

Legal measures for the construction of Critical Raw Material supply chain in EU under its twin transition

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Abstract. The green and digital transformation of the economy has become a global trend. Critical raw materials play a fundamental role in supporting energy transition and technological innovation. The increasing dependence on them has elevated the issue of supply security to the forefront of global policy debates. In 2020, the EU developed an industrial strategy to promote the “twin transition to a green and digital economy”. Highly dependent on mineral energy supply from external markets, EU attaches great importance to the supply security of critical raw materials and has taken a series of measures to strengthen the resilience of the supply chain. Examples of relevant legal measures include the enactment of the Critical Raw Materials Act and the signing of free trade agreements. Analyzing their content and characteristics can provide insights for the construction of China’s critical raw materials supply chain. Predicting the possible impact of these measures is also conducive to China’s vigilance and prevention of potential disadvantages.

Keywords: economic transformation, Critical Raw Materials, European Union policy, supply chain

1. Introduction

Recent years have seen the acceleration of the green and digital transition of the global economy. As the foundational resources of the energy transition and the scientific and technological revolution, critical raw materials (CRMs) are becoming increasingly significant in the development strategies of governments [1]. How to ensure their safe, stable and affordable supply has become one of the key issues of the international community.

There is no internationally agreed definition of CRMs (sometimes referred to as “critical minerals”), and the categories vary depending on different government considerations. In general, CRMs refer to a range of metal and mineral raw materials that are vital to social economy, national security and development [2]. Materials such as rare earth elements, lithium, cobalt are generally included in the list of CRMs. CRMs play an extremely important role in key sectors such as renewable energy, electronics, electric vehicles, and defense, and their international market demand has exploded, driven by green and digital transformation, and is projected to continue rising sharply [3]. According to the report released in 2024 by the International Energy Agency (IEA), the demand for lithium would grow by 30%, and the demand for nickel, cobalt, graphite and rare earth elements would grow by 8% to 15% [4].

In addition to the rising demand, CRMs also exhibit the main characteristics of high concentration, long mining cycles and insufficient supply chain resilience [1]. For example, China accounts for more than 60% of global rare earth production, and over 50% of the world’s lithium reserves are concentrated in Chile and Australia [5]. In terms of production cycle, studies have shown that it takes an average of 16.5 years from the discovery of a deposit to the realization of first production [6]. In addition, the supply chain for CRMs is fragmented, with the upper, middle and lower reaches of extraction, processing and consumption dominated by several countries or regions [7]. Thus, the supply is prone to disruption due to non-economic factors (such as geopolitical risks like the Russian-Ukrainian conflict, the Palestinian-Israeli conflict). Plus, the low recycling and substitutability of CRMs further increase their vulnerability to the global supply system.

The convergence of these factors has brought the security of CRM supply into sharper focus. Concerns have steadily intensified, and global economies have already entered into competition in this field. Countries and regions have promulgated relevant policies and regulations. Specifically, Canada [8], Australia [9], and the United States [10] are all examples.

On 10 March, 2020, the European Commission (EC) finalized a new industrial development strategy to support its dual transformation of the green and digital economy, promote the industrial international competitiveness, and strengthen its open

autonomy [11]. As a resource-scarce region, the Europe is particularly concerned about the secure and stable supply of CRMs. Beyond strategic dependence, the need for economic transformation has amplified the EU's perception of supply insecurity. To be specific, for instance, lithium demand in the EU is expected to increase by 12 times by 2030 compared to 2020 [12]. In recent years, the EU has adopted many policy measures, including a series of legal measures, in an attempt to strengthen its safe, diversified and resilient supply chain.

2. History and development of the CRMs supply chain construction in Europe

In Europe, securing of the CRMs supply chain is a long-standing issue, dating back to the establishment of the European Community's "Raw Materials Supply Group" in the 1970s. Since then, the field of CRMs has become one of the most active areas in the construction of supply chain security in the EU [13].

In 2007, the European Council urged the EC to develop a coherent political strategy for raw material supply. In 2008, the Commission launched the Raw Materials Initiative (RMI). In 2011, it published a list of 14 CRMs under the RMI and held the first EU-Japan-US Joint Workshop on Critical Materials. The European Innovation Partnership on Raw Materials was established in 2012 as a public-private network focused on technological innovation to meet raw material needs. From 2014 to 2023, the EU updated its CRM list every three years, gradually expanding it from 20 to 34. In 2018, the "EU-Latin America Raw Materials Partnership" was established.

Since 2020, the EU has increasingly issued policies related the CRMs. On September 3, 2020, the EC announced the Action Plan on CRMs, including the establishment of the European Raw Materials Alliance. That same year, the Commission also published a Foresight Study on CRMs. In 2021, the European Parliament adopted a resolution on the European Strategy for CRMs. And the European Council has requested the Commission to develop a programme to strengthen research, technology development and innovation in order to reduce the EU's strategic dependence on key technologies and value chains for security and defence. In response, the Commission established the EU Observatory of Critical Technologies (OCT) on 22 February 2021. The EU-US Trade and Technology Council was also launched that year. Moreover, the EU continued to advance its "raw materials diplomacy", signing memoranda of understanding with resource-rich countries including Ukraine, Kazakhstan, Namibia, Congo and Zambia, Greenland [14]. In 2022, the European Council issued the Versailles Declaration, calling for measures to reduce strategic dependence on CRMs. The EC joined Minerals Security Partnership launched by the Group of Seven, and proposed the Critical Raw Materials Act (CRMA). In 2023, the Committee formally adopted the proposal and published a second Foresight Study of critical materials. That year also saw the establishment of the EU-India Trade and Technology Council and the authorization of negotiations with the United States on the EU-US Critical Minerals Agreement, aimed at mitigating the negative impact of the Inflation Reduction Act on EU industry.

Since then, the EU has undertaken a series of actions to implement the relevant resolutions and ensure policy continuity. For example, in April 2024, the EU and Australia issued a joint statement on energy cooperation, proposing the establishment of a bilateral strategic partnership on CRMs. In September, the EU Energy Commissioner traveled to Namibia and South Africa to negotiate collaborative efforts on the energy transition, including cooperation across CRM value chains. In December, the EU and the Southern Common Market (MERCOSUR) announced the historic MERCOSUR - EU Free Trade Agreement [15], aimed at facilitating CRM exports from MERCOSUR to the European market by expanding trade and investment opportunities, thus enhancing the EU's supply chain diversification and supporting its green transformation.

The following section approaches the issue from a legal and political perspective, using the EU's CRMA and several recently signed free trade agreements (FTAs) as case studies to introduce the legal measures adopted to strengthen the security of CRM supply. Analyzing the content and impact of these measures could offer meaningful reference to China.

3. Legal measures

3.1. Formulation of the critical raw materials act

The CRMA is a landmark regulation adopted by the EU in 2024, serving as the core legislation in the EU's current strategy to build a resilient CRM supply chain. The Act aims to ensure the secure and sustainable supply of CRMs that are essential for achieving the EU's climate and digital goals, and intends to address the EU's over-reliance on single-source supplies of key materials such as lithium and rare earth. As stated in Article 1, its overall objective is to guarantee the secure, resilient, and sustainable access to CRMs, including through enhanced value chain efficiency, circularity and the improved functioning of the internal market [15].

The Act consists of 9 chapters, 49 articles, and 5 annexes. The main text sets out provisions on strategic raw materials, CRMs, raw material value chain alliances, supply risks, sustainable development, regulatory mechanisms. The 5 annexes contains the list of strategic raw materials, the list of critical raw materials, the evaluation criteria for strategic projects, the certification plan standards, and the environmental footprint. The Act's substantive content can be broadly categorized into the following five areas:

Firstly, in terms of ensuring internal supply, the Act introduces a series of provisions to strengthen the EU's domestic production capacity and sets out specific targets.

On the one hand, the Act emphasizes strengthening the EU's capacity for raw material mining, processing, and recycling. First, Article 19 stipulates the national exploration of CRMs. It requires that by May 24, 2025, each member state must develop a national CRM exploration plan, review it at least every five years, and keep updating when necessary. According to the Act, member states also need to provide funds for domestic mining projects, and the EU is relaxing its state aid rules accordingly. Second, the Act promotes recycling, reuse, and the development of secondary markets. Articles 26 and 27 require member states to foster a circular economy and technological innovation, including measures to enhance energy efficiency and relieve pressure from rising CRM demand. Given the vital role of permanent magnets in strategic technologies, Articles 28 and 29 of the Act also make more detailed provisions on the recycling and reuse of permanent magnets.

On the other hand, the Act sets specific targets for improving supply security, covering 17 types of "strategic raw materials". It should be noted that the Act has identified two lists: 34 "critical" raw materials and 17 "strategic" raw materials. The latter is selected from the former, based on indicators such as strategic importance, projected demand growth, and difficulty of production increase. These strategic raw materials are materials with exponential - growth market supply expectations in the future and complex production processes, and are essential to green sectors such as battery production, wind turbine manufacturing, automotive manufacturing, and strategic industries like aerospace. The specific targets include that by 2030, the EU should be able to mine at least 10% of its annual demand for strategic raw materials, produce at least 40% of its annual demand through processing, and produce at least 25% of its annual demand through recycling. In addition, no more than 65% of the EU's annual demand for any strategic raw material should come from a single non-EU country.

In practice, these provisions have begun to manifest. For instance, according to a Financial Times report, on 12 April, 2024, Romania granted a mining concession to Verde Magnesium for a formerly abandoned magnesium mine in Oradea. The investor will spend \$1 billion to build renewable-energy-powered processing facilities. This mine, once the last operational magnesium source in Europe before closing in 2014, is expected to resume production by late 2027, with an annual output of 90,000 tons - covering half of the EU's magnesium supply and 9% globally. This marks the first resumption of magnesium mining in Europe in over a decade, aiming to reduce dependency on China, which had previously supplied 97% of the EU's magnesium [16].

Secondly, in terms of strengthening the external supply, the Act highlights international cooperation and trade diversification. It calls for establishing and expanding strategic partnerships, creating a CRM club, and enhancing multilateral collaboration through the World Trade Organization (WTO) and bilateral agreements. The EU plans to partner with resource-rich third countries, particularly in Africa and South America, to reduce over-reliance on single suppliers (such as China) and bolster CRM supply chain resilience.

Thirdly, the Act introduces dedicated provisions for "strategic projects," which are intended to boost CRM supply both within the EU and abroad. These provisions address project identification, licensing procedures, timelines, environmental assessment, and planning [17]. Specifically, they can be mainly summarized as follows: First, the Act sets clear criteria and streamlined licensing processes for strategic projects. Second, Article 10 clearly gives priority status to strategic projects. For projects designated as "strategic", the EU will provide a more streamlined administrative licensing procedure. For example, for strategic projects involving extraction, the permit-granting process shall not exceed 27 months; and for those involving only processing or recycling, the duration is 15 months - a dramatic reduction compared to the 15-year wait in some member states. For another example, the Act requires member states to establish a single-contact point for necessary authorizations to more effectively manage and coordinate these strategic projects. Third, in Articles 15–17, the Act especially provides the support for the implementation of strategic projects, including more abundant and convenient financial support.

Fourthly, the Act puts forward extensive sustainability requirements. It emphasizes environmental and social responsibility practices throughout the supply chain to align with the EU's Green Deal and sustainable development goals. Chapter 5 addresses issues such as environmental footprint and the promotion of a circular and sustainable economy. Specifically, it mandates strict environmental standards to minimize negative impacts during the extraction and processing stages. The second part of Chapter 5 requires supply chain sustainability certification and the submission of environmental footprint statements for all CRMs placed on the EU market. These statements must be available to consumers, and suppliers must ensure that environmental evaluations are completed prior to market entry.

Fifthly, the Act outlines detailed provisions for supply monitoring and risk management, primarily in Chapter IV. First, it authorizes the EC to systematically monitor supply risks at all stages of the CRM value chain, conduct stress tests, and evaluate vulnerabilities and exposures. A monitoring dashboard must be developed, regularly updated, and made publicly accessible. Second, the Act requires member states to report and coordinate the "strategic stocks", and to set inventory security benchmarks based on national reserve data. Third, with regard to the supply risks of enterprises, the Act requires large companies using strategic raw materials to review their supply chain risks periodically. For example, Article 24 mandates risk assessments at least every three years to ensure timely identification and mitigation. Additionally, the Commission will build an information system to analyze demand from relevant EU enterprises. Through consultations, reasonable pricing and procurement terms will be negotiated, and joint procurement mechanisms promoted [17].

Finally, the Act also stipulates the establishment, operation, authorization, and supervision of the new European CRM Committee. The final provisions also include monitoring, reporting, confidentiality, penalties, evaluation, and the Act's entry into force. This study does not delve into these elements and thus does not provide further elaboration.

3.2. Negotiation and signing of free trade agreements

In addition to the CRMA, the EU has focused in recent years on signing economic and trade agreements with several resource-rich countries, particularly the free trade agreements (FTAs). Some of these FTAs include dedicated chapters or clauses specifically addressing CRMs to strengthen the security of raw material supply. Examples include the EU-Chile Interim Trade Agreement (EUCITA), the EU-New Zealand Free Trade Agreement (EUNZFTA), the Enhanced Partnership and Cooperation Agreement with Kazakhstan (EUKPECA), and the EU-Mexico Global Agreement (EUMGA).

In the above-mentioned agreements, the EU has designed a chapter on “energy and raw materials” as well as independent clauses on “cooperation on raw materials”, specifically to deal with raw materials. Examples include Chapter 8 of the EUCITA, Chapter 13 of the EUNZFTA, and Chapter 9 of the EUKPECA, all of which go beyond WTO rules. They require governments to make commitments to prohibit monopolies and dual pricing schemes for the import and export of goods, including raw materials. However, these commitments are not totally absolute. For instance, Chile may still apply dual pricing when certain conditions are met. Kazakhstan agreed only to regulate the pricing of industrial-use raw materials under government control, setting them at a level sufficient to recover costs and provide a reasonable profit. Nevertheless, they have agreed that their regulation of domestic pricing will be based on legitimate public policy objectives and will be transparent, non-discriminatory, and proportionate. According to WTO rules, pricing measures are not subject to further restrictions beyond the national treatment obligation [5].

Besides, the FTAs also include rules governing state-owned enterprises (SOEs). For example, the SOE Chapter of the EUMGA and Chapter 12 of the EUCITA are designed to prevent governments from directing state-owned enterprises in the extractive industry to sell products to domestic customers at preferential prices or to engage in other non-commercial activities that would put EU buyers at a disadvantage. Taking the EUMGA as an example, its SOE Chapter requires contracting parties to ensure that their SOEs operate on the basis of commercial considerations, with a particular emphasis on the “non-discrimination” principle. Since there are a large number of SOEs in the extractive industry, these commitments can be used to prevent the other party’s government from providing disadvantageous treatment to EU buyers, such as controlling its state-owned extractive enterprises to sell raw materials to the EU at higher prices.

Moreover, the EU has also formulated additional clauses to prohibit performance requirements in these FTAs. That is, foreign and domestic investors are no longer required to meet certain conditions such as export quotas or local content mandates. Such rules appear in Article 10.9 of the EUCITA on “Performance requirements” and in the Investment Chapter of the EUMGA. These provisions ensure that the other party’s government does not encourage investors in the mining sector to restrict exports, thereby facilitating the EU’s procurement of raw materials from abroad and stabilizing the EU’s supply of raw materials.

Additionally, beyond the traditional general rules (such as prohibiting import and export monopolies and strengthening partner cooperation), the EU has adopted tailored approaches based on the different circumstances of each partner country. For example, considering the national conditions of Kazakhstan, the EU has placed particular emphasis on market regulation in the electricity and gas sectors, and has prioritized disciplines in the renewable energy sector under the EUKPECA. Specific provisions are reflected in Articles 146 and 147.

4. Impact analyses

The measures taken by the EU to enhance the resilience of its CRMs supply may face resistance both internally and externally. Internally, provisions of the CRMA aimed at reducing the lengthy administrative procedures of member states and establishing a European investment mechanism may encounter opposition from some EU member states, as they may be reluctant to cede more economic power to the EU [18]. Externally, although the EU has achieved relatively significant results in its cooperative initiatives with allies, in fact, many resource-rich nations also hope to preserve sufficient policy space to maintain protective tools and develop their own green industries [19]. These countries may perceive the EU’s CRM agenda as an infringement upon their permanent sovereignty over natural resources [5].

Despite the significant obstacles that remain, if these measures are successfully implemented, they will undoubtedly have a broad impact - not only on the EU itself but also on China and the entire global trade landscape.

First and foremost, successful implementation of these measures will evidently help secure the EU’s raw material supply. Specifically speaking, the EU may increase its internal supply by expanding raw materials extraction and promoting resource recycling. More importantly, by forging strategic partnerships and joining raw materials alliances, the EU can ensure external access to CRMs and diversify supply sources.

Secondly, these actions may disrupt the supply of CRMs for China and affect international market competition in raw materials and related fields. Since 2019, the EU has labeled China as a systemic competitor [20]. As such, China plays a pivotal role in the EU’s supply chain considerations. The CRMA Impact Assessment identifies China as the dominant processor of CRMs, and characterizes it as a “monopolist” that “weaponizes” the supply chain, creating “political shortages” [21]. What’s more, there is substantial overlap between the strategic minerals identified by China and the EU, indicating potential competition across multiple resources [22]. The EU’s measures may intensify global competition for China’s CRMs. For example, the cooperative relationships formed under the aforementioned acts essentially form a relatively exclusive CRM supply and industrial chain. This exclusive CRM cooperation has a strong “de-Sinicization” tint, and may disrupt the supply of China’s CRMs industry [21].

However, some argue that the EU will find it difficult to decouple completely from China in the near future. Moreover, the 24th China-EU Summit in December 2023 also agreed to explore the establishment of a China-EU early warning mechanism for CRMs and build a stable and trustworthy supply chain partnership. Therefore, the impact of these measures on China may be limited [21]. On this point, it is necessary to wait and see. This study tentatively holds that significant negative consequences are unlikely in the short term.

Lastly, CRM trade remains shaped by market fundamentals such as supply and demand, comparative advantage, and industrial specialization. The existing global value chain pattern is designed to optimize resource allocation, but the EU's measures may disrupt market mechanisms, politicize supply chain relations, and escalate the global competition for CRMs. This could also provoke shifts in international labor divisions [21].

5. Implications and references from these measures

China is widely regarded by Western countries as the dominant player in the global CRM supply chain. However, in reality, China also faces a series of challenges regarding the CRM supply. First, China still has a relatively high dependence on foreign sources for certain CRMs. For example, its supply of nickel and cobalt relies on countries such as the Democratic Republic of the Congo and Indonesia. And Central Asia's oil and gas, as well as potash from Thailand and Laos, are also urgently needed for China's development [23]. Second, as global attention to sustainable development and environmental protection increases, China's environmental pollution issues in the mining and processing stages are often subject to both domestic and international scrutiny and criticism. For instance, rare earth extraction and processing can easily cause environmental harm, necessitating stricter environmental measures. This has led to higher production costs and mining restrictions, potentially affecting domestic production and supply. Third, as Western countries, especially the EU and the US, form alliances and competitive blocs, China faces increasingly pressure to secure external raw materials amid growing global scarcity.

Against the backdrop of the global green and digital transformation of the economy, the introduction and analyses of some of the EU's legal measures to enhance the security of CRM supplies can offer valuable insights and lessons for China to address these challenges, strengthen the CRM supply chain systems.

Firstly, in terms of ensuring internal supply, China should make full use of its resource endowments to expand domestic raw material supplies and consolidate existing competitive advantages. Drawing on the EU's approach, China could encourage enterprises to accelerate CRM extraction, processing, and recycling through the creation of special financial support mechanisms, and by identifying and backing strategic projects.

Secondly, in terms of stabilizing external supply, China should actively develop strategic partnerships, broaden international sourcing channels, expand cooperation with other resource-rich countries, and actively invest in overseas mineral development. China could also consider making specific provisions in bilateral or multilateral economic and trade agreements, negotiating different rules based on the specific conditions of each partner, and promoting mutual benefit and win-win outcomes with the orientation of a "community with a shared future for mankind."

Thirdly, in terms of sustainable development, China should also vigorously accelerate the development of green technologies in mining, smelting, and recycling, prioritize responsible production, and support the recycling industry and environmental footprint tracking. For one thing, it is necessary to strengthen green mining and processing to promote sustainable resource development and utilization. The extraction and processing of CRMs can negatively impact the water resources, soil, biodiversity, and the livelihoods of indigenous people [17]. China's Rare Earths Management Regulations, effective since 1 October, 2024, further clarify the need for protective exploitation of rare earth, and promote the high-end and green development of the rare earth industry [24]. For another, efforts should be made to increase the recycling rate of CRMs from abandoned facilities (e.g., tailing ponds, closed mines) and end-use products, with a focus on technological innovation in sustainable reuse—particularly for rare earth permanent magnets [21]. These practices not only help prevent environmental degradation and avoid socio-environmental risks, but also contribute to economic greening, resource efficiency, and enhanced supply resilience. At the same time, they help China project a responsible actor image in the international community.

6. Conclusion

The wheels of time roll relentlessly forward. On one hand, the global economy continues to move toward green and digital transformation; on the other, in the post-pandemic era and amid growing geopolitical tensions, supply chain development still faces multiple challenges [25]. The importance of economic security has become particularly pronounced. As the EU accelerates its twin transitions, CRMs, as indispensable strategic resources, play a crucial role in this process [26].

In addition to the inherent scarcity, low substitutability, and concentrated distribution of CRMs themselves, other factors such as geopolitical risks have further intensified concerns over supply security among countries. International competition in the field of CRMs is becoming increasingly fierce.

The EU has adopted a series of increasingly coherent policies to strengthen CRM supply [26], aiming to ensure stable, secure, affordable, resilient, and sustainable access to raw materials, thereby supporting economic transformation and safeguarding

economic security. The enactment of the CRMA and the negotiation and signing of numerous agreements represent the core legal measures in this regard.

The multilateral trading system and globalization remain fundamental pillars of the international order [27]. No country or region can remain isolated from these global trends. It must be acknowledged that China also faces significant challenges in building a reliable raw material supply chain. By analyzing the EU's policy measures, clarifying their content and deconstructing their impacts, important references can be drawn for China to cope with fierce international competition in an increasingly complex international environment, and to construct a more stable, diverse, and resilient CRM supply chain. This would facilitate industrial transformation and upgrading, and reinforce economic security.

Looking ahead, China should adopt a comprehensive, multi-dimensional strategy to improve CRM supply chain resilience. This includes consolidating internal supply, diversifying external sources, enhancing international cooperation, and improving resource efficiency. These efforts will help China respond to global uncertainties, accelerate green and digital economic upgrading, and safeguard national economic security in an increasingly complex world.

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