeted extraction to meet specific technological requirements.

Table 2: Countries with Largest Reserves and Production of CRMs

Critical Raw Material	Country with Largest Reserves	Share of Global Reserves	Country with Largest Production	Share of Global Production
Lithium	Chile	33.2%	Australia	47.8%
Cobalt	DR Congo	54.5%	DR Congo	73.9%
Nickel	Indonesia	42.3%	Indonesia	50.0%
Rare Earth Elements	China	40%	China	68.6%
Graphite (natural)	China	27.9%	China	76.9%
Copper	Chile	19.0%	Chile	22.7%
Tantalum	China	53.3%	DR Congo	40.9%
Niobium	Brazil	94.1%	Brazil	90.4%
Tungsten	China	52.3%	China	80.8%

Source: USGS, 2024.

The data in Table 2 illustrates the dominant role that certain countries play in both the reserves and production of key CRMs and shows a significant geographical concentration that has important geopolitical and economic implications. Chile emerges as a leading player in the lithium and copper sector and has around one third of the world's lithium reserves (33.2%) as well as substantial shares of copper reserves (19.0%) and production (22.7%). This underscores Chile's strategic importance for the global supply of these key materials, particularly lithium, which is crucial for the fast-growing electric vehicle and energy storage industries. The D.R. Congo has a marked dominance in cobalt, accounting for 54.5% of global reserves and an even more significant 73.9% of production. This concentration makes global cobalt supply chains very sensitive to the political and social conditions in this country and increases concerns about the security of supply and ethical sourcing.

China shows an overwhelming dominance in several CRMs, particularly rare earths, natural graphite, tantalum, and tungsten. With 40% of rare earth reserves and 68.6% of production, as well as dominant shares of natural graphite reserves (27.9%) and production (76.9%) and tungsten reserves (52.3%) and production (80.8%), China's control over these minerals is a key factor in global supply chain stability and geopolitical dynamics. On the other hand, Indonesia is also an important supplier due to its significant share of nickel reserves (42.3%) and production (50.0%), reflecting its strategic role in the production of stainless steel and batteries. In the case of niobium, Brazil stands out with an extraordinary 94.1% share of global reserves and 90.4% of global production.

The country thus controls this niche but strategically important material, which is used in steel alloys and superconductors.

Overall, this data highlights the marked concentration of critical mineral resources in a limited number of countries, posing challenges in terms of supply chain diversification, geopolitical influence, and the need for international cooperation to ensure stable and ethical access to these vital materials. At the same time, the strategic importance of certain minerals is also determined by their substitutability, their recycling potential, and the environmental and social costs of their extraction. Criticality is therefore a dynamic concept that needs to be regularly reassessed due to technological development and geopolitical changes.

The concentration of production and processing in a few regions of the world (e.g. China, Democratic Republic of Congo, South America, or Indonesia) creates systemic vulnerabilities in supply chains. This fact justifies the urgency to develop international partnerships to minimise the risk of disruptions and ensure stable access to these key commodities.

5 Strategic Partnerships and Global Alliances for Critical Mineral Supply

5.1 European Union Initiatives

The European Union has increasingly recognised the strategic importance of securing access to critical raw materials. In response, the EU launched the European Raw Materials Alliance (ERMA) in 2020, which aims to promote partnerships throughout the supply chain and reduce dependence on external actors, particularly China (European Commission, 2020). The Critical Raw Materials Act proposed in 2023 further formalises these efforts by setting concrete benchmarks: For example, the EU must not depend on any one country for more than 65% of its annual consumption of strategic raw materials by 2030 (European Commission, 2023). These initiatives are part of a broader strategy for open strategic autonomy that aims to maintain integration into global markets while improving resilience.

Through bilateral and multilateral agreements, the EU has also begun to enter into strategic partnerships with resource-rich countries. In response to growing concerns about supply chain vulnerabilities and geopolitical dependencies, the European Union has actively pursued Strategic Partnerships (SPs) aimed at ensuring access to CRMs. These partnerships are formalised through Memoranda of Understanding (MoUs) and reflect a broader strategy of external engagement and diversification. So far, the EU has concluded such agreements with a number of countries, including Canada and Ukraine (2021), Kazakhstan, and Namibia (2022) as well as Argentina, Chile, Zambia, the Democratic Republic of Congo, and Greenland (all in 2023). These collaborations are intended not only to secure reliable sources of CRMs, but also to promote sustainable mining practises, technology transfer and capacity building, thereby aligning supply chain security with broader development and environmental goals (Müller, Ghiotto & Bárcena, 2024). These agreements are intended not only to secure the supply of raw materials, but also to promote responsible mining practises, technology transfer and local value creation. For example, the partnership signed between the EU and Namibia in 2022 includes provisions for joint investment in refinery infrastructure and skills development. This reflects the ambition to go beyond traditional commodity relations by integrating the principles of sustainability and development cooperation.

5.2. The European Union's Key Strategic Partnerships

The European Union's heavy dependence on CRM imports and the importance of CRM-based raw materials for industry have made the risks associated with these resources a major concern at the EU level (Løvik, Hagelüken & Wäger 2018). The essential role of CRMs in European industry has led to a variety of policy initiatives, stakeholder collaboration platforms, activities, and research projects aimed at addressing security of supply concerns. While these efforts focus primarily on critical metals, they also recognise that other raw materials may pose equally significant or even greater supply risks (Lewicka, Guzik & Galos, 2021).

The strategic importance that the EU attaches to access to critical raw materials is reflected in various policy initiatives such as the *European Green Deal*, the *Industrial Strategy for Europe*, and the *EU Regulation on Sustainable Investments* (Guzik et al., 2021). These strategies emphasise the need to improve access to existing primary resources and increase recycling activities. The EU has implemented numerous political initiatives, stakeholder collaboration platforms, industrial activities and research projects to improve access to and utilisation of existing primary resources and to intensify recycling efforts.

EU-U.S.: Strengthening Cooperation on Critical Minerals Security

In March 2023, the President of the European Commission, Ursula von der Leyen, and US President Joe Biden announced their intention to conclude an agreement on critical minerals, which could represent a strategic step towards strengthening the supply chains necessary for the green transition (European Parliament, 2023). Although the negotiations were authorized by the EU Council in July 2023, the talks are still ongoing and remain unpredictable, particularly given the changes in the US administration.

This initiative was expanded in April 2024 (European Commission, 2024b) when the EU, the US, and other members of the Minerals Security Partnership (MSP) announced the launch of the Minerals Security Partnership Forum - a significant step towards international cooperation on critical mineral resources (Lewicka, Guzik & Galos, 2021). The initiative aligns with the EU's broader strategy to diversify sources of supply and reduce dependence on single suppliers, as outlined in the discussions on "raw materials diplomacy" (Guzik et al., 2021; Løvik, Hagelūken & Wäger 2018) and aims to expand collaboration on essential resources required for the green and digital transitions in a broader and more ambitious framework (Løvik, Hagelūken & Wäger 2018). The Forum's dual approach demonstrates a commitment to responsible sourcing and development: on the one hand, it supports sustainable projects on the ground; on the other, it facilitates political dialogue on sustainable production, regulatory cooperation, and standards related to environmental, social and governance (ESG) policies. The policy of openness to new members - which requires adherence to the MSP principles - encourages global participation in building resilient and sustainable supply chains for key mineral commodities.

EU-Canada: Collaboration on Critical Minerals and Sustainability

The Strategic Partnership on Raw Materials, signed in June 2021, is an important mechanism to engage the European Commission and EU Member States in Canada's critical minerals and batteries value chains (European Commission, 2021). Its main objective is to improve the value, security, and sustainability of trade and investment in critical minerals and metals, which are essential for the transition to a green and digital economy. Agreed areas of collaboration under this partnership include the integration of commodity value chains, cooperation in science, technology, and innovation, and coordination within international forums to promote ESG criteria and standards.

EU-Australia: An Essential Partnership for a Sustainable Future

The partnership between Australia and the EU on critical minerals represents a significant opportunity to accelerate the transition to a net-zero emissions future (European Commission, 2024c). As a major producer and exporter of various mineral commodities, Australia is well positioned to meet the EU's growing demand for critical minerals needed for the energy transition. Australia's considerable mineral wealth and long experience in the mining sector can provide the EU with a sustainable and reliable source of critical minerals (Golev & Corder, 2015). At the same time, the EU's emphasis on resource security and its policies aimed at reducing import dependence, as well as increased recycling efforts, complement Australia's capabilities (Lewicka, Guzik & Galos, 2021). This partnership is particularly important given the complementary strengths and resources of the two parties. The EU, with its ambitious environmental and sustainability goals, has a vested interest in securing reliable and sustainable sources of critical minerals to support its green transition (Guzik et al., 2021). Cooperation could not only help to reduce vulnerabilities in global supply chains, but also promote sustainable practises in the extraction and use of raw materials.

EU-Japan: Agreements for Trade and Sustainability

The EU and Japan share a long history of economic and diplomatic cooperation, which has been extended in recent years to include the management of critical raw materials. The EU's strategic focus on Asia and Japan's growing economic presence in Europe have laid the foundation for closer collaboration in this area (Jańczak, 2021).

A milestone in EU-Japan relations is the Economic Partnership Agreement between the EU and Japan, which was signed in 2017. This agreement, which creates the largest free trade area in the world, sends a strong signal against protectionism and supports the modernisation of global trade rules (Hilpert, 2018). It is not just a trade deal, but also a strategic alliance between the EU and Japan that has the potential to help the EU take a leadership role in setting global trade standards (Frenkel & Walter, 2017). The expanded cooperation between the EU and Japan reflects a shared vision for open, sustainable, and rules-based global trade and provides a solid platform for collaboration on critical minerals and other strategic initiatives.

5.3. Global Alliances for Critical Mineral Supply

U.S.-Australia: A Strategic Partnership for Energy Transition Security

The United States and Australia have long maintained a strong strategic partnership, working together on a wide range of economic, political, and security issues. In recent years, this relationship has grown in importance as both countries seek to navigate the complex geopolitical landscape of the Asia-Pacific region. A key area of cooperation is the development and securing of critical mineral supplies in support of clean energy goals (White House, 2023).

With its abundant natural resources, Australia is well positioned to play an essential role in this partnership. As a major exporter of various mineral commodities, Australia's mining sector has been a crucial driver of economic growth for decades (Golev & Corder, 2015). Furthermore, Australia's proximity to the Asia-Pacific region and its economic ties with both the US and China give the country a strategic position with significant implications.

As the US and its allies seek to reduce their dependence on China for critical minerals, the partnership with Australia has become increasingly important. Australia's role as a stable and reliable supplier of these critical resources can help mitigate the risks associated with global supply chain disruptions and geopolitical tensions. In addition, the U.S.-Australia partnership on critical minerals can serve as a foundation for broader cooperation on new technology development, the transition to clean energy, and regional security and stability. By working together, the two countries can leverage their strengths and resources to address these complex and interrelated challenges.

U.S.-Canada: A Joint Strategic Commitment to Critical Minerals

Announced in January 2020, the Canada-US Joint Action Plan on Critical Minerals Collaboration is a strategic partnership to secure the supply chains of key critical minerals for various industry sectors. These include communications technologies, aerospace, defence and clean technologies (Giese, 2022).

The Action Plan promotes collaboration in several areas: (i) Industry engagement – developing partnerships with industry stakeholders to support supply chain capacity; (ii) Innovation – supporting research and development to find more efficient and sustainable solutions; (iii) Supply chains – securing resilient and diversified supply networks for critical minerals; (iv) Information exchange – sharing data on mineral resources and their potential; and (v) International collaboration – promoting joint efforts globally to improve access to critical resources (Government of Canada, 2020).

This initiative reflects a shared Canadian and U.S. commitment to reducing the risks associated with dependence on individual suppliers and supporting strategic economic sectors essential to the transition to cleaner and more sustainable technologies.

U.S.-Ukraine: A possible triumph for diplomacy

On 30 April 2025, the United States and Ukraine established a Reconstruction Investment Fund, opening the door for significant US investment in Ukraine's critical raw materials (CRM). The agreement ensures shared decision-making and revenues, with all profits reinvested in Ukraine for the first decade. Importantly, the agreement confirms Ukraine's sovereignty over its CRM resources under international law and includes key mineral-rich areas, some of which are near or within Russian-occupied territories. This complicates any potential U.S. recognition of Russian territorial claims and may deter further aggression due to the increased presence of US economic interests.

The agreement represents a strategic shift in US policy under the Trump administration - from transactional diplomacy to a long-term partnership - and at the same time strengthens Ukraine's international negotiating credibility. By linking cooperation in the field of mineral resources with defence and reconstruction, the agreement positions CRM as both an economic and security asset. At the transatlantic level, the agreement strengthens cohesion between the US and EU on sanctions and Ukraine integration and signals a broader consensus on the geopolitical value of securing CRM supply chains against authoritarian actors (Gould-Davies, 2025).

Canada-Japan: Dialogue and Shared Vision for Energy Resources

The growing global demand for critical minerals—essential to the manufacture of a wide range of high-tech products and the transition to a low-carbon economy has led to increased attention being paid to securing reliable and diversified sources of these resources. The cooperation between Canada and Japan in the field of

critical minerals reflects this general trend, as the countries seek to strengthen international cooperation and ensure resilient supply chains for critical minerals.

In May 2021, Canada and Japan agreed on six areas of bilateral cooperation on critical minerals, including the establishment of a Canada-Japan Critical Minerals Working Group under the broader framework of the Canada-Japan Energy Policy Dialogue. This working group will serve as a platform for both countries to facilitate trade, exchange information, and collaborate on standards related to critical minerals (Lewicka, Guzik & Galos, 2021).

6 Conclusions

The global transition to clean and green energy has reaffirmed the strategic importance of essential minerals. This paper has emphasised that the geographic concentration of CRM reserves and supply chains, combined with economic, geopolitical, ethical, and environmental challenges, poses significant risks and creates major vulnerabilities in global supply chains. Analysis of international literature, official reports, and strategic partnerships show that geopolitical risks, resource nationalism, and social challenges threaten the stability and predictability of access to CRMs. Nations are responding with a combination of trade policy, domestic investment, and international partnerships to ensure a sustainable and resilient supply of CRMs.

The path to reducing dependence on CRMs is fraught with challenges, and both the EU and the US must grapple with rising demand, geopolitical rivalries and the technical complexity of CRM extraction and processing. Therefore, this paper emphasises the increasing role of international alliances, such as those forged by the European Union, the United States, Canada, Australia, and Japan, in promoting diversification, sustainability, and resilience in critical mineral supply chains.

Recycling initiatives, advances in the circular economy, and strategic partnerships with resource-rich countries will play a crucial role in ensuring a stable CRM supply. Collaboration between governments, industry, and international organisations will be critical to creating resilient and sustainable supply chains that can support the transition. This holistic approach will be crucial to support the green transition while managing the complexity of the critical minerals landscape.

For further research, it is recommended to deepen the analysis of the effectiveness of existing partnerships in practice, explore emerging technologies that can change demand and supply dynamics, and investigate the socio-environmental impacts of expanding mining activities in resource-rich regions. Unilateral actions, such as recent initiatives of the Trump 2.0 Administration also deserve attention, including the executive order entitled *Unleashing America's Offshore Critical Minerals and Resources* (April 24, 2025) and the launch of an investigation on potential national security risks from imports of critical minerals and their derivative products (April 15, 2025). The criticality of raw materials will continue to be relevant in the years to come.

References:

- [1] Althaf, S., & Babbitt, C. W. (2020). Disruption risks to material supply chains in the electronics sector. *Resources, Conservation and Recycling*, 167, 105248. <https://doi.org/10.1016/j.resconrec.2020.105248> (Accessed 2 June 2025).
- [2] Bhuwanka, K., Field, F. R., Kleine, R. D., Kim, H. C., Wallington, T. J., & Kirchain, R. (2021). Characterizing the changes in material use due to vehicle electrification. *Environmental Science & Technology*, 55(14), 10097–10107. <https://doi.org/10.1021/acs.est.1c00970> (Accessed 2 June 2025).
- [3] European Commission. (2020). *The Action Plan on Critical Raw Materials*. <https://ec.europa.eu/docsroom/documents/42852> (Accessed 20 May 2025).
- [4] European Commission. (2021). *EU and Canada set up a strategic partnership on raw materials*. https://single-market-economy.ec.europa.eu/news/eu-and-canada-set-strategic-partnership-raw-materials-2021-06-21_en (Accessed 18 May 2025).
- [5] European Commission. (2023). *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*. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2023:160:FIN> (Accessed 23 May 2025).

- [6] European Commission. (2024a). *Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials*. <https://eur-lex.europa.eu/eli/reg/2024/1252/oj/eng> (Accessed 6 May 2025).
- [7] European Commission. (2024b). *EU and international partners agree to expand cooperation on critical raw materials*. https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1807 (Accessed 6 May 2025).
- [8] European Commission. (2024c). *EU and Australia sign partnership on sustainable critical and strategic minerals*. https://ec.europa.eu/commission/presscorner/detail/en/ip_24_2904 (Accessed 6 May 2025).
- [9] European Commission (2025). *Commission selects 47 Strategic Projects to secure and diversify access to raw materials in the EU*, Press release, March 25 (Accessed 2 June 2025).
- [10] European Parliament. (2023). *EU-US agreement on critical minerals: Building stronger supply chains together*. [https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/754617/EPRS_BRI\(2023\)754617_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/754617/EPRS_BRI(2023)754617_EN.pdf) (Accessed 10 May 2025).
- [11] Frenkel, M., & Walter, B. V. (2017). The EU-Japan Economic Partnership Agreement: Relevance, content and policy implications. *Intereconomics*, 52(6), 358–363. <https://doi.org/10.1007/s10272-017-0704-5> (Accessed 22 May 2025).
- [12] Giese, E. C. (2022). Strategic minerals: Global challenges post-COVID-19. *Extractive Industries and Society*, 12, 101113. <https://doi.org/10.1016/j.exis.2022.101113> (Accessed 18 April 2025).
- [13] Golev, A., & Corder, G. (2015). Typology of options for metal recycling: Australia’s perspective. *Resources*, 5(1), 1. <https://doi.org/10.3390/resources5010001> (Accessed 17 April 2025).
- [14] Gould-Davies, N. (2025). *The US–Ukraine minerals deal: A triumph for Ukrainian diplomacy*. <https://www.iiss.org/online-analysis/online-analysis/2025/05/the-us-ukraine-minerals-deal-a-triumph-for-ukrainian-diplomacy/> (Accessed 2 May 2025).
- [15] Government of Canada. (2022). *The Canadian Critical Minerals Strategy*. <https://www.canada.ca/content/dam/nrcan-rncan/site/critical-minerals/Critical-minerals-strategyDec09.pdf> (Accessed 14 May 2025).
- [16] Guzik, K., Galos, K., Kot-Niewiadomska, A., Eerola, T., Eilu, P., Carvalho, J. M. F., Fernández-Naranjo, F. J., Arvidsson, R., Arvanitidis, N., & Raaness, A. (2021). Potential benefits and constraints of development of critical raw materials’ production in the EU: Analysis of selected case studies. *Resources*, 10(7), 67. <https://doi.org/10.3390/resources10070067> (Accessed 25 April 2025).
- [17] Hilpert, H. G. (2018). The Japan-EU economic partnership agreement – Economic potentials and policy perspectives. *Asia Europe Journal*, 16(4), 439–447. <https://doi.org/10.1007/s10308-017-0496-z> (Accessed 12 May 2025).
- [18] International Energy Agency (IEA). (2022). *The Role of Critical Minerals in Clean Energy Transitions*. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions> (Accessed 12 May 2025).
- [19] IEA. (2025). *Global Critical Minerals Outlook 2025*. <https://www.iea.org/reports/global-critical-minerals-outlook-2025> (Accessed 20 May 2025).
- [20] International Renewable Energy Agency (IRENA). (2023). *Geopolitics of the energy transition: Critical materials*. <https://www.irena.org/Publications/2023/Jul/Geopolitics-of-the-Energy-Transition-Critical-Materials> (Accessed 17 April 2025).
- [21] Jańczak, J. (2021). The European Union – Japan Strategic Partnership in the contested global order. In *External Relations of the EU in the Context of Economic, Normative and Security Framework* (pp. 59–73). <https://doi.org/10.14746/ps.2021.1.4> (Accessed 14 April 2025).
- [22] Lewicka, E., Guzik, K., & Galos, K. (2021). On the possibilities of critical raw materials production from the EU’s primary sources. *Resources*, 10(5), 50. <https://doi.org/10.3390/resources10050050> (Accessed 20 May 2025).
- [23] Løvik, A. N., Hagelūken, C., & Wäger, P. (2018). Improving supply security of critical metals: Current developments and research in the EU. *Sustainable Materials and Technologies*, 15, 9–18. <https://doi.org/10.1016/j.susmat.2018.01.003> (Accessed 13 May 2025).
- [24] Kramarz, T., Park, S., & Johnson, C. (2021). Governing the dark side of renewable energy: A typology of global displacements. *Energy Research & Social Science*, 74, 101902. <https://doi.org/10.1016/j.erss.2020.101902> (Accessed 2 June 2025).

- [25] Månberger, A., & Johansson, B. (2019). The geopolitics of metals and metalloids used for the renewable energy transition. *Energy Strategy Reviews*, 26, 100394. <https://doi.org/10.1016/j.esr.2019.100394> (Accessed 7 May 2025).
- [26] Müller, B., Ghiotto, L., & Bárcena, L. (2024). *The Raw Materials Rush: How the European Union is using trade agreements to secure supply of critical raw materials for its green transition*. <https://www.tni.org/en/publication/the-raw-materials-rush> (Accessed 7 May 2025).
- [27] Organisation for Economic Co-operation and Development. (2016). *OECD due diligence guidance for responsible supply chains of minerals from conflict-affected and high-risk areas* (3rd ed.). OECD Publishing. <https://doi.org/10.1787/9789264252479-en> (Accessed 23 May 2025).
- [28] U.S. Geological Survey (USGS). (2024). *Mineral commodity summaries 2024*. <https://doi.org/10.3133/mcs2024> (Accessed 23 May 2025).
- [29] White House. (2023). *Australia-United States Climate, Critical Minerals and Clean Energy Transformation Compact*. <https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/australia-united-states-climate-critical-minerals-and-clean-energy-transformation-compact/> (Accessed 10 May 2025).
- [30] Xinhua. (2024). *China passes law to boost reserves, production of strategic minerals*. https://english.www.gov.cn/news/202411/09/content_WS672ef2afc6d0868f4e8ecc4f.html (Accessed 10 May 2025).