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Policy Discourse on the EU Critical Raw Materials Act

Contemplation, Challenges and Comparison

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Contents

Abstract

Core elements of countries' clean energy industry success, as well as low-carbon economic development, have attracted various levels of interest from countries around the world.

This thesis is based on an analysis of the EU Critical Raw Materials Act. With regard, it gives the background of what the regulation is about and its rationale. In a critical way, it has analyzed some elements of the challenges of the implementation of the regulation: the vagueness of the specific implementation by the Commission and member states; the imperfect establishment of the price formation mechanism of the system; the added burden put on the company's reporting obligations at a company level; and its establishment has been met with high resistance to the local supply chain of raw materials; the capability to recycle the main raw material is seriously overestimated; there are not enough funds demanded for its implementation; and the formation of the Strategic Partnership is not solid enough. This thesis gives recommendations on the means of overcoming the challenges. Later on, the chapter compares some selected countries— including the United States, China, and Australia—related laws of critical minerals in order to explain the present provisions of these countries in the role of their supply of critical raw materials and mechanism determination. Since the national defining features and priorities of the identified countries are changing according to these major differences, the legal strategies and definitions have variations. But on the whole, the proposed critical raw materials act with the EU has its shortcomings. On the other hand, it does represent a qualitative advance by the EU toward the goal of ensuring secure and resilient access for the EU to the critical raw materials necessary for the EU's economy and critical raw materials, which value chain efficiency and circularity will be realized.

Keywords: Critical Raw Materials Act, Strategic Partnership, Supply Chain, Recycle, EU, the United States, China, Australia

Abbreviations

AHWG-CRM	Ad-Hoc Working Group on Defining Critical Raw Materials
CRMA	Critical Raw Materials Act
CRM	Critical Raw Materials
EU	European Union
IEA	International Energy Agency
JRC	Joint Research Centre
MNC	Multinational Corporation
NGO	Nongovernmental Organization
NPC	National People's Congress
RMI	Raw Materials Initiative
SRM	Strategic Raw Materials
US	United States
USGS	United States Geological Survey
URC	U.S. National Research Council
WTO	World Trade Organization
WEEE	Waste Electrical and Electronic Equipment

1 Introduction

1.1 Background

Although different countries have different definitions of critical raw materials, most countries and regions select minerals and metals that are economically important and have high supply risks as critical raw materials.[1] The majority of countries and regions now share the common objective of being carbon neutral by the middle of the twenty-first century, as environmental preservation and sustainable development gain global prominence.[2] Because of this, countries and regions are becoming more and more driven to create non-fossil energy, so clean energy sectors like wind and solar energy are growing rapidly.[3] In addition to clean energy, automobile exhaust emissions have promoted the continuous development of the electric vehicle industry, and research on electric vehicle batteries has also continued to deepen.[4] Mineral and metal resources play a critical role in the development of these industries. The above trends link critical raw materials with the low-carbon economy.

A study reported by the World Bank focuses on what is commonly recognized as key elements in delivering future energy needs at low/zero GHG emission levels.[5] It draws a conclusion that wind, solar, hydrogen, and electricity supply systems are much more material-intensive than fossil-fuel-based energy supply systems. The International Energy Agency (IEA) published a World Energy Outlook special report on The Role of Critical Minerals in Clean Energy Transitions and identifies risks to critical minerals and metals.[6] If the risks are left unaddressed, it could make the global clean energy future slower and more expensive and therefore slow down the efforts of the world towards climate change. The report also emphasized that the clean energy transition is not simply a substitution between different energy types, but a transformation of the world's energy system from traditional fossil fuel-intensive to mineral-intensive, thereby a new energy trade model has emerged.[7]

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[1] Barteková, Eva, and René Kemp, 'Critical raw material strategies in different world regions.' (2016) *The United Nations University−Maastricht Economic and Social Research Institute on Innovation and Technology*.

[2] Le Mouel, Marie, and Niclas Poitiers, 'Why Europe's critical raw materials strategy has to be international. Analysis. BruegelSolow, RM (1956). A contribution to the theory of economic growth.' (2023) 70(1), *Quarterly Journal of Economics*, 65-94.

[3] Sen, Souvik, and Sourav Ganguly, 'Opportunities, barriers and issues with renewable energy development−A discussion.' (2017) *Renewable and sustainable energy reviews*, 1170-1181.

[4] Liu, Wei, Tobias Placke, and K. T. Chau, 'Overview of batteries and battery management for electric vehicles.' (2022) *Energy Reports*, 58-84.

[5] World bank group, 'The Growing Role of Minerals and Metals for a Low Carbon Future' (*The World Bank*, June 2017) <https://documents1.worldbank.org/curated/en/207371500386458722/pdf/117581-WP-P159838-PUBLIC-ClimateSmartMiningJuly.pdf> acessed 21 May 2024.

[6] IEA, 'The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions.' (2022) <https://iea.blob.core.windows.net/assets/ffd2a83b-8c30-4e9d-980a-52b6d9a86fdc/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf> accessed May 21, 2024.

[7] ibid.

Daniel Scholten explores clean energy and energy geopolitics in his book 'Clean Energy Geopolitics' relationship between changes in the political landscape.[8] The book proposes that although most clean energy sources such as wind energy, solar energy, and low-carbon hydrogen energy are widely distributed and are mainly determined by local energy supply capabilities, the development, and utilization of these energy sources.[9] The critical mineral resources required for the processes and manufacturing of clean energy-related equipment are highly dependent on global supply chains.[10] The geographical attributes of the supply of critical minerals for clean energy are mainly reflected in the following points: First, the reserves of critical minerals are smaller than those of fossil energy, and production and processing are concentrated in a few countries. This high degree of geographical concentration makes the supply chain very fragile and susceptible to market volatility and logistics risks. Secondly, the competition for critical mineral resources around the world has changed greatly. It has shifted from simply obtaining primary mineral resources to spreading to the entire industrial chain and closely integrating with the high-value-added development process of industrial terminals. The technical relevance of critical minerals has also changed. It's becoming more and more obvious. Third, the quality degradation of global critical mineral resources is accelerating, mining and smelting are becoming more difficult, and the risk of overall environmental pollution is relatively high.[11]

With the above factors superimposed, countries have begun to formulate ecological environment and labor standards related to the development of critical minerals and seize the opportunity by formulating standards. It can be concluded from the above that countries control clean energy production, information technology manufacturing, etc. by controlling critical minerals. Laws related to critical minerals and raw materials are a concentrated expression of the above competition. Driven by the reasons aforementioned, the European Commission released a proposal for establishing a framework for ensuring a secure and sustainable supply of critical raw materials in March 2023.[12] This is the first time that the EU is coming up with a regulation which is the EU Critical Raw Materials Act (EU CRMA) for reducing supply risks that can directly apply to all its member states.[13] This regulation enters into force on May 24, 2024 which is the twentieth day following its publication in the Official Journal of the European Union.[14]

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[8] Daniel Scholten, *The Geopolitics of Renewables* (Cham Springer International Publishing 2018).

[9] ibid.

[10] ibid.

[11] ibid.

[12] European Commission, '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,' COM (2023) 160 final.

[13] European Commission, 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 and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020 <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32024R1252#d1e4568-1-1> accessed 19 May 2024(EU CRMA).

[14] ibid.

1.2 Purpose and research questions

Against the above-mentioned background, analysis of this thesis surrounds legal issues of the newly adopted EU CRMA with threefold research objectives (RO). The thesis aims to provide (RO1) deep insights into the purposes and features of the EU CRMA, identify (RO2) challenges for the implementation of the EU CRMA, and explore (RO3) the commonalities and differences between the EU CRMA and its key trading partners' critical materials instruments (the United States, China and Australia). In order to achieve the threefold research objectives, this thesis focuses on threefold research questions (Q), as follows:

Q1. Why does the EU introduce the EU CRMA? **(RO1, chapter 2)**

Q2. What are the challenges to implementing the EU CRMA? **(RO2, chapter 3)**

Q3. What are the commonalities and differences between the EU CRMA and its trading partners' critical materials instruments (the United States, China and Australia)? **(RO3, chapter 4)**

Q1 focusing on RO1 will be discussed in chapter 2, Q2 focusing on RO2 will be discussed in chapter 3, and Q3 focusing on RO3 will be discussed in chapter 4.

1.3 Scope and limitations

This thesis involves the legal fields of the EU, US, China, and Australia. However, considerations respecting time and the length of the thesis mean the matters to be addressed within the scope of the present text are limited, covering only certain, specific areas. This thesis combines the current legislative framework of the EU with the newly passed regulation, i.e, the EU CRMA,[15] since part of it is combined with relevant EU legal documents relating to electronic waste recycling, mining, and environmental protection, among others, since it lacks importance and relevance. No joint specific analyses were performed. Instead, it addresses the history of policy development by the EU on critical raw materials and the analysis of the reasons for its introduction.

At the same time, it links some of the EU legal documents and initiatives with the EU CRMA.[16] In analyzing the specific content of the EU CRMA, there is not enough on analysis of the other legal coordination within the frames of the EU and the principle of non-discriminating treatment by the WTO, since specific definitions of the subsequent regulation system are not released yet, established alliances, established environmental footprint standards, etc, and some of them are not released yet up to 2025.[17] It will be released in 2028, some in 2027 and in 2028, and some do not have a specific time of release. More than that, some of the regulations will be effective not on May 24, 2024, but in the following years.[18]

[15] European Commission (no. 13).
[16] ibid.
[17] ibid.
[18] ibid.

Upon the analysis of the EU CRMA, the default regulations do not need to be translated by the member states and are directly and uniformly applied, and the effectiveness of EU regulations is higher than the ordinary laws of the member states. In this way, the critical raw material-related issues earlier introduced to the different member countries, such as mineral development and protection, e-waste recycling, environmental footprint standards, etc, remain non-analyzed. In practice, though, there are very slim chances of there not being any conflicts between the relevant and critical raw materials legislation by the member states.

Some of the problems arising in the process of implementing the EU CRMA have been solved and a number of problems have just been marked out. For example, the uncertainty about the specific implementation by the committee and member states will be improved after the relevant standards stipulated in subsequent regulations are established. Some problems, such as the incomplete price formation mechanism of the established system, belong to the research direction related to financial futures. However, thesis mainly focuses on constitution-related content. Therefore, the dissertation does not provide solutions but simply points out issues. For instance, the shortage of funds needed for the implementation of the regulation and the poor stability of establishing Strategic Partnerships both belong to the field of macro-political and economic games and are difficult to solve through legislation, so no legal solutions have been put forward.

In determining countries that are compared with analysis, through economic data, this article directly selects US, China, and Australia because the relevant legislation in these countries is relatively complete and the data is easy to find. However, other major critical raw material exporting countries are also worth analyzing, and due to time and space problems, it is not retrievable and analyzable in this thesis.

1.4 Method and materials

This thesis uses a comprehensive approach including :the EU legal method, a contextual approach, a literature review, policy analysis, and research from a comparative approach.

Laws do not operate in a vacuum, and different policy orientations affect the formulation and implementation of laws.[19] Through policy analysis, this thesis discusses the EU's raw materials-related policies before the introduction of the EU Critical Raw Materials Act. Through the discussion of the raw materials policy of the EU and relevant legal documents prior to the introduction of the Critical Raw Materials Act, it shows the understanding of critical raw materials is always changing. It has different definitions in the different periods and focused not the same either of the legal objectives. The EU Critical Raw Materials Act is taking into account the safety, resilience, and sustainability in critical raw materials supply chain.[20] 'The law in contextual approach is not new in EU legal

[19] Myres S. McDougal, 'Law as a Process of Decision: A Policy-Oriented Approach to Legal Study', (1956) *Natural Law Forum,* 53-72.

[20] European Commission, (no. 13)

scholarship',[21] this thesis analyzes the motivations for the EU CRMA through a contextual research by describing the green and digital transformation in the EU, needs to maintain strategic autonomy of the EU and EU green industry-related legislation. In conducting the EU legal method, this research was conducted to understand the position of critical raw materials law within the EU legal system and how the intended objectives can be fulfilled. In addition to the detailed explanation of the peculiar text of the Critical Raw Materials Act.[22] It is necessary in the introduction and within the methodological framework of the study to provide a short description of the European Green Deal, RE Power EU, Net Zero Industry Act, and The Raw Materials Initiative.The EU CRMA is a newly adopted regulation, so this thesis will not have any case to discuss.

Chapter 3 applies a literature review of analyzing the challenges for the implementation of the EU CRMA. The use of the method is in the research of the price formation mechanism, the cost of the reporting obligation of the company, the environmental and legislative obstacles that mining mines may deal with, the economic analysis of e-waste recycling, the current situation of the EU fiscal deficit, and the impact of geopolitics on law. Published academic books, academic journals, reports, and others have been used to conduct systematic studies of the challenges that may be faced during the implementation of the regulation.

This thesis also conducts a comparative study, such a comparison may help to form an idea about the quality of the rules that are applied in relevant countries, and, thus, draw some conclusions whether and in what form they are necessary to be adopted in a particular legal system.[23] The thesis compares the EU, US, China, and Australia from the critical raw material concepts, critical raw material lists, and selected critical raw material calculation standards. Comparative of laws and policies relating to critical raw materials in four economies. In order to make it the most representative to the world, and from a geographical perspective, the EU is in Europe, the United States is in America, China is in Asia, and Australia is in Australia.

1.5 Outline

After that introduced the attitudes within the EU towards critical raw materials and the changes in these attitudes, this thesis introduces motivation, and main content of the EU CRMA, of which the main motivation has been divided into three aspects. First is the promotion of the EU's strategic goals of green and digital transformation; the need to maintain strategic sovereignty is the second; the third is the promotion of the EU's relative act on the green industry. On chapter three, the introduction of the article has been encountered with the need for the realizations of the EU CRMA: the indecisiveness of the specific implementations of the Commission and member states; the establishment of a system price formation mechanism is not perfect; the company reporting obligation has added the burden

[21] Davies Bill, and Fernanda Nicola, *EU Law Stories: Contextual and Critical Histories of European Jurisprudence* (Cambridge University Press 2017).

[22] ibid.

[23] Konrad Zweigert and Hein Kötz, *An Introduction to Comparative Law*, (3rd edn, Clarendon Press 1998) 15.

of a company; the resistance of the local raw material supply chain is high, and it can reuse critical raw material ability, and the funds are in short supply, need to carry through the implementation of the regulation; also less stable Strategic Partnership.Chapter 4 does a comparison between the EU, US, China, and Australia regarding the legislation on the critical raw materials in respective economies, the setting of the standard and raw material catalog has been completed.In the last chapter, the thesis is summarized, research issues are considered, and conclusions are drawn from the legal analysis that was done.

2 EU CRMA Overview

2.1 Historical development of the EU raw materials policy in a nutshell

The raw materials produced within the EU have long been unable to meet development needs, and large-scale imports from abroad are the basic norm. As early as the mid-1970s, the EU began to be concerned about the potential risks of heavily relying on imported raw material supplies.[24]

As early as 1975, the Commission of the European Community published a notice on the security of the supply of raw materials in the Community: 'Even if the possibility exists of an absolute shortage of raw materials on a world scale being almost non-existent, The Community is dependent on outside sources for its supplies of materials entirely.[25] All other products of a non-energy origin enter into this category, with the exception of tin 40%, iron c.a.20%, and zinc nearly 10%, more than 80 % of which comes from outside.[26] The committee has confined itself to examining twenty or so minerals aluminum, chromium, cobalt, copper, tin, iron, magnesium, manganese, mercury, molybdenum, platinum, lead, titanium, tungsten, vanadium, zinc and phosphates, a few products of vegetable origin, two products of animal origin and proteins.[27] Commission aluminum, chromium, tin, iron, manganese, platinum, tungsten, zinc, and phosphates View Minerals such as salt, some products of plant origin, and protein products as raw materials of concern.[28] It also calls for European countries must unite and take some measures to deal with this problem, such as storing raw materials, signing long-term supply contracts, and proactively signing relevant international agreements.[29] Although this document is a reflection of the European Community's commitment to raw material security during the entire Cold War, there is no major crisis in raw materials. Therefore, the

[24] McGowan, Francis, 'Putting energy insecurity into historical context: European responses to the energy crises of the 1970s and 2000s.' (2011) Geopolitics, 486-511.

[25] Proposal Commission of the European Communities, 'ARCHIVES HISTORIQUES de LA COMMISSION COLLECTION RELIEE DES DOCUMENTS', COM (75) 50 (1975) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:51975DC0050> accessed 12 May 2024.

[26] ibid.

[27] ibid.

[28] ibid.

[29] Benno W.K. Risch, 'The raw material supply of the European Community: The importance of secondary raw materials' (1978) 4(3), *Resources Policy* 181-188.

European Community does not promote a more practical policy on the supply of raw materials.

The globalization trend of raw material trade becomes more and more obvious with the end of the Cold War. The global market can provide sufficient raw materials at high prices, and the EU's concerns about its supply security decline.[30]Before entering the 21st century, only a handful of senior officials of the European Commission cared about raw materials issues and member states were increasingly withdrawing themselves from the resource sector.[31] Although it is increasingly out of the member country's control, the EU's common raw materials policy has changed little, and the raw materials market is still mainly dominated by multinational corporations(MNCs).[32] The 21st century sees strategic emerging industries led by information technology increasingly playing a role in economic development and national competition.[33] The demand for so-called high-tech metals that meet the sustainable development of such tech industries has soared.[34] On the other hand, there have been fundamental changes in the global market of high tech metals. The explosive demand from China, India, Brazil, and other emerging economies has boosted high-tech metal prices.[35] From 2002 to 2008, the price of high-tech metals soared until the financial crisis in the same year, which fell sharply.[36] However the prices began to rebound after summer 2009, and even some prices reached a record high.[37] The huge price fluctuations have put the supply risks of many raw materials to the EU in crisis. This led the EU to begin thinking about raw material supply security.

The Raw Materials Initiative（RMI）—Meeting Our Critical Needs for Growth and Jobs in Europe was published by the European Commission in 2008.[38] The EU thinks raw material issues are not a matter for one country and that it should strengthen foreign cooperation and trade in the era of economic globalization through multilateralism and global governance, i.e, signing raw material trade agreements with raw material supplier countries to stabilize the source of raw material supply.[39] On the one hand, the new change in the EU's reliance on the import of high-tech metals, especially in its high degree of reliance on imports from several third countries has triggered concerns in the EU in the event of raw material supply security.[40]The initiative has three pillars. The first of them is ensuring access to international markets of raw materials under the same conditions

[30] McGowan, Francis, (no.21).

[31] ibid.

[32] ibid.

[33] Han, Kunsoo, Young Bong Chang, and Jungpil Hahn. 'Information technology spillover and productivity: the role of information technology intensity and competition.'(2011) Journal of Management Information Systems, 115-146.

[34] Izatt, Reed M, 'Challenges to achievement of metal sustainability in our high-tech society.' (2014) Chemical Society Reviews, 51-75.

[35] UMBACH, FRANK. THE NEW 'RARE METAL AGE': NEW CHALLENGES AND IMPLICATIONS OF CRITICAL RAW MATERIALS SUPPLY SECURITY IN THE 21st CENTURY. (S. Rajaratnam School of International Studies, 2020) <http://www.jstor.org/stable/resrep25385> accessed 21 May 2024.

[36] ibid.

[37] ibid.

[38] Commission of the European Communities, 'The Raw Materials Initiative— Meeting Our Critical Needs for Growth and Jobs in Europe,' (4, November 2008) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52008DC0699&qid=1715554718562>.

[39] ibid.

[40] ibid.

as with other industrial competitors.[41] The second one is setting reasonable frame conditions inside the EU to obtain raw materials coming from within Europe.[42] The third pillar is the security of supply; as the overlying objective within this pillar, it is proposed to heighten the overall resource efficiency, improve recycling, reduce raw material consumption in the EU, and dependency on imports of primary raw materials.[43] Besides, the initiative included a priority action to make a common limit of critical raw materials, which is provided in close collaboration with the member states and stakeholders. It is one of the primary instruments of EU raw materials policy.[44] According to RMI, the EU has taken a series of non-regulatory actions from a national strategic perspective. The first one is determining the list of critical raw materials. In April 2009, the European Commission established an ad hoc working group on defining critical raw materials that is a panel of specialists 'support and advisory group identifying non-energy raw materials that are critical to the EU.'[45] Since 2011, the European Commission has used different criticality assessments and demoralized the EU list of critical raw materials every 3 years in light of changes in production, market, and technology.[46] From the list announced in the background report, the number of critical raw materials in the EU market has been steadily increasing year by year. The year 2011 had 14 types of materials in the EU market, 20 types in 2014, 27 types in 2017, 30 in 2020, and most recently 34 types of materials in 2023.[47] The second non-regulatory action is concerned with trade and investment policies in the raw material sector.[48] Based on the ban criterion, many non-EU countries have taken such measures as import and export bans or export quotas, or market disturbance tactics such as price manipulation. In the trade sector, the EU fights against restrictions such as bans, quotas, tariffs, and non-automatic licensing as opposed to free, fair, and transparent so-called price setting on the market.[49] Under the second action, the EU is simplifying and liberalizing its imports of the world, while global power is demanding that the EU and others reduce restrictions such as bans, quotas, tariffs, and non-automatic licenses.[50] Conversely, the EU and the affected states liberalize their raw material markets. For example, the EU-Korea and EU-Singapore free trade agreements include undertake clauses that none of the countries party to the agreement shall impose duties, taxes, or other charges on exported goods.[51] The third action is to be carried out under raw material diplomacy.[52] The EU has signed market agreements

[41] ibid.

[42] ibid.

[43] ibid.

[44] ibid.

[45] European Commission, 'The European Critical Raw Materials review' (Europa.eu, 2014) <https://ec.europa.eu/commission/presscorner/detail/en/MEMO_14_377>accessed 13 May 2024.

[46] ibid.

[47] European Commission, 'Critical Raw Materials Resilience: Charting a Path Towards Greater Security and Sustainability' (Europa.eu, 2020) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0474&qid=1715558317789> accessed 13 May 2024.

[48] European Commission, 'COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS TACKLING THE CHALLENGES IN COMMODITY MARKETS AND ON RAW MATERIALS' (Europa.eu, 2011) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0025>accessed 13 May 2024.

[49] ibid.

[50] ibid.

[51] European Commission, 'Access2Markets Free Trade Agreements' (*trade.ec.europa.eu*) <https://trade.ec.europa.eu/access-to-markets/en/content/free-trade-agreements>accessed 13 May 2024.

[52] European Commission, (no. 45).

with Argentina, Canada, Chile, the Democratic Republic of the Congo, Greenland, Kazakhstan, Namibia, Norway, and Rwanda: in addition, a trade agreement with Ukraine and a concluded market agreement has been reached with Zambia.[53] The EU has policy dialogues with China, the United States, Japan if necessary, Australia, and the African Union for the production, trade, or recycling of raw materials.[54]

On September 3, 2020, the European Commission again updated the RMI and published an action plan on critical raw materials called 'Critical Raw Materials Resilience: Charting a Route to Higher Security and Sustainability,' proposing a strategy to boost the EU's resilience and openness through ten concrete actions on autonomy.[55] The strategy wishes the EU to act right now to coordinate the efforts of firms, local and national governments, and EU institutions so that a safe and sustainable supply of raw materials is realized, and it suggests that the EU implement the critical raw material action plan from the following four aspects:

Make the EU industrial ecosystem's value chain resilient.[56] Action 1: Launch an industry-led 'European Raw Materials Alliance'. In the first place, the focus of this alliance should lie on the most acute need—to improve EU resilience in the value chain of rare earths and magnets —because this is urgently needed for the entire important EU industrial ecosystem, including renewable energy, defense, and aerospace. Over time, the alliance can expand to other critical needs in raw materials and base metals. Action 2: Standards for sustainable financing of the mining, extraction, and processing sectors for it to provide financial support for the development of the mining industry chain, recently embraced a new energy loan policy in which it is stated that the bank will back projects related to the supply of critical raw materials needed for low-carbon technologies in the EU.

The second is to promote resource recycling and sustainable product innovation.[57] Action 3: Launch, in 2021, research and innovation on critical raw materials for waste treatment, advanced materials, and alternatives under Horizon Europe, the European Regional Development Fund, and national research and innovation projects. Action 4: Map the current and future secondary supply in the EU Map the secondary supply potential of critical raw materials and identify feasible recycling projects by 2022.

Third, seek the development of local EU resources.[58] Action 5: Identify EU mining and processing projects for critical raw materials, investment needs, and related financing opportunities that can be operational by 2025, with priority given to coal mining areas. Action 6: Develop expertise and skills in the technologies for mining, extraction, and processing as part of the balanced transformation strategy for transition regions after 2022. Action 7: Deploy earth observation projects and

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[53] European Commission, 'Raw Materials Diplomacy - European Commission' (single-market-economy.ec.europa.eu) <https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/raw-materials-diplomacy_en> accessed 13 May 2024.

[54] ibid.

[55] European Commission (no. 17).

[56] ibid 6.

[57] ibid 9.

[58] ibid 12.

remote sensing for resource exploration, operations, and post-closure environmental management. Action 8: Develop, starting from 2021, Horizon Europe research projects, innovative in the mining and processing technology of critical raw materials, for reduced environmental impact.

The fourth is diversified procurement from third countries.[59] Action 9: Engage in strategic international collaboration and relevant financial ties with Canada, related African countries, and EU neighboring countries from 2021 to ensure diversified and sustainable provisions of critical raw materials through non-distorted trade and investment conditions. Action 10: Promote responsible mining of critical raw materials through the EU regulatory framework (Proposal 2020-2021) and relevant international cooperation.[60] Annex 1 provides the stage of raw material processing and the procurement proportion of machinery from the main purchasing countries of raw materials. Also, the import dependence and the end-of-life recycling investment rate as a percentage of the overall demand that can be met by secondary raw materials (EoL-RIR) are illustrated to link raw materials to final products.[61] In Annex 2, the significance of critical raw materials and industrial ecosystems is provided based on Annex 1. Most of the critical raw materials are focused on aerospace/defense, textiles, electronics, mobile vehicles, energy-intensive industries, renewable energy, and digital related to other industries.[62]

For the EU CRMA, which is formed to establish a framework for ensuring a secure and sustainable supply of critical raw materials and amending some other regulations, its proposal was adopted by the European Commission on March 17, 2024. It got the approval of the European Parliament's first reading position by the Council(adoption of the legislative act) on March 18,2024. And it was igned by the President of the European Parliament and by the President of the Council of the European Union on April 11, 2024. The EU CRMA shall get entry into force on May 24, 2024.[63]

2.2 Motivations for the EU CRMA

2.2.1 Promotion of green and digital transformation in the EU

Already in 2019, the von der Leyen-led new European Commission set points of strategic goals for green and digital transformation: that was from the year 2019 to 2024, for a period of five years, with the dual priority of the green and digital transformation.[64] These are the two dimensions of the EU in general, its approach to economic and social transformation and development, key levers of the

[59] ibid 15.

[60] ibid 18.

[61] ibid annex 1: List of Critical Raw Materials.

[62] European Commission (no. 17) annex 2: Relevance of Critical Raw Materials for industrial ecosystems.

[63] European Commission (no. 5).

[64] European Commission. 'Shaping Europe's Digital Future' (19, February 2020), <https://ec.euro-pa. eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/shaping-europe-digital-future _ en>.

European Union to promote economic recovery, and in order to cope with competition among major powers.[65]

First, the green industry is increasingly important for the EU to free itself from external dependence on fossil energy.[66] The EU always marked the large importation of fossil energy as its dangerous dependence on foreign countries, especially Russia.[67] Under the EU's influence, the mid-to-long-term promotion of reducing consumption and imports of fossil energy is recognized as an important geopolitical impact caused by the rigid constraints of the EU on energy factors, the social welfare squeezed by reducing energy imports, and the impact of the weakening demand for fossil energy on the global economy and trade pattern.[68] The Ukraine war has fundamentally changed the perception and value positioning of Russia by the EU. In regard to security, the EU considers Russia a country against which it must guard, which is its threat and competitor. The overall consideration of EU-Russia energy relations by the EU has changed from a view of economic mutual benefit to geopolitics and security.[69]

Promoting zero exposure of European energy imports is already an established energy policy goal of the EU.[70] From a short-term perspective, the EU employs import diversification, increasing revenue， reducing expenditures, etc. to achieve substitution for Russian energy. From a long-term perspective, the development of green industries promotes transformation in the energy and economic system with the purpose of reducing its dependence on Russia, or further defossilizes energy in energy and economy.[71] European Central Bank President Christine Lagarde refers to the fact that the Russia-Ukraine war has 'triggered a fundamental reassessment of our economic relations and dependence in economic globalization' and purports that trade must be decoupled from so-called universal values like the respect of international law and human rights. She also pointed out that the alliance of supplier countries has become more important.[72] That is to say, with the completion of the construction of solar power-related industries in the EU, its energy will be further freed from restrictions by other countries. In this context, the sources of renewable energy come from solar energy rather than other aspects for rising EU awareness of its energy sovereignty. On the realization of independent energy production and supply, it may be the first important task of Europe. Next, the EU needs to replace fossil energy with renewable energy, mainly including

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[65] ibid.

[66] Mark Leonard, Jean Pisani-Ferry, Jeremy Shapiro, Simone Tagliapietra, Guntram Wolff, 'The geopolitics of the European Green Deal' (*ECFR*, 3 February 2021) 8.

[67] ibid.

[68] ibid.

[69] László Andor and Uwe Optenhögel, 'EUROPE AND THE WAR IN UKRAINE from RUSSIAN AGGRESSION to a NEW EASTERN POLICY' (2023) <https://feps-europe.eu/wp-content/uploads/2023/06/Europe-and-the-war-in-Ukraine.pdf> accessed 21 May 2024.

[70] Giovanni Sgaravatti Simone Tagliapietra Georg Zachmann, 'Adjusting to the Energy Shock: The Right Policies for European Industry' (*Bruegel* | The Brussels-based economic think tank17 May 2023) <https://www.bruegel.org/policy-brief/adjusting-energy-shock-right-policies-european-industry> accessed 21 May 2024.

[71] ibid.

[72] European Central Bank, 'Central Banks in a Fragmenting World' (2023) www.ecb.europa.eu <https://www.ecb.europa.eu/press/key/date/2023/html/ecb.sp230417~9f8d34fbd6.en.html> accessed 21 May 2024.

solar energy, and finally rearrange the structure of energy, economy, and security interests.[73]

However, the EU requires a very large scale of renewable energy deployment for the realization of its energy transition targets. To meet its energy consumption by the year 2030, the EU has set a target of up to 42.5% for the proportion of renewable energy in energy consumption.[74] On the other hand, the level of renewable energy in energy consumption in 2021 is only 21.8%.[75] That is to say, to make the EU double the total proportion of renewable energy, at least twice the installed capacity is required in renewable energy compared to the current level, and this is on the premise that the total energy consumption basically does not rise. But for the EU, more challenges would probably be met in the future in terms of getting adequate supply and cost control for stability in the EU's own renewable energy supply and the rising installed costs affected by the new green industry policy, along with more uncertainty.

Second， enhance the medium- and long-term competitiveness of the EU's green industry.From 2011 to 2021, the cost of deploying photovoltaic in the EU has decreased by 82%; the decline in 2021 led to it becoming the cost-competitive source of electric power most in the EU.[76] Data in the same period shows that the EU has established the world's deepest and most competitive renewable energy consumption market. For example, in 2022, EU renewable energy consumption of 14.8% of primary power consumption is about twice the global average 7.5%.[77] However, with the promotion of the development of related industries by China and other emerging market countries that attract foreign capital to build factories, introduce advanced foreign technologies, and develop industrial policies to support the development of domestic manufacturers, products also obtained a strong competitive advantage. In terms of costs and the scale of its production capacity has expanded rapidly, and it has seized and occupied a share of the global production capacity market, which can cause a certain compression of the European green industry.[78] Take the photovoltaic industry as an initial point. In February 2022, the U.S. Department of Energy released data indicating that Chinese products account for more than 80% of the global photovoltaic board production capacity. Intermediate products such as polysilicon, silicon ingots, silicon wafers, battery packs, and solar modules account for all global production capacity.[79] It has exceeded 70% and has become one of the largest production

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[73] Stefan Bayer, Jana Puglierin, Guntram Wolff, 'You can't switch off the sun: How Germany can gain energy sovereignty with renewables' (*ECFR*, December 2022) <https://ecfr.eu/article/you-cant-switch-off-the-sun-how-germany-can-gain-energy-sovereignty-with-renewables/> accessed 21 May 2024.

[74] RENA, 'Powering the Energy Transition with Smart Electrification' (*IRENA*, 20 June 2023) <https://www.irena.org/News/pressreleases/2023/Jun/Powering-the-Energy-Transition-with-Smart-Electrification> accessed 21 May 2024.

[75] Eurostat, 'Shedding Light on Energy - 2023 Edition - Interactive Publications - Eurostat' (*ec.europa.eu,* 2023) <https://ec.europa.eu/eurostat/web/interactive-publications/energy-2023> accessed 21 May 2024.

[76] European Commission, 'EU Solar Energy Strategy,' (May 2022), <https://www.europarl.europa.eu/legislative-train/package-repowereu-plan/file-eu-solar-strategy?sid=5901>5-7

[77] Eurostat, 'Electricity from Renewable Sources on the Rise - Eurostat' (ec.europa.eu, 2023) <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20230127-1> accessed 21 May 2024.

[78] ibid.

[79] U.S. Department of Energy, 'Solar Photovoltaics Supply Chain Deep Dive Assessment,' (February 2022) 17-25.

capacity countries of photovoltaic boards in the world.[80] In the same period, there were less than 9 photovoltaic manufacturing companies in the EU.[81]

The development focus in green has gradually shifted from the large-scale promotion of renewable energy to the storage, transformation, and use of clean energy.[82] Continuous improvement of market potential and increased economic opportunities for batteries, green hydrogen, electric vehicles, and their derivative applications are continuously increasing.[83] As battery intermediate products go, China produces more than 75% of the cathode, anode, separator, and electrolyte.[84] The stats above indicate that the advantage of the EU from the first player is no more, and its industrial advantage gradually declines. For example, China occupies 76%, while, on the other hand, the global battery end-product production capacity accounts for only 7% in the EU. For the proportion of contribution, the performance in South Korean accounted for 33.8% in the first three quarters of 2021.[85] In the field of electric vehicles, the market value for American car company Tesla reached US$763.3 billion at the end of September 2023 to become the world's most valuable car enterprise.

Third, critical raw materials are needed to achieve digital transformation.[86] Changes in digital technology across the globe undoubtedly change the economy and society, but, on the flip side, increase the competition in the race of digitization among countries or blocs. The EU is worried that its lack of digital competitiveness might earn it a shove to the periphery in the digital age and has, therefore, been proposed to the strategic goals on how to become a global leader for digital transformation and play the central lead role in the area of the human-centered artificial intelligence, on the creation of a single secure and dynamic data market. It is believed digitization will also play a big role in the fight against climate change and on the green transition.[87]

Therefore, having stated the importance of critical raw materials for the above two dimensions of change, the demand for critical raw materials in the EU has seen unprecedented growth and is expected to grow exponentially in the coming decades. The International Energy Agency (IEA) predicts that the total global demand for minerals underpinning key large-scale clean energy technologies will be 2-4 times the 2020 level by 2040.[88] The World Bank similarly forecasts that by the year 2050, global production of mineral resources such as graphite, lithium, and cobalt will rise more than four times the levels recorded in 2018.[89] For the EU,

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[80] ibid.

[81] ibid.

[82] ibid.

[83] ibid.

[84] ibid 16-23.

[85] Invest Korea, 'S Korean companies account for 338 pct of global battery market in Jan-Sept: report' (*Invest Korea*, 29 October 2021) <https://www.investkorea.org/ik-en/bbs/i-465/detail.do?ntt_sn=491513> accessed 21 May 2024.

[86] European Commission, 'Shaping Europe's Digital Future: Commission Presents Strategies for Data and Artificial Intelligence,' (February 2020) <https://ec.europa.eu/commission/presscorner/detail/en/ip_20_273>.

[87] ibid.

[88] IEA (no. 2).

[89] World Bank Group, 'Minerals-For-Climate-Action-The-Mineral-Intensity-of-The-Clean-Energy-Transition' (*The World Bank*, 2020) <https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition> accessed 21 May 2024.

compared to 2020, the demand for rare earth and gallium is projected to increase 6-7 times and 17 times respectively by 2050, the demand for lithium shall increase 21 times, and the demand for platinum increase 200 times.[90] The EU will therefore, without safety and sustainability in access to these resources, find it hard to achieve its goals of becoming the first climate-neutral continent and the ambitions of leading the digital age.[91]

2.2.2 Needs to maintain strategic autonomy of the EU

Driven by the full-scale strategic confrontation between the US and China, combined with the COVID-19 epidemic and war between Russia and Ukraine, major power competition has returned, and geopolitics has returned once again.[92] The field of competition constantly expanded from the concentrated one at the beginning through the political and military fields to the industrial, technological, and cyberspace fields as found today.[93] So, the growing geopolitical anxiety in the EU day by day has reached the level of belief that mere strength in the economy and soft power in the culture are gradually outgrowing into trickling effective means of safeguarding its own interests, and it has already started to look at Europe geopolitically.[94]

After years of development, under the background, a green industry has formed a refined and specialized division of labor that is closely related to the era of globalization.[95] Enterprises in various countries are pursuing cost reduction through economies of scale throughout the entire process from raw materials to finished products. Improve the scale of supply efficiency.[96] In the latest form of energy geopolitics, whether a country has the metals and minerals needed to make low-carbon products determines the future potential of the country's low-carbon manufacturing industry. Most of these critical raw materials are characterized by high geographic concentration of production and processing. From the perspective of energy geopolitics, the economic profit margins of the major global CMR reserve and production countries and regions are expected to grow.[97] But for the EU, the supply and purchase costs of raw materials are increasingly foreseeable, the prices of European photovoltaic modules and wind turbines in 2022 will be 25% to 30% higher than in 2020; even under the premise of large-scale deployment, the cost of onshore wind power and photovoltaic in 2025 will still be higher than that in 2020.[98] This trend, which will be higher than 8% and 14.6% in 2020, may

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[90] Samuel Carrara and others, 'Supply Chain Analysis and Material Demand Forecast in Strategic Technologies and Sectors in the EU- A Foresight Study' (2023) <https://rmis.jrc.ec.europa.eu/uploads/CRMs_for_Strategic_Technologies_and_Sectors_in_the_EU_2023.pdf> accessed 21 May 2024.

[91] European Commission, 'Press Corner' (European Commission) <https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_22_5523> accessed 21 May 2024.

[92] Shawn Donnelly, 'Semiconductor and ICT Industrial Policy in the US and EU: Geopolitical Threat Responses' (2023) 11(4) Economic Security and the Politics of Trade and Investment Policy in Europe.

[93] ibid.

[94] ibid.

[95] UMBACH (no. 35).

[96] ibid.

[97] ibid.

[98] International Energy Agency, 'Renewable Electricity – Renewables 2022 – Analysis' (*IEA* 2022) <https://www.iea.org/reports/renewables-2022/renewable-electricity> accessed 21 May 2024.

cause European energy companies to reduce product demand due to cost considerations, which will have a negative impact on the development of the entire industry chain.[99] For example, in 2010, China stopped all exports of rare earth elements to Japan for a period of time, and restricted China's total exports of rare earth elements to the world, reducing its original export volume by 40%.[100] In 2016, rare earth production in China represented about 90% of global production. Where China reduces the exports of rare earths, among other products, prices are likely to go up.[101] Rare earths are considered very crucial in high technology, clean energy products such as wind turbines and electric vehicles, as well as the defense industry. Without rare earths, final products cannot be produced in the related industries.[102]

This will eventually cause supply shortages, lack of related product production, and finally develop into limited industrial development. Before the new EU Green Strategy, the EU is mostly based on supply dependence rather than the cost efficiency and the perspective of the fair market to choose partners.[103] Although it is also relatively independent, it also means that the EU will spend huge time and economic cost on the investment in local capacity under the situation that its previous partners are both economical or replaceable with itself and reliable on the supply side of raw material and semi finished goods. According to a study based on data from 1900, high inflation, lower economic activity and a fall in international trade is instigated by geopolitical risks.[104] That is to say, geopolitical risks will not only affect the cost of the related products in the EU but also, through its cooperation network and production upstream and downstream, relations influence the trade cooperation relations of the relevant countries and further continue to squeeze the strategic autonomy space of the EU.

2.2.3 Promotion of EU green industry-related legislation

It was in December 2019 when the European Commission presented The European Green Deal, suggesting the possibility that the EU must be the first in the world to achieve 'carbon neutrality' that is net-zero carbon emissions, by the year 2050.[105] It is also known as climate neutrality, and it consists of overall goals and very specific actions in eight areas: other goals and policy measures aside from funding, technology, and safeguards to ensure joint member participation to support the achievement of such goals.[106] Its overall goal applies to effectively respond to the issues of climate and the environment in the application of a new growth strategy that links the goal of leading the EU toward a fair and prosperous society with the building of the EU into a competitive and resource-efficient economy by

[99] Rishab Shrestha, 'Renewable energy COSTS continue to fall across Europe' (*Wood Mackenzie*, 08 March 2023) <https://www.woodmac.com/news/opinion/renewable-energy-costs-europe/> accessed 21 May 2024 .

[100] IEA (no. 98).

[101] ibid.

[102] LEE Simmons, 'Rare-Earth Market' (*Foreign Policy*, 12 July 2016) <https://foreignpolicy.com/2016/07/12/decoder-rare-earth-market-tech-defense-clean-energy-china-trade/> accessed 21 May 2024.

[103] European Commission, 'The European Green Deal,' COM/2019/640 final.

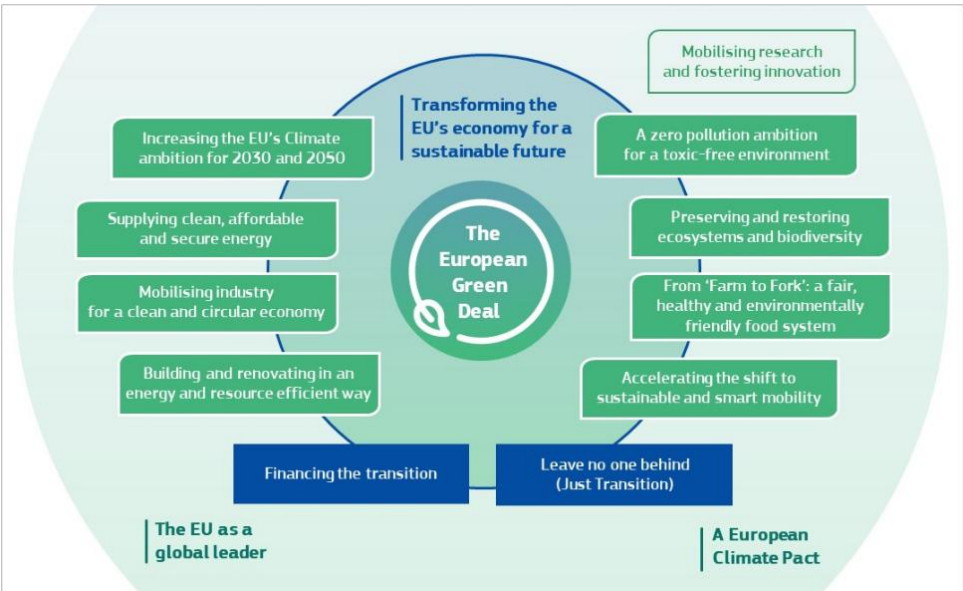
[104] Caldara, D. et al., 'Do Geopolitical Risks Raise or Lower Inflation?' (22 April 2024) < https://www.matteoiacoviello.com/research_files/GPR_INFLATION_PAPER.pdf> accessed 21 May 2024.

[105] European Commission (no. 103).

[106] ibid

promoting the EU to have greenhouse gas emissions that will reach net greenhouse gas emissions by 2050 with EU economic growth decoupled from resource use.[107] See Picture 1 for details.

Picture 1. The European Green Deal[108]



As a strategy that the Commission proposed in the RE Power EU plan, which was proposed on May 18, 2022, in response to the troubles sparked by Russia's invasion of Ukraine and chaos in global energy markets, several measures for rapid reduction of dependence on Russian fossil fuels were also proposed for upping the green transition for attaining affordable, safe, and sustainable burdens for Europe. In the RE Power EU plan proposed on May 18, 2022, as a response to the troubles sparked by Russia's invasion of Ukraine and the chaos in global energy markets, the Commission proposed a strategy to rapidly decrease dependence on Russian fossil fuels and to also make the green transition for the achievement of affordable, safe and sustainable burdens for Europe.[109]

In fact, the phase-out of fossil fuels in Russia is accelerating a new industrial revolution, which will put a definitive end to the fossil fuel era. The whole set of new net zero technologies is to be invented and scaled up across the economy in transport, buildings, manufacturing, energy, and in the creation of entirely new markets. The net zero ecosystem of the EU has an estimated value of over €100 billion in 2021, having doubled in value in the period of one year since 2020.[110] The Green Deal Industrial Plan, presented in February 2023, complements the ongoing work on the update of the EU industrial policy, which looks from the perspective of the European Green Deal and, in particular, the Circular Economy

[107] ibid

[108] ibid.

[109] European Commission, 'Repower EU: Affordable, Secure and Sustainable Energy for Europe' (European Commission, 18 May 2022) <https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en#diversifying_our_energy_supply>.

[110] Dealroom.co, 'The rise of European climate tech' (*Dealroom*, April 2022) <https://dealroom.co/uploaded/2022/04/Dealroom-Talis-Climate-Tech-Europe-2022.pdf> accessed 21 May 2024.

Action Plan and the EU Industrial Strategy.[111] In spring 2023, the Commission will put forward a series of key initiatives on industrial competitiveness, which will build on the 'Strengthening the Single Market' and fostering 'Innovation' twin pillars to design a predictable, coherent, and simplified regulatory framework. As a first flagstone of the Green Deal industrial package, the European Commission is putting forward the Net Zero Industry Act intended to address the needs of European citizens and industry, providing for a more coherent and simplified regulatory framework for the manufacturing of products key to the EU's climate neutrality targets, such as batteries, windmills, heat pumps, solar energy, electrolysers and key components of carbon capture and storage technologies.[112] The committee will propose a critical raw materials act, Net Zero Industry Act in the EU can only be made possible if relevant critical raw materials are available considering diversified sourcing and recycling of materials to reduce the EU's exposure to highly concentrated supplies from third countries and promote high-quality jobs and economic growth in the EU. It shall also take into account various aspects of EU supply security, from international engagement to extractive—where relevant — processing, recycling, and guarantee of high environmental standards and continuous research and innovation, including notably development towards the decreased use of materials and biotechnological solutions.[113]

2.3 Key elements of the EU CRMA

This act is driven by the following factors: enhance the capability level at every step of the critical raw materials value chain in Europe, diversify sources of EU imports of critical raw materials, empower the monitoring and mitigation abilities of critical raw material supply risks in the EU, ensure the proper functioning of the Single Market by further enhancing the sustainability and circularity of critical raw materials, making sure that the EU can have access to secure and sustainable supplies of CRM.[114]

Ursula von der Leyen, President of the Commission, commenting on the regulation :

> This Act will bring us closer to our climate ambitions. It will significantly improve the refining, processing and recycling of critical raw materials here in Europe. Raw materials are vital for manufacturing critical technologies for our twin transition – like wind power generation, hydrogen storage or batteries. And we're strengthening our cooperation with reliable trading partners globally to reduce the EU's current dependencies on just one or a few countries. It's in our mutual interest to ramp up production in a sustainable manner and at the same time ensure the highest level of diversification of supply chains for our European businesses.[115]

After being signed by the President of the European Parliament and the President of the European Council on April 11, 2024, the final version of the regulation has

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[111] European Commission,(no. 44).

[112] European Commission, 'Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act),' COM (2023) 161 final.

[113] ibid 2.1.

[114] EU CRMA, art. 5.

[115] European Commission, 'Critical Raw Materials: Ensuring Secure and Sustainable Supply Chains for EU's Green and Digital Future' (European Commission, 16 March 2023) <https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1661>.

been published in the Official Journal of the European Union and will enter into force on May 23, 2024. Some articles will be implemented on May 24, 2028.[116]

The overall objective of this regulation is to improve the functioning of the internal market by establishing a framework to ensure that the EU has access to secure, resilient and sustainable supplies of critical raw materials, including improving efficiency and circularity throughout the value chain.[117] According to the main content of regulation, it can be divided into four aspects. The first is to increase the EU industry's awareness of CRM-related risks in the supply chain; the second is to mitigate CRM supply risks and improve extraction, processing, import and recycling capabilities within the EU; and the third is to establish the EU Critical Raw Materials Committee and some important systems to treat the EU as a Overall, improve overall planning capabilities. Fourth, to ensure the smooth progress of regulation, monitoring and reporting obligations at different levels are regulated.[118]

2.3.1 Increase the awareness of CRM-related risks

First, in order to increase the EU industry's awareness of CRM-related risks in the supply chain, the concepts related to waste recycling and critical raw materials involved in legal documents are defined.[119] The definitions of 'recycling', 'waste', 'collection', 'treatment', 'recovery' and 're-use' directly follow Article 3, of Directive 2008/98/EC; 'extractive waste', 'extractive waste' The definition of facility directly follows Directive 2006/21/EC. The definition of 'motor vehicle' directly follows Regulation (EU) 2018/858.[120]

Then, in order to focus EU actions on the most relevant raw materials for the technologies required for dual transformation, defense and aerospace, this regulation not only updates the list of critical raw materials, but also adds those with the highest scores on the list in terms of strategic importance, expected demand growth, and increased production difficulty. The raw materials were officially named strategic raw materials (SRM) for the first time, and a list of strategic raw materials was determined and promised to be updated every three years. Specifically, strategic raw materials (SRM) and critical raw materials are defined in Annexes 1 and 2, where SRM is 'the raw material with the highest score in terms of strategic importance, expected demand growth and increased production', and CRM is these strategic raw materials and all Raw materials exceeding certain thresholds of economic importance and supply risk. While three criteria for classifying materials as strategic are specified, referring to their relevance to strategic technologies and the growth in demand for these technologies, no specific methodology or further explanation is provided. In contrast, the basic methodology for criticality assessment is public and has remained unchanged since 2017. Copper and nickel do not meet the CRM threshold but are classified as strategic raw materials and are therefore included in the CRM list.

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[116] EU CRMA, art. 49.
[117] ibid art. 1.
[118] ibid.
[119] ibid.
[120] ibid art. 2.

2.3.2 Reduce the CRM supply risks and recycling capabilities

In order to mitigate CRM supply risks, it is not only necessary to strengthen internal supply and improve its own mining, processing and recycling capabilities, but also to strengthen external supply and diversify imports.[121] The EU CRMA proposes new standards from four perspectives: mining, processing, recycling, and import diversification:

(A) ensure that, by 2030, Union capacities for each strategic raw material have significantly increased so that, overall, Union capacity approaches or reaches the following benchmarks:

(i) Union extraction capacity is capable of extracting the ores, minerals or concentrates needed to produce at least 10 % of the Union's annual consumption of strategic raw materials, to the extent possible in light of the Union's reserves;

(ii) Union processing capacity, including for all intermediate processing steps, is capable of producing at least 40 % of the Union's annual consumption of strategic raw materials;

(iii) Union recycling capacity, including for all intermediate recycling steps, is capable of producing at least 25 % of the Union's annual consumption of strategic raw materials and is capable of recycling significantly increasing amounts of each strategic raw material from waste;

(b) diversify the Union's imports of strategic raw materials with a view to ensuring that, by 2030, the Union's annual consumption of each strategic raw material at any relevant stage of processing can rely on imports from several third countries or from overseas countries or territories (OCTs) and that no third country accounts for more than 65 % of the Union's annual consumption of such a strategic raw material.[122]

In order to mitigate supply risks and realize the plan for intra-EU mining in 2030, the regulation proposes that by May 24, 2025, each member state should develop a national overall exploration plan for critical raw materials and critical raw material carrier minerals. and provides for review at least every five years and updates as necessary.[123] Regulation also proposed Criteria for the recognition of Strategic Projects, viewing it as an important measure to ensure the security of the supply of strategic raw materials within the EU. However, it is also stipulated that The recognition of a project as a Strategic Project pursuant to this Article shall not affect the requirements applicable to the relevant project or project promoter under Union, national or international law.[124] And shall not affect the application and recognition of Strategic Projects. The documents that need to be submitted, the time limit for application comparison, and the information reporting obligations after being recognized as Strategic Projects are stipulated.[125]

In addition to facilitating the supply of strategic raw materials on the procurement side, the Committee is required to formulate standards for strategic inventory coordination, and to issue member states' expansion of production capacity and strategic inventory handling methods without requiring member states to hold and release strategic inventories. Views.[126] EU member states are improving the recycling recycling of CRMs at different levels, with special attention being paid to the recycling of permanent magnets.[127] Stipulates the standards for the development of certification programs and the standards for some CRM

[121] ibid.

[122] ibid art. 5.

[123] ibid art. 19.

[124] ibid art. 6.

[125] ibid art. 7-8.

[126] ibid art. 23.

[127] ibid art. 26-29.

environmental footprint statements, and both stipulate that they should be published on a free website and be easily understood.[128]

2.3.3 Establish the EU Critical Raw Materials Institutions

The act provides for the establishment of the European Critical Raw Materials Board at EU level to carry out tasks related to the project and its financing development, exploration programs, monitoring capabilities or strategic reserves.[129] Provides that the Board of Directors shall be composed of representatives of all Member States and the Commission, that each Member State shall appoint a senior representative to the Board of Directors, that only Member States shall have voting rights, and that each Member State shall have only one vote regardless of the number of its representatives.[130] It also stipulates the content of board meetings, rules of procedure, standing groups and information security provisions.[131] Furthermore, working with selected third countries declared as strategic partnerships is another key strategy to achieve the benchmarks.[132] The act also stipulates the rights granted to the committee and the committee procedures.[133]

For Strategic Projects in the Union, Member States shall establish or designate one or more authorities as single points of contact, resolve all matters through a single point of contact, and provide that all documents can be submitted electronically to establish the administrative approval process.[134] It also stipulates that Strategic Projects in the Union is given priority in terms of importance and may be considered to have an overriding public interest. And the issuance of permits for Strategic Projects in the Union before any national courts, tribunals or panels, including with regard to mediation or arbitration, where they exist in national law, shall be treated as urgent.[135] After stipulating the priority of the permit-granting process and the slogan of processing it as soon as possible, the maximum time limit is directly stipulated.[136] The regulation also requires member states to consider possible critical raw material projects when planning and zoning and comply with relevant international regulations.[137] Strategic projects are further supported by coordinated financing, off take agreements and online access to key information.[138]

In order to improve procurement bargaining power, the regulation proposes to create a joint procurement platform at the EU level for companies and member states to facilitate better transactions or prevent supply shortages.[139]

The Commission shall set up and operate a system to aggregate the demand of interested undertakings consuming strategic raw materials established in the Union and to seek offers from suppliers to

[128] ibid art. 20-31.
[129] ibid.
[130] ibid.
[131] ibid art. 35-36.
[132] ibid art. 37.
[133] ibid art. 38-39.
[134] ibid.
[135] ibid.
[136] ibid art. 9-11.
[137] ibid art. 12-14.
[138] ibid art. 15,16,18.
[139] ibid art. 17.

match that aggregated demand. This shall cover both unprocessed and processed strategic raw materials.[140]

2.3.4 Regulate monitoring and reporting obligations

In order to ensure smooth progress, relevant requirements have been put forward for the monitoring process, information confidentiality, punishment and evaluation.[141] The Commission shall monitor supply risks related to critical raw materials, Member States shall provide information to the Commission on new or existing critical raw material project and strategic stocks on their territory, Large companies shall, at least every three years and to the extent the required information is available to them, carry out a risk assessment of their raw materials supply chain of strategic raw materials.[142] Combining the committee, member states, and member state internal reports on renewable energy, digital and other related large companies to achieve the purpose of more efficient monitoring and mitigation of raw material supply risks. In order to monitor the 2030 benchmark proposed in Article 5 of the regulation, the Commission has a reporting obligation.[143] However, confidential information during the implementation process should be properly maintained. It also stipulates the penalty obligations of member states, and each member state should set penalty standards. After a period of implementation, member states should submit annual reports to the Commission, and the Commission should submit an evaluation report on the results of the implementation of this Regulation in 2028 based on the goals pursued.[144]

2.4 Concluding remarks

This chapter begins with an introduction to historical changes in EU law and policies related to critical raw materials. Then it analyzes why the EU introduced EU CRMA. The reasons are divided into the following three: The EU's green and digital transformation strategic goals are inseparable from the stable supply of critical raw materials. Secondly, the global critical mineral resources market is highly concentrated, and most of the critical mineral reserves are concentrated in a few countries. This poses a potential risk to EU supply security, and the EU needs to maintain strategic autonomy. Finally, the EU green industry-related leagal documents directly promoted the introduction of CRMA. Then the key elements of EU CRMA are introduced. This chapter can also be summarized via the following Table 1:

[140] ibid art. 25.
[141] ibid.
[142] ibid art. 20-22, 24.
[143] ibid art. 5.
[144] ibid art. 44-48.

Table 1 Legal features of the EU Critical Raw Materials Act[145]

EU CRMA	
Timeline	Proposal adopted the European Commission(March 17,2024)
	Signed by the President of the European Parliament and by the President of the Council of the European Union(April 11,2024)
	Entry into force(May 24,2024)
Motivations	Promotion of green and digital transformation in the EU
	Needs to maintain strategic autonomy of the EU
	Promotion of green and digital transformation in the EU
Key elements	Increase the EU industry's awareness of CRM-related risks in the supply chain
	Establish the EU Critical Raw Materials Committee and some important systems
	Regulate monitoring and reporting obligations in different levels

[145] Elaborated by the author.

3 Challenges for the implementation of the EU CRMA

The possible challenges during the implementation of the Critical Raw Materials Act are mainly reflected in the following seven aspects, judging from the specific content of the regulations.

3.1 Uncertainty about the specific implementation

Although some provisions in the regulation stipulate specific tasks for the committee and member states, their expressions are vague and uncertain, resulting in low enforceability and difficulty in achieving practical effect.[146] Article 7 of the act states that by November 24, 2024, the Committee shall adopt an implementing act establishing a single template for use by project sponsors in Applications for recognition of a critical raw material project as a Strategic Project.[147]The range of documents required for a single template should be reasonable. However, the specific and reasonable definitions, as well as the financial burden that may be caused by the project sponsor's application and the relevant subsidies after application are not elaborated and stipulated.[148]

Article 9 of the act provides that 'By 24 February 2025, Member States shall establish or designate one or more institutions as single points of contact.' and proposed that Member States should ensure that applicants have easy access to dispute resolution information and procedures, including (where applicable) alternative dispute resolution mechanisms, regarding the licensing process for critical raw material projects.[149] And it stipulates that Member States shall ensure that a single point of contact has a sufficient number of qualified staff and sufficient financial, technical and technological resources to effectively carry out the tasks set out in this Regulation.[150] But regarding the specific number of qualified staff required for a single point of contact, what kind of staff can be defined as qualified, and what qualification certificates or work-related experience can be defined as qualified. The definition of valid performance is what is not determined. And if effective performance is required, there are no corresponding penalties and supervision provisions on how to ensure effective performance.Article 18 states that Member States shall make available online, in a centralized and easily accessible manner, information on administrative processes related to critical raw material projects and that the Commission shall make available in a centralized and easily accessible manner administrative processes related to strategic project accreditation and such accreditation. Online information

[146] ibid.
[147] ibid art. 7.
[148] ibid.
[149] ibid art. 9
[150] ibid.

on the benefits.[151] However, it is not clear what the specific centralized and easily accessible method refers to. For example, it is not sure whether it is necessary to build a new website or open a new section on the EU official website for easy query.

However, the above challenges can be solved in practice. While uncertainty is a challenge, it can also be an advantage. Member states and the Commission can adjust the above content according to the latest reality to make it more in line with practical needs.

3.2 Imperfection of the established system's price formation mechanism

Although the act requires the establishment of a raw material procurement and strategic project off take system, the price formation mechanism is not sound.[152] Article 17 provides that the Commission shall establish a system in accordance with competition rules to facilitate the conclusion of offtake agreements related to strategic projects.[153] The system allows potential offtakers to submit bids, specifying price ranges, quantities to be purchased, and the duration of the offtake agreement. The system also allows strategic project sponsors to initiate price, quantity and quality quotations. The committee is supposed to broker system deals.[154] Article 25 Joint Procurement states that The Committee shall establish and operate a system to aggregate the needs of relevant enterprises within the alliance that consume strategic raw materials and seek quotes from suppliers to match this aggregated demand. This should cover both raw and processed strategic raw materials.[155] The system described by these statements is very similar to existing metals and other bulk futures exchange systems. The existing issues regarding mineral pricing on futures exchanges will always exist. Moreover, the committee's dominance of pricing may have negative impacts such as corruption.[156]

For example, taking the actual price fluctuations of nickel in critical minerals as an example, we can conclude that the price formation mechanism of the above system is likely to be unsound. Before the 1980s, nickel resource prices were mainly determined by manufacturers and the government.[157] In 1979, the LME introduced nickel contracts, and nickel resource pricing gradually shifted to a futures market pricing model.[158] The futures market is unstable, and prices fluctuate greatly due to various factors such as political, economic and natural factors. Some large players may influence prices through large volumes of transactions or even implement market manipulation, thereby distorting the formation of market prices.[159] Futures prices are often also affected by the spot market. If there are abnormal fluctuations or instability in the spot market, the futures market may also be affected.[160] In addition, if supervision is not strict or enforcement is weak, irregularities may

[151] ibid art. 18.

[152] ibid.

[153] ibid art. 17.

[154] ibid.

[155] ibid art. 25.

[156] ibid.

[157] Mudd, Gavin, and Simon Jowitt, 'A detailed assessment of global nickel resource trends and endowments' (2014) *Economic Geology*, 13-41.

[158] ibid.

[159] Liu Jialei, 'Case Analysis and Future Expectations of Chinese Enterprises Suffering Heavy Losses in the International Futures Market: Take the Bank of China and Tsingshan LME as Examples' (2024), *EDP Sciences*.

[160] ibid.

occur in the market, harming the fair competition environment in the market, thus affecting the formation of futures prices.[161] Due to the war between Russia and Ukraine, major Western economies led by the United States have imposed financial sanctions on Russia. Russian nickel products have been removed from LME inventories and delivery restrictions.[162] LME nickel prices have increased significantly, reaching an intraday high of US$101,400 on March 8, 2022. /t, LME steps in to suspend nickel trading. Affected by this, the LME has repeatedly set single-day price limits for nickel futures, requiring members to report all OTC positions and make transactions transparent.[163] One of the reasons for the outbreak of this incident is the information asymmetry in the futures market, which led to the illusion of mismatch between nickel supply and demand, and nickel prices fluctuated significantly.[164]

The challenge of an imperfect price formation mechanism should be solved using financial knowledge. The current best solution for price regulation is to combine the invisible hand of the market with this regulation. Moreover, establishing a system which is required in the terms will also help to solve the problem of transaction information asymmetry. In short, it is not feasible to continue adjusting this price formation mechanism using legal provisions. The main function of the provisions is to formulate the framework of this mechanism, and at the same time, it can supplement the liability provisions for corruption and malfeasance.

3.3 Additional reporting obligations for companies

Ariticle 24 states:

> Member States shall identify the large companies operating which use strategic raw materials to manufacture batteries for energy storage and e-mobility, equipment related to hydrogen production and utilisation, equipment related to renewable energy generation, aircrafts, traction motors, heat pumps, equipment related to data transmission and storage, mobile electronic devices, equipment related to additive manufacturing, equipment related to robotics, drones, rocket launchers, satellites or advanced chips.[165]

These large companies identified by member states should conduct a risk assessment of their raw material supply chains for strategic raw materials at least every three years and to the extent that they have the required information.[166] It also stipulates that if significant vulnerabilities to supply disruption are identified as a result of risk assessments, large companies should work to mitigate these vulnerabilities, including assessing the possibility of diversifying their raw material supply chains or replacing strategic raw materials. Member states can require relevant reports and information from large companies to their boards of directors.[167] The purpose of a company's existence is to make profits. Although large companies will control raw material supply risks, different companies deal with them in different ways. Forcing reporting requirements on companies will increase the company's financial burden. The cost of this kind of report is close to

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[161] ibid.

[162] Mysteel, 'LME Abandoning Russia Nickel' (www.mysteel.net) <https://www.mysteel.net/market-insights/5052439-lme-abandoning-russia-nickel-a-potential-boost-for-domestic-nickel-brands> accessed 2 June 2024.

[163] MEPS International, 'Russian nickel ban an 'upward driver' of LME prices' (*MEPS International*, 19 April 2024) <https://mepsinternational.com/gb/en/news/russian-nickel-ban-an-upward-driver-of-lme-prices> accessed 21 May 2024.

[164] ibid.

[165] CRMA, (no. 53) art. 24.

[166] ibid.

[167] ibid.

the price of the project feasibility report. The price of the 2023 feasibility report is generally 1% of the total cost of the relevant project.[168]

Although this act imposes an additional burden on the company, these are all large companies, and the strategic raw material supply chain risk assessment itself partially overlaps with the company's internal risk assessment. And the relevant costs can be passed on to material suppliers or consumers. Moreover, the economic attributes and social attributes of these companies also need to be coordinated. This increased cost can be regarded as the social responsibility assumed.

3.4 Great resistance in establishing a local raw material supply chain

It is not easy for the EU to put up a local raw material supply chain. This regulation, which will make the approval, launch, and supervision of critical raw material projects easier than ever.[169] It is hoped to accelerate administrative licensing and increase raw material mining capacity by the EU.[170] However administrative licensing takes a long time and is not the main difficulty at present for related investment. It is impossible to build a stable local supply system in the short term, and the cost is very huge. As early as 2020, the EU has no rare earth mining or refining capabilities, and the recovered rare earth elements are less than 1%. Lithium, graphite, and platinum group metals are also very small. The shares of mining or refining are less than 1%, 2%, and 2% respectively.[171] And many large oil companies unified mineral exploration and discovery during mining in the 1970s and 1980s and discovered that mineral development was a high-risk and time-consuming endeavor.[172] It is completely different from the exploration of oil, which means success as long as an oil well is discovered, and it usually only takes a few months for the project to enter the production stage, while mineral deposits often take years or even decades from the start of exploration plans to the time the new mine actually begins production.[173] And the likelihood of success is slim, with more than 1,000 geological idea or prospects likely needed to produce a successful mine.[174] What is more, these recently found critical deposits are unlikely to produce enough in the short term to meet the demand. That is, the average cycle from discovery to the production of a mine may be about 15 years while being faced with environmental problems, EU countries mine locally.[175] The new mines are hampered by strict environmental regulations in the European Union. The mining industry is the largest waste-generating industry in the world, contributing to more than 90% of factors affecting global biodiversity loss and water stress.[176] At the same time, about half of the greenhouse gas emissions causing global

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[168] Sharukh, 'How Much Does a Feasibility Study Cost?' (*Medium*, 25 July 2023) <https://medium.com/@sharukhayesha28/how-much-does-a-feasibility-study-cost-bf783febe69c> accessed 21 May 2024.

[169] CRMA, (no. 53).

[170] CRMA, (no. 53) ch. 5.

[171] 'World Mining Data' (www.world-mining-data.info) <https://www.world-mining-data.info/?World_Mining_Data___PDF-Files> accessed 19 May 2024.

[172] Hammond and Brady, 'Critical minerals for green energy transition: A United States perspective' (2022) 36(9) International Journal of Mining, Reclamation and Environment .

[173] ibid.

[174] ibid.

[175] Paul Manalo, 'Discovery to Production Averages 15.7 Years for 127 Mines' (*Spglobal*, 6 June 2023) <https://www.spglobal.com/marketintelligence/en/news-insights/research/discovery-to-production-averages-15-7-years-for-127-mines> accessed 19 May 2024.

[176] Kalisz Szymon, 'Waste management in the mining industry of metals ores, coal, oil and natural gas-A review' (2022) *Journal of environmental management*.

climate change come from resource extraction and processing.[177] With the metals like nickel, cobalt, manganese, rare earths, and copper metals found in the deep sea, deep-sea mining is becoming a global mining frontier.[178] However, like land mining, deep-sea mining is also going to produce much waste and ultimately endanger many living things.[179] What is more, the environmental outcomes of extracting, processing, and using the various material resources differ. The improved recycling rate of waste and the shift of the raw material of the material resource steel production from iron ore to iron will make waste gas emissions increase significantly and further aggravate global climate change.[180]

The mining and processing of copper and precious metals can produce high levels of toxicity. Though the Critical Raw Materials Strategy of the EU puts forward the specific response measures for environmental protection, it tries to balance protecting nature and mineral extraction.[181]

Despite the fact that EU members have formed diversified environmental regulations, the opposition has yet to break out between politicians, regulators, local communities, non-governmental organizations, and environmental groups.[182] Though in China, this is not the case, mining projects will still face opposition between environmental groups and people in mining areas.[183] They fear that the strategic balance of critical raw materials will not shift in their favor. They believe that mining works might cause critical water and soil pollution, and biodiversity loss, and might also result in the destruction of years of nature and biodiversity protection. They see the mining works as killing the environment to save it.[184] For instance, in Portugal, the construction of lithium mines was delayed for over ten years due to complaints of environmental organizations and local communities.[185] This is exactly why, on the contrary, this regulation would bring with it the reduction of licensing time for strategic projects.

Since the approval is the exclusive competency of the member states, it will be hard, unless the European Union solves this problem of reducing the environmental load, to have the possibility for member states to promote the localization of critical raw material value chains.Therefore, the EU can help member states coordinate and solve environmental problems by strengthening environmental protection-related legislation.

3.5 Great resistance to critical raw materials recycling capabilities

The regulation proposes to increase the supply of secondary critical raw materials by increasing the quantity and quality of mining waste recycling.[186] ‘Urban mining’,

[177] ibid.

[178] Durden J. M, Lallier L. E, Murphy K, Jaeckel A, Gjerde K, and Jones D. O, ‘Environmental Impact Assessment process for deep-sea mining in ‘the Area’’ (2018) *Marine Policy*, 194-202.

[179] ibid.

[180] ibid.

[181] Meadhbh Bolger, Diego Marin, Adrien Tofighi-Niakietal, ‘Green mining’ is a myth: the case for cutting EU resource consumption’ (*Europe Environmental Bureau*, 5 October 2021) <https://eeb.org/library/green-mining-is-a-myth/> accessed 21 May 2024, 10, 18, 20.

[182] Cheba, Katarzyna, and Iwona Bąk, ‘Environmental production efficiency in the European Union countries as a tool for the implementation of goal 7 of the 2030 agenda.’ (2021) *Energies*.

[183] Thea Riofrancos, ‘The Security − Sustainability Nexus: Lithium Onshoring in the Global North’ (2023) 23(1) Global Environmental Politics 21.

[184] ibid.

[185] Larisa Stanciu, Lotte Hoex, ‘EU’s new critical raw materials act could be a recipe for conflictff (Euobserver, 24 March 2023) <https://euobserver.com/eu-and-the-world/arf0aaf2fc> accessed 21 May 2024.

[186] CRMA, (no. 53) art 5.

which recovers rare metals from waste electrical and electronic equipment through mechanical and chemical processing, is very promising. Disposal of waste electrical and electronic equipment (WEEE) is a potential source for recycled CRM. In 2018, only 52% of WEEE generated was correctly collected and reported, with 48% unreported or unaccounted for. When analyzing the economic impact of these flows, the combined losses for Cr, Cu, In, Mg, Nb and Nd were estimated at €1.41 billion.[187]

Taking mobile phones as an example, just 1 million mobile phones contain 16,000 kilograms of copper and 14 kilograms of palladium. However, recycling depends on end-of-life volumes and recycling alone is clearly not enough to meet the demand for critical raw materials within the EU. Lithium-ion batteries used in electric vehicles take about 15 years to reach the end of their useful life under the most optimistic scenario.[188] Only by 2040 can recycling become the EU's main source of supply of some critical raw materials.[189] The main problem here is that the existing waste stream, which is dominated by personal care, IT and telecommunications products due to their short lifespan, not only has low recycling rates. For example almost two thirds of end-of-life computers are not recycled into Danish municipal waste at the collection point, the recyclable metal in one third of discontinued desktop and laptop computers has a calculated value of 45,000 euros, and the recycling cost of magnets is 160,000 euros. From an economic perspective, it is unattractive for e-waste disposal companies to invest in it.[190] But most products that are attractive for permanent magnets recycling, such as wind turbines and electric vehicles, remain untapped and appear in the waste stream.[191] The products with the least difficulty in recycling at this stage mainly include passenger cars, Washer and dryer, refrigerator and more. Ownership of these products is mostly at the household level, with each household owning one product. Such products have a relatively short service life, usually 8-15 years, and contain less heavy magnets per unit of product, such as 0.1-3 kg. These products can also be recycled at the end-of-life stage, as people tend to throw these products into waste collection stations due to their larger size, and these products are usually disposed of promptly.[192]

The EU can improve recycling and reuse rates which helps reduce the great resistance to recycling raw materials by encouraging technological innovation.

3.6 Insufficient financial resources to implement the EU CRMA

Regulation mentions that in the process of increasing the production capacity of critical minerals, financial measures can be used if the corresponding conditions are met.[193] Drawing on existing EU funds, such as the European Regional Development fund, The Just Transition Fund, The Innovation Fund and European

[187] Michelle A Wagner and others, 'Unlocking the potential of e-waste: A material quantification analysis of Cu, Cr, In, Mg, Nb, and Nd in the EU' (2023) 199(22) *Resources, Conservation and Recycling*.

[188] Oliver Noyan, 'How the EU Plans to Win the Global Race for Critical Raw Materials', (*uractiv*, November16, 2022) <https://www.euractiv.com/section/energy-environment/news/how-the-eu-plans-to-win-theglobal-race-for-critical-raw-materials/>.

[189] Guillaume Ragonnaud, 'Securing Europe's Supply of Critical Raw Materials:The Material Nature of the EU'-s Strategic Goals' (*Think Tank European Parliament*, 9 March 2023) 10.

[190] Komal Habib, 'A product classification approach to optimize circularity of critical resources – the case of NdFeB magnets' (2019) 230 *Journal of Cleaner Production.*.

[191] Komal Habib and others, 'Tracking the Flow of Resources in Electronic Waste - The Case of End-of-Life Computer Hard Disk Drives' (2015) 49(20) *Environmental Science & Technology* .

[192] Oliver Noyan (no. 91).

[193] EU CRMA.

Sovereignty Fund. Projects in third countries contributing to the diversification of Union's supply could be supported through relevant funds, such as the Neighborhood , Development and International Cooperation Instrument and the European Fund for Sustainable Development Plus established by Regulation (EU) 2021/947 of the European Parliament and of the Council.[194]

There is still great uncertainty about the financial support of the EU.[195] In terms of critical raw materials, European companies need to invest heavily in infrastructure, technology research and development, and mineral development in third countries in corresponding fields. This requires large-scale support from the EU and member states at the public financial level. However, the current downward pressure on the EU economy is increasing and the proportion of the fiscal deficit is rising. At the same time, the EU still needs to maintain expenditures to cope with challenges in aid to Ukraine, Palestine and Israel, refugees, energy subsidies, etc. Investments for future development such as green and digital transformation will be affected. Significant impact, support for critical raw material projects may not be significantly increased.[196]

At the same time, differences among EU member states on financing issues will continue to increase, and the overall budget may face cuts.[197] In addition, according to EU practice, projects such as agricultural subsidies are often allocated in advance, squeezing out the funding space for reshaping the clean energy supply chain.[198] For example, from a source perspective, sovereign funds are raised by allocating part of the funds drawn from relatively wealthy countries to relatively poor countries. Von der Leyen planned to modify some existing EU funds and replenish 100 billion euros from the treasury of member states. Austria, Denmark, Finland, Germany, the Netherlands, Sweden, etc. were firmly opposed.[199] They believed that sharing a Covid recovery fund was enough, Germany and the Netherlands also pointed out that there is still money in a Covid recovery fund that has not been used. But even if the patchwork is successful, the EU's funding scale will be difficult to match that of China and the United States. Judging from the response, both rich and poor countries are dissatisfied.[200] Wealthier member states are not only unwilling to share more funds, but also enjoy greater development opportunities because they have more start-ups, so they see no need to establish this fund.[201] Although poorer countries, such as those in Southeast Europe, expect to receive more financial support through sovereign funds, they will not sign on

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[194] CRMA (no. 53) ch. 3.

[195] European Commission, 'eonomic and Financial Affairs 2024 Euro Area Report EUROPEAN ECONOM' <https://economy-finance.ec.europa.eu/system/files/2023-11/ip259_en.pdf> accessed 21 May 2024.

[196] Arnaud Vanolli, 'Back to Black: EU States Face a Budget Squeeze as Fiscal Rules Return' (*Swiss Re Institute* 30 January 2024) <https://www.swissre.com/institute/research/sigma-research/Economic-Insights/eu-states-budget-squeeze.html> accessed 19 May 2024.

[197] ibid.

[198] ibid.

[199] Beatriz Rios, 'Von Der Leyen: EU Budget Should Be the Marshall Plan We Lay out Together' (www.euractiv.com2 April 2020) <https://www.euractiv.com/section/economy-jobs/news/von-der-leyen-eu-budget-should-be-the-marshall-plan-we-lay-out-together/accessed 21 May 2024.

[200] Dave Keating, 'In Green Subsidy Race with US, EU Lacks Focus' (*Energy Monitor* 6 February 2023) <https://www.energymonitor.ai/finance/regulation-policy/in-green-subsidy-race-with-us-eu-lacks-focus/> accessed 19 May 2024.

[201] ibid.

unless a pan-EU sovereign fund is established that does not take into account wealth and size factors.[202]

The shortage of funds is a long-standing problem that is difficult to solve. Therefore, this article cannot provide solution suggestions.

3.7 Instability of establishing strategic partnership

CRMA states:

> 'Strategic Partnership' means a commitment between the Union and a third country or an overseas country or territory to increase cooperation related to the raw materials value chain that is established through a non-binding instrument setting out actions of mutual interest, which facilitate beneficial outcomes for both the Union and the relevant third country or overseas countries or territories.[203]

However, major resource supplier countries have the possibility to seek to maximize the value of the supply chain. For example, Indonesia's Mining Law promulgated in 2009 mentioned a ban on the export of nickel ore, and it was officially implemented in 2014.[204] The ban on the export of nickel ore is to replace the sales method of nickel ore with ferronickel, increase the financial revenue of the Indonesian government, promote the improvement of the country's nickel ore smelting capacity, and seek to maximize the value of the supply chain.[205] However, because the production speed of ferronickel was too slow, the export ban increased the survival pressure of Indonesian nickel mining companies. Therefore, Indonesia conditionally allowed the export of nickel ore in 2017, and then again in 2020 after the ferronickel production line was put into production and reached the target. Implement a comprehensive ban on nickel ore exports.[206] At present, Indonesia is gradually extending its complete mining ban to further smelting in the middle reaches of the industrial chain, imposing export restrictions or imposing export taxes on products such as ferronickel and intermediate products, thereby achieving localization of processing and smelting of advantageous minerals.[207] The prerequisite for efficient acquisition of critical minerals is the formation of a supranational strategy within the group, but such collective action is usually difficult to achieve. Different countries have different willingness to join, even the degree of support for joining and the specific types of minerals that require reciprocity are also different.[208] The EU CRMA provides for Strategic Partnership, and the design prioritized by some countries and regions is elitist and exclusive, is a new trade protectionist thinking that may lead to market supply shortages, price

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[202] ibid.

[203] CRMA, (no. 53) art 2.

[204] Prasetyo Erwin, 'Questioning Indonesia's Ban on Export of Ore Policy Under International Investment and Trade Law' (2015) *Juris Gentium Law Review*, 54-62.

[205] ibid.

[206] Farawansa, Syukron Mahal, and Elfrida Ratnawati Gultom, 'Diagnosis Of Nickel Industry Downstreaming Policy In Export Restriction Towards Increasing Economic Added Value In Indonesia' (2024) *Jurnal Legalitas*, 1-16.

[207] HAO Hongchang, WANG Anjian, MA Zhe, HAN Mei. Composition and evolution of the nickel global governance framework and the participation path of China, (2024) 42(5) *Science & Technology Review* 61-69.

[208] Vlado Vivoda, 'Friend-Shoring and Critical Minerals: Exploring the Role of the Minerals Security Partnership' (2023) 100 Energy Research & Social Science.

signal failure and other problems.[209] Although the EU has eased mineral trade frictions between the two sides by signing the Critical Minerals Agreement with the United States.[210] In order to avoid bidding competitions among members, Group of Seven also proposed the creation of a new critical minerals buyer's club and the signing of the Five Critical Minerals Security Negotiation measures such as the 'Point Plan'[211] cannot change the self-interested motives of various economies to enhance industrial competitiveness.

On the above basis, establishing a Strategic Partnership will most likely lack stability.Regarding the instability of Establishing Strategic Partnership, the way to solve this is not only to provide it from a legislative perspective. Strengthening diplomatic and trade relations with major mineral resource countries can also help build long-term stable supply chains.

3.8 Concluding remarks

This chapter focuses on the challenges facing the implementation of EU CRMA. For example, there may be uncertainties in the implementation process between the Commission and Member States, and differences in resource policies and economic interests among different Member States may lead to inconsistent implementation. In addition, the systematic price formation mechanism established in supervision is not yet complete and may not be able to effectively reflect changes in market supply and demand. While corporate reporting obligations can help increase transparency, they can also increase a company's operating costs. In addition, although establishing a local raw material supply chain can reduce dependence on external supplies, in practice it may encounter multiple resistances such as technology, finance and policy. Insufficient recycling capacity of critical raw materials is also a problem, requiring significant investment to establish effective recycling systems. In addition, the implementation of regulations requires substantial financial investment to support, and lack of funds may become a constraint. Finally, while strategic partnerships with other countries can help diversify resource supplies, there are also uncertainties about the stability and sustainability of such partnerships. In response to these challenges, several recommendations are made. This chapter can also be summarized via the following Table 2:

[209] Rick Mills, 'Why Freeland's 'Friend-Shoring' Is Such a Bad Idea' (MINING.COM 25 October 2022) <https://www.mining.com/web/why-freelands-friend-shoring-is-such-a-bad-idea/> accessed 20 May 2024.

[210] European Commission, 'Press Corner' (European Commission 14 June 2023) <https://ec.europa.eu/commission/presscorner/detail/en/IP_23_3214> accessed 20 May 2024.

[211] IRENA, 'Geopolitics of the energy transition: critical materials' (*IRENA,* July 2023) <https://www.irena.org/Publications/2023/Jul/Geopolitics-of-the-Energy-Transition-Critical-Materials> accessed 21 May 2024.

Table 2 Challenges for the implementation of the EU CRMA[212]

Challenges	Solutions
Uncertainty about the specific implementation by the Commission and member states	Adjust with reality to fit the practical needs by the Commission and member states
Imperfection of the established system's price formation mechanism	Combine the free market and regulation
Additional reporting obligations for companies	Force large companies transfer the cost
Great resistance in establishing a local raw material supply chain	Member states can coordinate environmental problems by firming the legislation with the help from the EU
Great resistance to critical raw materials recycling capabilities	Stimulate technical innovation to increase the recycling rate
Insufficient financial resources to implement the EU Critical Raw Materials Act	Out of thesis' study scope ,so no suggestion is provided
Instability of Establishing Strategic Partnership	Strength the legislation and improve the relations with the major resource countries

[212] Elaborated by the author.

4 Comparison of critical materials law and policies among the EU, US, China and Australia

The critical minerals are mainly distributed in a few resource-rich countries. According to 2021 US Geological Survey data, the world's proven lithium resource reserves are 89 million tons, mainly distributed in South America, Australia, the United States and China, of which Australia's lithium production accounts for more than 50% of the world's lithium production.[213] According to the degree of energy intensity, Chapter 4 mainly discusses the relevant situations in Australia, the United States and China, and the situation in the European Union comparing.

4.1 Comparison of mineral resources situation and policies

Australia is an important producer and exporter of mineral resources in the world.[214] It is rich in critical minerals. The resource reserves of gold, iron ore, lead, nickel, tantalum, uranium, zinc, and zircon rank first in the world, and there are 8 types of bauxite. Its resource reserves rank second in the world.[215] The output of 20 mineral products including lithium ranks among the top five in the world.[216] The connection with critical minerals in the EU ,US and Australia are very close, as shown in Picture 2:

[213] US geological survey, 'Mineral Commodity Summaries 2021' (USGS, 1 February 2021) <https://pubs.usgs.gov/publication/mcs2021> accessed 21 May 2024.

[214] The Commonwealth of Australia, 'Australian Critical Minerals Prospectus', 2019.

[215] ibid.

[216] ibid..

Picture 2 The connection with critical minerals in the EU ,US and Australia[217]

	Critical Mineral	U.S. list[5]	E.U. list[6]	Australia's Geological Potential[8]	Australia's Economic Demonstrated Resource[9]	Australia's Production	Global Production	Market Value (Global) (US$m)[10]
1	Antimony	✓	✓	Moderate	138 kt	5.5 kt	150 kt	$185.2
2	Beryllium	✓	✓	Moderate	-	-	230 t	$918.6[11]
3	Bismuth	✓	✓	Moderate	-	-	14 kt	$69.2
4	Chromium	✓		High	-	-	31 000 kt	$4,705.3
5	Cobalt	✓	✓	High	1221 kt	5 kt	110 kt	$541.8
6	Gallium	✓	✓	High	-	-	495 t	$918.6[11]
7	Germanium	✓	✓	High	-	-	134 t	$918.6[11]
8	Graphite	✓	✓	Moderate	7140 kt	0	1200 kt	$1,076.1
9	Hafnium	✓	✓	High	756 kt	-	-	$918.6[11]
10	Helium	✓	✓	Moderate	-	4 hm^3	160 hm^3	$591.0
11	Indium	✓	✓	High	-	-	0.72 kt	$918.6[11]
12	Lithium	✓		High	2803 kt	14.4 kt	43 kt	$1,430.6
13	Magnesium	✓	✓	Moderate	-	0	1100 kt	$716.4
14	Manganese	✓		High	231 000 kt	3200 kt	16 000 kt	$5,443.7
15	Niobium	✓		High	216 kt	-	64 kt	$1,709.5[12]
16	Platinum-group elements	✓	✓	High	24.9 t	2.6 t	200 kt	$19,316.6
17	Rare-earth elements	✓	✓	High	3270 kt	14 kt	130 kt	$415.4[13]
18	Rhenium	✓		Moderate	-	-	52 kt	$918.6[11]
19	Scandium	✓	✓	High	-	-	-	-[13]
20	Tantalum	✓	✓	High	55.4 kt	-	1.3 kt	$1,552.9
21	Titanium	✓		High	Ilmenite: 276 500 kt Rutile: 32 900 kt	Ilmenite: 1400 kt Rutile: 300 kt	Ilmenite: 6700 kt Rutile: 750 kt	$1,609.9
22	Tungsten	✓	✓	Moderate	386 kt	0.11 kt	95 kt	$164.0
23	Vanadium	✓	✓	Moderate	3965 kt	0	80 kt	$1,709.5[12]
24	Zirconium	✓		High	52 662 kt	600 kt	1600 kt	$1,003.4

As a federal country, Australia, in addition to federal laws and regulations, states have also promulgated mineral-related policies.[218] For example, South Australia enacted the Mining Act in 1971 and Western Australia enacted the Mining Act in 1978.[219] Since then, they have also continued to enact mining laws based on economic and social development.[220] Amended to provide a framework for regulating mineral exploration and mining. Australia's policy on critical minerals was formulated relatively late at the federal level.[221] In 2019, the first list of critical minerals and the Critical Minerals Strategy was formulated to accelerate the layout of the critical minerals strategy.[222] In 2020, the Australian Department of Industry, Science and Resources established the Office of Critical Minerals, which is responsible for formulating national policies and strategic recommendations, coordinating Australia's critical mineral industry, and conducting international cooperation.[223] In 2022, Australia released a new list of critical minerals, formulate a new critical minerals strategy, and promote earlier implementation of projects

[217] ibid.

[218] Mills Lisa Nicole, 'Getting closure? Mining rehabilitation reform in Queensland and Western Australia.' (2022) *The Extractive Industries and Society*.

[219] ibid.

[220] ibid

[221] ibid

[222] The Commonwealth of Australia, 'AUSTRALIA'S CRITICAL MINERALS STRATEGY' (2019) <https://apo.org.au/sites/default/files/resource-files/2019-03/apo-nid227646_1.pdf> accessed 20 May 2024.

[223] Australian Department of Industry, Science and Resources, Critical minerals strategy (2022).

through government investment. For example, it established a critical minerals fund to help finance critical minerals strategic projects.[224]

During the World War Two and the Cold War, out of the need to reserve strategic military materials, carry out arms races, and ensure national security, the U.S. Military Commission issued the Strategic and Crisis Raw Materials Reserve Act in 1939, which included antimony, chromium, mercury, Nickel, tin and tungsten are listed as strategic raw materials.[225] In 1974, the Task Force established to implement the National Security Study Memorandum: Critical Imported Materials was issued, listing minerals such as bauxite, chromium, and platinum as critical minerals that needed to be protected and preserved.[226] In 1979, the U.S. Military Commission amended the Raw Materials Reserve Act and classified 28 raw materials such as beryllium and bismuth as strategic and crisis raw materials.[227] Since 2008, the United States has upgraded the supply guarantee of critical minerals to a national strategic level.[228] The U.S. Geological Survey has identified a list of 11 critical strategic high-tech minerals, including rare earth metals, lithium, platinum group, niobium, tantalum, vanadium, titanium, gallium, indium, manganese, and copper.[229] In 2010, the U.S. Department of Energy publicly released a U.S. critical minerals research report, listing rare earth, lithium, cobalt, gallium, indium, tellurium, etc. as critical minerals for protection.[230] In 2018, the U.S. Department of the Interior officially announced a list of 35 critical minerals based on the supply and demand situation and production concentration, combined with U.S. policy priorities.[231] In 2022, by the instructions of the U.S. Energy Act of 2020, the Department of the Interior updated the critical minerals catalog and increased the number of critical minerals to 50 types.[232]

China is the largest producer of mineral resources, the largest consumer of mineral raw materials, and the largest importer of mineral products in the world today.[233] The term ‘strategic minerals’ has always been a Chinese official term. On April 11, 2001, the State Council approved the national mineral resources plan and authorized the former Ministry of Land and Resources to issue and implement it, requiring ‘implementation of important mineral reserves and protective mining of strategic mineral resources’.[234] The National Mineral Resources Plan (2008-2015) clearly states that it is necessary to ‘implement a strategic mineral reserve system’ and ‘promote the establishment of mineral resource reserves for critical minerals such as petroleum, special and scarce coal types, copper, chromium, manganese,

[224] ibid.

[225] Gregory Wischer and Morgan Bazilian, ‘The Rise of Great Mineral Powers’ (2024) <https://media.defense.gov/2024/Mar/11/2003410998/-1/-1/1/VIEW%20-%20WISCHER%20&%20BAZILIAN.PDF> accessed 21 May 2024.

[226] ibid.

[227] ibid.

[228] ibid.

[229] ibid.

[230] ibid.

[231] ibid.

[232] Huo Wenmin, Chen Jiabin, Nie Binhan. ‘Research on the evolution of key mineral strategies and policies in the United States - Enlightenment on ensuring the supply of mineral resources in my country’ (2023) 36(09) *China Land and Resources Economy* 40-46.

[233] Chen Congxi, et al., ‘International comparative study on the concept of strategic minerals and mineral species catalog’ 30(01) (2024) *Journal of Central South University* (Social Science Edition) 87-98.

[234] ibid.

tungsten, and rare earth' [235]. National Mineral Resources Planning (2016-2020) clarifies the strategic mineral catalog, containing a total of 24 mineral species.[236] China's current annual consumption of mineral resources is equivalent to that of the United States, and the European Union, the total annual consumption of major economies is shown in Picture 3 below.

Picture 3 Annual consumption of mineral resources among the EU, US and China.[237]

Number	Comparative classification	Minerals
1	China has advantages and the United States or the EU are highly dependent on China	Rare earth, graphite, fluorite, barite, antimony, vanadium, molybdenum, germanium, gallium, cesium, tellurium, arsenic
2	China has advantages in minerals, but the United States or the EU are less dependent on China	Tungsten, indium, bismuth, magnesium, titanium, rhenium, phosphorus
3	China, the United States, and the European Union all have shortages, but the shortage is more serious in China	Iron ore, manganese ore, chromite, copper, cobalt, lithium, potassium salt
4	China, the United States, and the European Union all have shortages	Niobium, tantalum, platinum group metals
5	Minerals that are in short supply in China but not of high priority to the U.S. or EU	Aluminum, tin, nickel, strontium, boron
6	The U.S. or EU have advantages, but China has minerals in short supply	Gold, beryllium, zirconium, polysilicon

4.2 Comparison of critical raw material catalogs and release cycles

A clear national list of critical minerals helps various departments to carry out targeted construction of resource exploration and mining management systems, strategic reserve systems, supply chain risk prevention systems, trade control and

[235] Former Ministry of Land and Resources. 'National Mineral Resources Planning (2008 ~ 2015year)' (7 January 2009) <https://www.mnr.gov.cn/gk/tzgg/200901/t20090107_1989949.html>.

[236] Ministry of Natural Resources of the People's Republic of China, 'National Mineral Resources Planning ' (15 November 2018). <https://www. mnr. gov. cn/gk/ghjh/201811/t20181101_2324927.Html>.

[237] Chen Jiabin, Yu Lianghui. Comparative analysis of mineral resource situations in China, the United States and Europe, (*Beijing Geology Press*, 2020)

safety review systems. At the same time, it can also form long-term market expectations and guide all sectors of society invest technology research and development, capital application, and talent training in critical mineral categories. Under different positions, major countries or regions in the world use different carriers when publishing strategic or critical mineral catalogs. At present, the assessment methods of most countries or regions do not include introduce the catalog changes of other countries into the model, missing the political dimension. In the current context of globalization, the connections between countries or regions are becoming increasingly close, and it is very necessary to incorporate them into the model. Third-party country directories and policies are taken into consideration.

China's strategic mineral inventory is included in the Mineral Resources Plan.[238] China regularly updates the list of critical minerals based on the needs of the national development strategy and changes in the internal and external environment of mineral supply.[239] In 2016, the National Mineral Resources Plan (2016-2020) jointly prepared by multiple ministries and commissions under the State Council defined 24 minerals such as nickel, molybdenum, rare earths, and petroleum as strategic minerals, reflecting the role of critical minerals in national resource security and supporting the economy. strategic position in development.[240] However, China has not updated its strategic mineral catalog after 2020, so the China Geological Survey has proposed a recommended list covering 37 critical minerals through research reports and other forms.[241]

A list of critical minerals in the United States is contained in the Critical Minerals Report.[242] The United States has released its list of critical minerals at irregular times since 2008, but the past six editions of the list have included more categories of critical minerals than the EU list of the same period, especially rare earths, which have been distinguished in detail.[243] The U.S. Department of Energy released the Critical Materials Strategy in 2011, and the U.S. Geological Survey released a list of 50 minerals.[244] According to the Energy Act promulgated by the United States in 2020, the U.S. Department of the Interior should review and update the critical mineral list and methodological system recommended by the USGS at least every three years, and determine the final list after completing public comments and feedback.[245] Therefore, in the future, the critical minerals in the United States Determination will be more regular and systematic.

The Australian government has published a list of critical minerals, which lists metallic or non-metallic materials that are critical to Australia's modern technology, economy, and national security and whose supply chains are vulnerable to

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[238] Ministry of Natural Resources of the People's Republic of China (no. 214).

[239] ibid.

[240] ibid.

[241] Zhang Shenghui, Wang Zhentao, Li Yongsheng, etc. 'China's critical mineral list, application and global pattern' (2022) 42(05) *Mineral protection and utilization* 138-168.

[242] Fortier S M, Hammarstrom J H, Ryker S J, et al, 'USGS critical minerals review' *Mining Engineering*, (2019), 35-47.

[243] ibid.

[244] ibid.

[245] US geological survey, '2022 Final List of Critical Minerals Federal Register Notice' (USGS, 24 February 2022).

disruption.[246] The list was first determined in 2019 and includes 24 critical minerals. It will be expanded to 26 types in 2022 and is consistent with the revised critical minerals strategy in December 2023, increasing mineral types to 30 types. Arsenic, fluorine, molybdenum and selenium, tellurium are added, and helium is removed.[247] In December 2023, while revising the critical minerals list, the Australian government also released a strategic materials list, which lists minerals that are critical to the global transition to net zero emissions and wider strategic applications that are important to Australia. There is demand from international partners, but their supply chains are not currently fragile enough to be considered critical minerals. The list of strategic materials includes aluminum, copper, nickel, phosphorus, tin, and zinc.[248]The list was updated twice in 2023, and the latest version was updated in 2024.

The United States adjusted the 2018 critical mineral catalog in 2022, with an interval of four years.[249] Since the EU launched the Raw Materials Initiative in 2008 and formed a catalog of critical raw materials, it has made modifications and adjustments in 2011, 2014, 2017, 2020, and 2023, with a cycle of roughly three years.[250] China's strategic mineral catalog is updated along with the mineral resource planning. The release cycle is not fixed, and there is no clear provision on the update cycle. The release cycle of the mineral resource plan is generally five years or more.[251] Although the two parties in the United States hold different positions on clean energy issues, Presidents Trump and Biden have successively issued Executive Orders 13953 and 14017 to strengthen the security of critical mineral supply chains. Accordingly, the U.S. Department of Energy has announced support for the U.S.[252] Two policy documents: A Strategy for Critical Minerals and Materials Supply Chains and a U.S. Strategy for Securing Supply Chains for a Robust Clean Energy Transition.[253]

Generally speaking, the positioning of critical minerals, critical raw materials and important minerals in the United States, the European Union, Australia and other countries is to develop high-tech industries and promote low-carbon transformation; while the positioning of China's strategic minerals is related to the stable development of the national economy and national defense security. In terms of release cycle, the release cycle in the United States, the European Union, is 3 to 4

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[246] Geoscience Australia, 'Critical Minerals at Geoscience Australia' (www.ga.gov.au 5 May 2022) <https://www.ga.gov.au/scientific-topics/minerals/critical-minerals> accessed 21 May 2024.

[247] The Commonwealth of Australia, 'Australian Critical Minerals Prospectus Acknowledgements' (2024) <https://igmining.com/epsaveeg/2024/03/ATIC_Australian_Critical_Minerals_Jan_2024-1.pdf> accessed 20 May 2024.

[248] ibid.

[249] Jason Burton, 'U.S. Geological Survey Releases 2022 List of Critical Minerals | U.S. Geological Survey' (www.usgs.gov 22 February 2022) <https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-minerals> accessed 21 May 2024.

[250] European Commission, 'Critical Raw Materials' (single-market-economy.ec.europa.eu 2023) <https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en> accessed 13 May 2024.

[251] Ministry of Natural Resources of the People's Republic of China (no. 214).

[252] National Archives, 'Executive Orders' (Federal Register) <https://www.federalregister.gov/presidential-documents/executive-orders/joe-biden/2021> accessed 13 May 2024.

[253] U. S. Department of Energy, 'Critical Minerals and Materials: US Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains' (2021) and U. S. Department of Energy, 'America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition' (2022).

years, while the release cycle in China is more than 5 years and the release cycle in Australia is not stable.

4.3 Comparison of evaluation method of strategic or critical raw materials

The evaluation method of strategic or critical materials directly determines the types of minerals entered into the catalog, reflecting the definition and positioning of related minerals in major countries or regions in the world. Due to the extent of information disclosure, relevant documents on Australia's assessment of strategic minerals or critical minerals are not yet available, while the United States, China and the European Union have issued clear assessment methodology documents.[254] Combined with China's determination method of strategic minerals and based on the evaluation processes of major countries or regions in the world, the currently known evaluation methods can be summarized as three models: 'three dimensions', 'two dimensions' and 'three steps', respectively based on the United States, the European Union and China are represented.[255]

The definition of critical minerals in the United States is characterized by joint multi-agency actions.[256] In 2008, the U.S. National Research Council (URC) made the first attempt to define the criticality of mineral raw materials and recommended the introduction of subdivision indicators from two aspects: supply risk, also known as the possibility of supply disruption, and economic vulnerability, also known as the economic consequences of supply disruption. On this basis, the United States Geological Survey (USGS) introduced a new dimension of trade risk in 2021, expanding the mineral criticality assessment system to three dimensions.[257] In the new assessment system, USGS recommends reflecting supply in the definition of mineral criticality Based on recent events and multi-year trends, the critical minerals identified in the United States are the weighted results of assessments over the past four years.[258] The EU's methodological design was initially undertaken by the Ad-Hoc Working Group on Defining Critical Raw Materials (AHWG-CRM) by the European Commission in 2011. The overall framework is similar to the system recommended by the U.S. URC, and was used in the second meeting of 2014. Under evaluation.[259] In 2017, The Joint Research Center (JRC) has updated the methodological framework to make the evaluation system more EU-specific in the following three aspects: first, focusing on the sustainability of EU bilateral supply chains and global supply chains; second, integrating trade agreements into the impact is included in the assessment dimension of supply risk; third, the significant impact of recovery rate on the

[254] See USGS List of Critical Minerals, China National Mineral Resources Planning and the EU CRMA.

[255] ibid.

[256] Nedal T., Nassar and S. M. Fortier, 'Geopolitics of the Methodology and Technical Input for the 2021 Review and Revision of the US Critical Minerals List' (*USGS*, 7 May 2021) <https://pubs.usgs.gov/publication/ofr20211045> accessed 21 May 2024

[257] ibid.

[258] ibid.

[259] GianAndrea Blengini and others, 'EU methodology for critical raw materials assessment: Policy needs and proposed solutions for incremental improvements' (2017) 53 *Resources Policy* 12-19

criticality of minerals is considered.[260] China mainly takes three major steps when identifying strategic minerals.[261] First, conduct a preliminary analysis of the minerals that have been discovered in China and select critical mineral species for evaluation; second, use a combination of subjective and objective methods such as mathematical evaluation methods, qualitative analysis of single mineral species, and expert questionnaires to determine strategic mineral types; Third, the final catalog is determined based on the evaluation results of the three methods.[262] Among them, the mathematical evaluation method is the core of determining mineral types, focusing on five aspects: supply risk, economic importance, importance of strategic emerging industries, importance of national defense and military industry, and the degree of advantageous minerals. Five sets of evaluation index systems are established, using Analytical hierarchy process is used to evaluate the importance of mineral species. Among them, supply risks include domestic supply risks, overseas acquisition risks and international market risks. Economic importance involves economic contribution, economic value of resources and future demand trends.[263]

Although the three models of evaluation of the United States, the European Union, and China are not exactly the same, they share commonalities, including the following critical aspects:

First, multidimensional factors are considered. It can be seen that regard for national economic security, and supply risks, as well as their strategic significance, is a necessary dimension, regardless of it being strategic minerals, critical minerals, or critical raw materials. Second, they are dynamically adjustable. The evaluation methods in the United States, the European Union, and China are not immutable. They form based on experience learned in practice and are constantly improved with the changing environment and policy adjustments. Third, in terms of evaluation methods, absolute standards are adopted. The catalog can be set up by creating thresholds through certain criteria, and reaching these thresholds is a necessary condition for joining the catalog. The evaluation process is also divided into two stages: pr-selection and in-depth research, and finally, the final catalog is formed through extensive solicitation of opinions.

4.4 Concluding remarks

This chapter's comparison of the EU, US, China, and Australia reveals significant differences in resource management and legal strategies between these countries. The EU, like the United States, focuses on internal resource development and technological innovation, China ensures resource supply through global resource procurement and foreign investment, and Australia uses its rich mineral resources to promote economic development through exports. The catalogs of critical raw material and release cycles among these economies is sightly different. The

[260] European Commission, 'Methodology for Establishing the EU List of Critical Raw Materials – Guidelines' (2017).

[261] Zhang Shenghui (no. 115).

[262] ibid.

[263] ibid.

evaluation method of strategic or critical materials is quite different. These different strategies provide valuable experience for future EU CRMA implementation.This chapter can also be summarized via the following Table 3:

Table 3 Comparison of critical materials' law and policies among the EU, US, China and Australia[264]

Economies		EU	US	China	Australia
Commonalities	Multidimensional factors are considered in evaluation methods				
	Valuation methods are dynamically adjustable				
	Absolute standards are adopted in evaluation methods				
Differences	Critical materials' law and policies	A regulation which is the EU Critical Raw Materials Act	Federal laws and regulations, states have also mineral-related policies	Administrative regulations issued by the State Council	Federal laws and regulations, states have also mineral-related policies
	The catalogs of critical raw material and release cycles	EU CRMA clarifies the critical raw materials and Strategic raw materials catalog.Release cycle is about 3 years per edition.	The Department of the Interior updated the critical minerals catalog and increased the number of critical minerals to 50 types.Release cycle is about years per edition.	National Mineral Resources Planning (2016-2020) clarifies the strategic mineral catalog, containing a total of 24 mineral species.Release cycle is about 5 years per edition.	Australian government released a strategic materials list.Release cycle is not stable.
	Evaluation methods	Two dimensions	Three dimensions	Three steps	Not yet available

[264] Elaborated by the author.

5 Summary and Conclusions

As for the newly introduced regulation, the EU has outlined the Critical Raw Materials Act. This act is to guarantee the security, resilience, and sustainability of the EU's supply of critical raw materials. Mainly, the content of the act includes establishing a more stringent resource supply chain supervision mechanism, promoting the efficient use and recycling of resources, and reducing dependence on a single supplier country. Three questions were raised regarding this new regulation: Why does the EU introduce the EU CRMA? What are the challenges to implementing the EU CRMA? What are the commonalities and differences between the EU CRMA and its trading partners' critical materials instruments (the United States, China, and Australia)?

The background to the introduction of the act is multi-faceted. First, the global demand for clean energy and low-carbon technologies has increased sharply, leading to rising market demand for these resources and price fluctuations, which may affect the industrial development and implementation of energy transition policies within the EU. The EU's green and digital transformation strategic goals are inseparable from the stable supply of critical raw materials. Secondly, the global market for critical mineral resources is highly concentrated, with most reserves of critical minerals concentrated in a few countries. This poses potential risks to the EU's supply security, and the EU needs to maintain strategic autonomy. Finally, the EU green industry-related acts directly promote the introduction of the critical raw materials act.

However, the implementation of the Critical Raw Materials Act also faces many challenges. For example, there may be uncertainties between the Commission and member states during the implementation process, and differences in resource policies and economic interests among different member states may lead to inconsistent implementation. In addition, the systematic price formation mechanism established in the act is not yet complete and may not effectively reflect changes in market supply and demand. Although corporate reporting obligations help improve transparency, they may also increase the operating costs of enterprises, especially small and medium-sized enterprises. Furthermore, although establishing a local raw material supply chain can reduce reliance on external supplies, it may encounter multiple technical, financial, and policy resistances in practice. Insufficient recycling capacity of critical raw materials is also a problem, requiring significant investment to establish an effective recycling system. In addition, substantial financial investment is required to support the implementation of the act, and funding shortages may become a constraint. Finally, although establishing strategic partnerships with other countries can help diversify the supply of resources, there are also uncertainties about the stability and sustainability of such partnerships.

In response to these challenges, the thesis proposes a series of strategies and recommendations. First of all, it is recommended to strengthen the coordination

and cooperation of domestic, EU and international policies to ensure the consistency and efficiency of the implementation of the act. Secondly, it is recommended to optimize the economic incentives in the EU CRMA to reduce compliance costs for enterprises. Thirdly, promotes technological innovation and improves the recovery rate and reuse efficiency of critical raw materials, which can not only reduce dependence on original resources but also help environmental protection. In addition, strengthen diplomatic and trade relations with critical mineral resource countries to establish long-term and stable supply chains.

Comparing the critical minerals legal approaches of the United States, China, and Australia reveals significant differences in the resource management and legal strategies of these countries. The United States usually focuses on the development of domestic resources and technological innovation, while China ensures resource supply through global resource procurement and foreign investment, and Australia uses its rich mineral resources to promote economic development through exports. These different strategies provide valuable lessons for the EU.

Overall, despite some shortcomings and challenges, the EU's Critical Raw Materials Act is a forward-looking policy aimed at ensuring that the EU remains competitive in the global energy transition and improves the efficiency and circularity of the value chain. This will not only help ensure the EU's energy security but also help promote the development of clean energy and low-carbon technologies globally.

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