Lund University
Department of Political Science

SIMZ11
Supervisor: Hyeyoon Park

European Union's Achilles' Heel

Securing the supply of critical raw materials

Author: Karla Jozic

Abstract

This paper examines the policy measures employed by the European Union (EU) to mitigate external risks to the supply of critical raw materials (CRMs). The research makes an informed overview on the dynamics of contemporary international relations and challenges it may pose for EU's CRM supply security, necessary for its green transition, against the backdrop of the *complex interdependence theory*. The main theoretical framework is formed around the concept of *supply security* with three external threats—dependence, political risks, and lack of diversification— serving as criteria for the analysis. The first two factors are discussed in the context of the EU's reliance on other nations for CRMs while diversification is examined by analyzing EU – published documents, such as proposals, regulations and staff working documents, as well as initiatives aimed at addressing the Union's dependence. Two levels of focus of action are international and domestic. Lastly, the paper reflects on some of drawbacks and remaining challenges of the current EU policy measures.

Key words: critical raw materials, supply security, EU, dependence, diversification, political risks, strategies, challenges

Word count: 19 752

Abbreviations

Belt and Road Initiative – BRI

Critical raw materials – CRMs

Critical Raw Materials Act – CRMA

Democratic Republic of the Congo - DRC

Document analysis – DA

Electric vehicles – EVs

European Green Deal - EGD

European Union – EU

Green Deal Industrial Plan – GDIP

Herfindahl-Hirschman Index – HHI

Important Projects of Common European Interest - IPCEIs

International Atomic Energy Agency – IAEA

International Energy Agency – IEA

Inflation Reduction Act – IRA

International Renewable Energy Agency – IRENA

Memorandum of Understanding – MoU

Net Zero Industry Act – NZIA

Rare earth elements - REEs

United Nations Development Program – UNDP

United Nations Stabilization Mission in the Democratic Republic of the Congo – MONUSCO

Table of contents

1. Introduction

Supply security of renewable energy sources has become a crucial topic of discussion among states, international organizations, and international and regional forums lately. The field of energy supply security has up until recently been substantially saturated with the research and emphasis on oil and gas as the indispensable energy resources in the modern world (Westphal, 2006; Correlje and van der Linde, 2006; Aslantürk and Kıprızlı, 2020). Although it is unlikely these resources will cease to be exploited, recent times have witnessed a sharp turn to more sustainable and energy efficient resources that have the potential of replacing the former. Adverse impact of extraction and production of oil and gas prompted policy makers to devise and put forward proposals and initiatives set to manage a man-driven phenomenon – *climate change*. To tackle the challenges brought on by climate change, the focus has been shifted to renewable sources of energy, or colloquially known as *green energy*. Solar and wind energy, electrification of transport, carbon capture and storage among other all rely on the same elements to varied agrees – *critical raw materials,* henceforth CRMs.

As a *catchphrase*, renewable energy has grown to become a key focus for governments and organizations all over the world. Numerous countries and institutions have acknowledged the need to lessen reliance on non-renewable energy sources, which help drive global warming, as the detrimental impacts of climate change become more obvious. Shift to renewable energy can change how nations and regions interact with their external energy markets and exert impact on a global scale (Sattich et al, 2021, p. 1). The emerging energy policies thus cannot be understood in isolation from what is happening in the global system. Global energy interactions take shape along the contours of the present and future global political and economic systems (Correlje and van der Linde, 2006, p. 533). With the growing demand for renewable energy and limited availability of CRMs, the EU is increasingly reliant on external sources to meet its renewable energy needs for deployment of solar photovoltaic (PV) panels and wind turbines, the storage of electricity in batteries and the use of heat pumps for cost-effective heating and cooling, and other technologies

(Carrara et al., 2023, p. 4). This dependence on external sources, coupled with the current geopolitical tensions, presents significant challenges to the EU's energy and resource security. Hence, as argued by Correlje and van der Linde (2006), taking into account *external factors*, namely relations among global actors and evolving balance of power, is necessary for research of resource supply security. Depth of existing rivalries over resource availability, excessive reliance on a handful of exporters and the urge to achieve energy independence have (re)surfaced. This set in motion a race for CRMs – metals and minerals that are economically significant, have a high supply risk, and are vital to the operation and integrity of a variety of industrial ecosystems (European Commission, 2020a, p. 1).

The EU has acknowledged the importance of CRMs in preserving economic development and competitiveness in recent times as they are indispensable in a wide range of high-tech goods, including phones, EVs, and renewable energy systems (European Commission, 2020a). Because many of these commodities are produced in countries with uncertain political climates or are subject to trade barriers, such as those imposed by China, India, Russia and Argentina, EU's increased need for them has raised worries about their supply (Kowalski and Legendre, 2023). To combat these external risks to its energy and resource security, the EU has established a number of policies and initiatives, accompanied by supporting documents, targeted at ensuring a consistent and long-term supply of CRMs. At the international level, the EU has recognized the relevance of forming alliances with other likeminded nations, by means of Global Gateway Initiative among others, in order to expand collaboration on raw material supply and trade as a means of mitigating supply disruptions. At domestic level, these strategies include recycling and expanding local manufacturing capacity.

Main objective of this research is to comprehend how a quite sudden realization of CRMs' significance has stimulated interest in re-examining the issue of supply security and has prompted EU to reconsider its approach to dealing with threats from third parties, i.e., external risks to the security of CRM supply. This calls for examining those same threats, reviewing EU response, and discussing what should be put to the forefront. In other words, the aim is to gain a better grasp of *how the EU has responded to the external threats to supply security of CRMs, and what challenges remain to be*

addressed. CRMs shape the trajectory of EU actions in achieving its objective of becoming the first climate neutral continent as various industries, especially those centered on clean energy, depend on a steady supply thereof (European Commission, 2019).

The scope of the paper is thus *threefold* with each part focusing on one aspect of the research question. The first part, after the contextual background and conducted literature review which guides the analysis, investigates threats to the EU's supply security of CRMs: *dependence* and *political risks* which are both a result of the *absence of source diversity.* This will give a better understanding of what EU is currently confronted with. The analysis of the EU's response to supply security concerns is the focus of the second part of the research. It examines the various strategies, such as proposed policies, regulations and initiatives the EU has implemented or aims to put into effect to mitigate the risks associated with supply of CRMs. The comprehensive overview is given by employing the SWOT analysis framework, aiming to bridge an existing gap in literature and help define a development strategy (Fertel et al., 2013). Finally, the fundamental shortcomings and constraints of the analyzed policies and initiatives are addressed briefly in the research by pointing out areas that require additional examination. The evaluation of these measures' efficiency and identification of potential contribution to those not already set in stone is the main objective of this part.

2. EU's critical raw materials dilemma

EU has established a legally binding objective of being climate-neutral by 2050 as part of what is known as the European Green Deal (EGD) (European Commission, 2019). It calls for large reductions in present greenhouse gas emissions over the next few decades. To boost its aspirations, it set an intermediate aim of decreasing emissions by at least 55% by 2030. As part of the Fit for 55 package, a set of recommendations for updating and revising EU law, EU is amending its regulations in the areas of climate, energy, and transportation to meet these aims. This initiative tries to integrate current legislation with 2030 and 2050 goals by adopting a proactive approach to

climate change (European Commission, 2019, Domaracka et al., 2022, pp. 2 – 3). In essence, EGD seeks to transform the European economy and consumer behaviors. Yet, given its importance on the EU policy agenda and the necessity for a full reorganization of the European energy system, it will change the dynamics between the EU and surrounding nations, as well as reshape Europe's worldwide policy ambitions, as measures for securing CRMs will cause counter initiatives on a global level (Leonard et al., 2021, p. 4). This makes EGD a foreign policy with far-reaching geopolitical ramifications (Leonard et al., 2021, p. 2). A greener Europe, dependent on imports for clean energy and technologies, will call for the establishment of novel trade, investment deals, the creation of innovative forms of technical and financial assistance, and an alternative approach to international diplomacy, all with the goal of promoting long-term growth and investment (Leonard et al., 2021, p. 3).

Nevertheless, EGD has already introduced new supply security risks, owing especially to the import of minerals and metals required to produce a variety of renewable technologies: solar panels, wind turbines, lithium-ion batteries, fuel cells, and electric cars. The worsening climate challenges are forcing a significant transition in the global energy landscape, implying that conventional fossil fuels such as coal, oil, and natural gas will be phased out as principal sources of energy supply (Kalantzakos, 2020, p. 6). As a result, there is a growing emphasis on developing and installing carbon-neutral renewable energy technologies. This shift to renewable energy is critical for long-term sustainability and lessening the world's dependency on fossil fuels (Wang et al., 2021, p. 2).

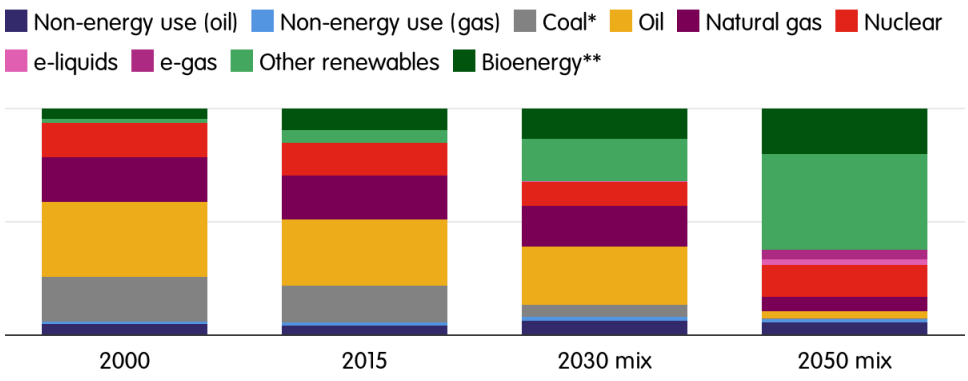

Figure 1. Evolution of the EU energy mix (Leonard et al., 2021, p. 5).

As can be seen from the *Figure 1*., indicated in light green, renewable energy technologies will represent the majority of EU's energy sources by 2050. The EU's objective of making renewable energy the dominant source of energy by 2050 will necessitate considerable efforts to get the CRMs required for these technologies. However, these materials have specific properties and few to no substitutes, posing a severe threat to Europe's energy security (Leonard et al., 2021, p. 11; Lewicka et al., 2021, p. 1). As geopolitical tensions and trade conflicts escalate, EU is increasingly concerned about its reliance on imports of these commodities (van Wieringen and Fernandez Alvarez, 2022; Domaracka et al., 2022, p. 3). According to current trends, political and commercial entities are worried that the use of renewable energies and EU's technical edge may be jeopardized owing to high raw material costs and scarcity. Several reasons contribute to this fear, including growing demand for technologically advanced applications in emerging countries and a small number of enterprises and governments controlling the production and supply of CRMs (Rabe et al., 2017, p. 693).

The stability of supply chain of CRMs has long been a source of worry. Indeed, the European Commission acknowledged the importance of these resources in 2011 when it issued a list of 14 key raw materials, underlining the importance of a dependable and sustainable supply chain crucial for development of new technology (Reisch, 2022, p. 1). This can be seen by examining the recently published list of CRMs as the number of raw materials listed has grown exponentially over the years. For comparison, below listed are CRMs list from 2011 (*Table 1*) and 2023 (*Table 2*). However, despite the

efforts to diversify its suppliers, EU's reliance on third nations, namely China, has grown over time (Reisch, 2022, p. 3).

Antimony	Germanium	Platinum group metals
Beryllium	Graphite	Rare earth elements
Cobalt	Indium	Tantalum
Fluorspar	Magnesium	Tungsten
Gallium	Niobium	

Table 1. List of CRMs 2011 (European Commission, 2011).

Antimony	Gallium	Phosphate rock
Arsenic	Germanium	Phosphorus
Bauxite/Aluminium	Hafnium	Platinum Group Metals
Baryte	Helium	Scandium
Beryllium	Heavy Rare Earth Elements	Silicon Metal
Bismuth	Light Rare Earth Elements	Strontium
Boron/Borate	Lithium	Tantalum
Cobalt	Magnesium	Titanium Metal
Coking Coal	Manganese	Tungsten
Copper	Natural Graphite	Vanadium
Feldspar	Nickel (battery grade)	Rare Earth Elements for magnets (*)
Fluorspar	Niobium	

(*) Neodymium, Praseodymium, Terbium, Dysprosium, Gadolinium, Samarium, and Cerium

Table 2. List of CRMs 2023 (European Commission, 2023a).

The race for CRMs prompted other nations, including the US and Canada, to reevaluate their position in the CRMs supply chains, facilitating the competition and partnering up. Additionally, there are conversations in Africa and Latin America about enhancing regional cooperation. Such trend of looking for likeminded partners around the world became prevalent in EU measures as well. Simply owing to limited geological availability of CRMs, EU will continue to rely on imported CRMs. However, the nature of cooperation with the sourcing countries will shape EU's dependencies amid growing geopolitical tensions (Reisch, 2022, p. 3).

The present significant geopolitical upheaval is the rise of China, threatening the old industrial powers (the US, the EU and Japan) and disrupting the current order as its

economic and technological might expands swiftly and massively. At the political level, the EU has made steps to deal with its fears about China's trade policies, as those have grown into a source of dispute in recent years. The EU, alongside the US and Japan, filed a complaint against China's rare earth export restrictions at the World Trade Organization in 2012. The goal was to challenge China's prohibitions on the export of certain minerals and prove that the EU was willing to address obstacles to trade. The WTO later found that the restrictions were not tied to conservation measures, but rather to accomplishing industrial policy goals, thereby breaking international trade law. This decision sent an unambiguous signal to China that the EU would oppose such restrictions (Rabe et al., 2017, pp. 695 - 696). This historical event illustrates a larger shift in the EU's assessment of China as a potential economic and strategic foe in the context of CRM value chain, which became more visible in EU measures aimed at derisking its relationship with China through source diversification.

Since 2013, China's rise and global reach became evident through its massive international infrastructure program – *Belt and Road Initiative (BRI)* (Russel and Berger, 2020). According to its *win-win vision*, BRI aspires to enhance financial, trade and social connectedness, deal with infrastructure funding and development, synchronize policies, and encourage financial integration (Russel and Berger, 2020, p. 7). As a result, BRI represents a substantial shift in the global economy and has the potential to influence the future of global commerce and collaboration (Kalantzakos, 2020, p. 2; Theodosopoulos, 2020, p. 1). China's BRI, however, depends heavily on CRMs listed in *Table 2*. Because of its objectives to lead in innovation, digitization, and green economy, China has increased its focus on key minerals, essential to the creation of green technologies and renewable resources. As a result, the implications for availability of these materials, critical for the *next industrial revolution,* have grown (Kalantzakos, 2020, pp. 2 – 3). Chinese companies, for instance, have made large investments in mining in South America and Australia to cement their position in downstream sectors and maintain control of the whole supply chain. Tianqi Lithium, a Shenzhen Stock Exchange-listed firm, purchased the second-largest ownership in Sociedad Qumica y Minera, a Chilean mining business, in 2018. In addition, Tianqi Lithium owns 51% of the world's biggest hard-rock lithium mine at Greenbushes,

Western Australia. Via those investments, Chinese corporations hope to preserve their dominating position in downstream sectors and gain more control over the supply of critical minerals needed in batteries and electric cars, such as lithium (Kalantzakos, 2020, p. 7).

Besides extraction, China dominates another stage of the CRMs value chains: *processing*. Europe has grown more concerned over China's *Made in China 2025* ambition, a state led initiative that could eventually replace foreign technology with domestic alternatives and penetrate international markets, potentially upsetting the global economy and damaging European technical competitiveness (Kalantzakos, 2020, p. 2; Rabe et al., 2017, p. 695, McBride and Chatzky, 2019). China has the monopoly over processing and refining of certain CRMs, currently the most congested stages in global CRMs value chains (Carrara et al., 2023, pp. 21 – 22). EU CRMs geological availability, as argued before, is miniscule. Hence, investing in mining projects alone is insufficient if the recovered ore must be shipped for further processing. Establishing a strong and secure supply chain, requires identifying vulnerabilities at the processing level. A more complete European plan would include investments in domestic processing and refining capabilities in order to lessen reliance on overseas supplies and gain better control over the CRM supply chain (Theodosopoulos, 2020, p. 5). As will be shown later, EU measures are directed in a similar manner, focusing on domestic supply of CRMs as well.

On the other side of the globe, the US has exhibited its strength as well. A recently introduced legislation dubbed the 2022 US IRA seeks to lower inflation while strengthening climate actions. However, it also contains trade-distorting subsidies that may go against the rules of international trade and lead to protectionism in other nations. The scale of the green subsidies in IRA is comparable to that of the EU, although there are some significant variations. EU subsidies have an emphasis on innovation and do not disadvantage foreign producers, in contrast to the IRA concentration on widespread adoption of green technologies which might make Europe less competitive (Kleimann et al., 2023, p. 1). IRA includes a commitment to increase domestic production of CRMs such lithium, nickel, manganese, and graphite. This pledge intends to offer the funds necessary to assist the rapid expansion of EVs,

batteries, and infrastructure for the generation of renewable energy (Bazilian and Brew, 2022). EVs must source at least 40% of their CRMs from the US or a nation with which the US has a free trade agreement to qualify for subsidies according to the IRA. President Biden and President von der Leyen agreed to engage in conversations regarding a raw material deal in March 2023 to make vehicles with minerals supplied or processed in Europe eligible for advantages under this agreement (Reuters, 2023). In other words, CRMs sourced and processed domestically by the EU are becoming ever more important to preserve its competitiveness, especially given the possibility that the US-EU raw material agreement will open new opportunities for EU businesses to export products to the US market.

Rapid economic expansion and fast technical breakthroughs have changed the demand for many metals and minerals dramatically. Moreover, CRM markets are progressively migrating to Asia, with China playing a key role. This trend has created worries about supply security for developed economies, especially the EU. When dominant producers control a large portion of the worldwide supply of these commodities, they can put pressure on reliant importers by putting at risk, i.e., limiting or cutting off their supply. This pressure can be utilized to advance geopolitical goals or as a bargaining chip in trade talks. As a result, the potential of CRM supply interruptions has grown for import-dependent countries and regions, posing serious consequences for their businesses and economies. As a result, developing and implementing plans to assure the security of supply for mining raw materials is critical (Lewicka et al., 2021, p. 1). Mineral-rich areas in Europe, such as the Fennoscandian, Iberian, and Carpathian-Balkan belts, are promising sites for resource exploitation. However, ensuring an adequate quantity of raw materials from primary sources within the EU is complicated by variables including land accessibility, national legal limits, and popular opposition (Lewicka et al., 2021, p. 13). Given the obstacles faced on international and domestic levels, the EU decided to take steps to safeguard its access to CRMs, aiming to do so quickly and effectively.

3. Literature review

This section serves as an overview of some academic debates on *complex interdependence theory* and literature review of the concept of *supply security.* As was already mentioned in the introduction, the theory will serve as an overarching theoretical framework, making the research more informed by shedding light on how various factors in international relations can affect EU's supply of CRMs. The theory will imply to what extent EU policies and initiatives are shaped and determined by external factors, such as the region's dependence on imports and other countries' political stability. By employing this theory, the aim is to gain a deeper understanding of complex international political dynamics of resource supply and adherent strategies aimed at securing it.

3.1. Complex interdependence theory

The paper makes use of the complex interdependence theory to understand EU policies and initiatives aimed at diversifying its suppliers of CRMs. The goal is to explain how the energy related interactions between the EU and countries it depends on for sourcing CRMs has the potential to shape EU's measures.

Robert O. Keohane and Joseph S. Nye created the theory of complex interdependence in the late 1970s, which posed a significant challenge to the basic principles of traditional and structural realism that relied on military and economic power to explain state behavior. They highlighted the emergence of international regimes and institutions as important players in foreign policy matters, while downplaying the importance of status and security issues and emphasizing the significance of welfare and trade (Rana, 2015, p. 290; Keohane and Nye, 2011). According to Keohane and Nye, in the age of interdependence, the fundamental nature of international relations has transformed, and the world has become increasingly

interdependent, particularly in economic terms. In this state of mutual dependence, the connection between the various actors, including both states and other non-state entities, is marked by a mixture of collaboration and rivalry. Within such interdependent framework, there are significant reciprocal effects resulting from transactions between the actors, which can be costly. The decisions and behaviors of one actor can have a profound impact on the decisions and behaviors of other actors, and *vice versa* (Rana, 2015, pp. 290 – 291; Keohane and Nye, 2011; Coate et al., 2015, p. 2).

In their renowned analysis of *power and interdependence*, Keohane and Nye (2011) distinguish between two forms of interdependence: *symmetrical* and *asymmetrical*. Symmetrical interdependence implies that two both states are equally dependent on one other, so that the relationship's dissolution would have an equal impact on both parties. Asymmetrical interdependence, on the other hand, occurs when one state is much more dependent on the other, providing the less dependent counterpart with political influence over the more dependent. This can cause anxiety and escalate tensions and conflict between governments (Krickovic, 2015, p. 6; Sattich et al., 2021, p. 3). However, in complex interdependence scenarios, determining which party is more dependent on the other can be challenging due to the dispersed nature of dependence across various dimensions. Zhao (2019, p. 111) gives an example of China's energy shortage causing an economic downturn, which in turn would have an adverse effect on the expansion of the world economy. In the global energy market, both energy importing and exporting actors are unavoidably mutually reliant, i.e., interdependent (Zhao, 2019, p. 111).

The possibility of one state exploiting the other's dependence for political gain, as the first state might be reliant on the second in a different context thus decreases. For example, China's greatest commercial partner is the EU, with two-way trade amounting to almost €700 billion in 2021. While the EU relies on China as a market for its goods, China relies on the EU as a provider of foreign investment and technology (European External Action Service, 2022). Additionally, the EU and China have shared goals on climate change, and regional security, which limit their capacity to employ dependence as an instrument of power without jeopardizing their interests in other aspects

(European Commission, 2022a). In other words, since the EU and China have considerable economic, political, and security links, they can be reluctant to utilize dependence as a tool for political pressure (De Paoli et al., 2010). Finding a common ground and bringing together different interests is necessary for maximizing implications of interdependence. This will be shown later on when analyzing EU international strategic partnerships and projects with the goal of diversifying CRMs sources and deepening mutually beneficial interdependence.

According to the theoretical paradigm, conflict, on top of collaboration, nevertheless characterizes contemporary international relations as actors are interdependent and use various means of communication and conduct – from export restrictions to trade agreements. The significance of international organizations and international regimes increases due to multilayered nature of interdependence. They offer decision-making platforms for improving communication and information flows, lowering uncertainty, and providing forums for defining agendas, forming alliances, negotiating, and obtaining influence. They level the playing field in significant ways between players with otherwise different power capacities (Coate et al., 2015, p. 17). By putting this theory into practice, the paper seeks to shed light on how the EU, as an economic and political association of twenty-seven states, manages interdependence and complexity of the global markets and supply chains of CRMs on their behalf, acting in its own right. Additionally, the theory serves as an illuminating scheme as it recognizes the importance of non-traditional issues in shaping international politics, such as climate change (Keohane and Nye, 2011).

As the world is changing, the agenda is adapting to its evolving needs and aims. In this case it is the energy transition which calls for renewable energy-oriented and climate neutral strategies and economy. Keohane and Nye (2011, p. 9) argued: *the resources that produce power capabilities have become more complex*. Military strength and capacity are replaced to an extent by other more relevant power indicators, such as control over critical materials and supply thereof. CRMs are essential for a range of industrial processes and for EU's green energy transition which makes cooperation in the energy sector essential for maintaining both the supply security of energy and the Union's security. Energy trade and interdependence expand as actors

become increasingly interconnected, as maintaining a reliable energy supply, requires producers and consumers cooperating (Zhao et al., 2019, p. 134). This implies that supply challenges or disruptions in one part of the chain can have cascading effects throughout the entire system. In other words, in the context of the EU, CRMs, and security of supply, complex interdependence theory provides a useful lens through which to analyze the various actors and interests involved, and to understand the dynamics of cooperation and conflict that may arise.

The theory suggests that the EU's efforts to secure its supply of CRMs cannot be understood in isolation from the interests and actions of other states and actors - EU's dependence on external sources of CRMs means that it is likely to be involved in a complex web of relationships and dependencies with other states and actors, such as suppliers, customers, competitors, and regulators (Keohane and Nye, 2011). Measuring and focusing on EU's dependence on certain countries for import of CRMs falls out of the scope of this paper. The purpose of this theoretical framework is to provide, in addition to the contextual background, a more insightful means of analyzing EU – published documents in the upcoming sections. Having an idea of how international relations are shaped makes an analysis of EU policies and initiatives more informed when one can reflect on the context underpinning them.

Lastly, later in the research it becomes apparent from examining the remaining obstacles the EU must overcome in order to diversify CRMs sources that interdependence can be leveraged against EU. As the EU broadens its partner nations in the search for diverse sources of CRMs, it unavoidably multiplies the number of actors with various interests. To prevent any unfavorable effects, it is crucial to align their objectives with those of the EU. The complex interdependence theory can be helpful in illuminating the extent to which EU measures that seek to utilize interdependence as a tool by varying CRMs sources might go awry.

3.2. Exploring supply security

As explained above, complex interdependence theory is a valuable lens through which to view the interaction between the EU and its CRMs suppliers. However, the concept of supply security provides greater clarity on the elements that shape this connection. Understanding the multifaceted nature of supply security by examining certain criteria that affect it, helps mitigate the risks and challenges that come with reliance on CRMs. Hence, the second part of the section begins by discussing a few definitions of supply security offered in the academic literature, ultimately providing the version that will be referred to throughout the paper. The discussion then moves on to draw attention to the three key aspects for assessing supply insecurity: dependence, political risks and lack of source diversification. However, it is worth mentioning that the topic of CRMs and related supply security is relatively new and the paper therefore depends on broader, existing literature, greatly focused on other energy resources, such as fossil fuels.

3.2.1. Supply security: A multifaceted concept defined

Majority of the focus in the literature has been on the energy supply security more broadly. The definition put forward by IEA is quite extensive: *energy supply security as the uninterrupted availability of energy sources at an affordable price* (IEA, 2023). Such definition leaves a lot of space for discussion and different interpretations and has been adopted by several scholars (Aslantürk and Kıprızlı, 2020; Azzuni and Breyer, 2017; Jasiūnas et al., 2021; Proskuryakova, 2018). The focus is largely on the economic aspect and pricing of resources. However, one important aspect seems to be absent – *issue of sustainability*. In this research, sustainability is not only linked to the environmental concerns, but encompasses a more extensive understanding of the concept - minimizing waste and increasing the value of resources by extending the lifecycle of materials through techniques like recycling, repurposing, and reusing.

Recycling is a crucial component of *circular economy*, a concept that has gained great importance in the past decade due to its indispensability in securing the supply of CRMs (more on this in Section 5.3.2.1). Therefore, the definition proposed by IEA and embraced by so many might have been suitable for research of supply security of fossil fuels but remains quite limiting in the context of CRMs. The definition of supply security proposed in this paper goes as follows: *supply security involves having access to energy sources that are affordable, continuously available, and sustainable in terms of their (re)use*. This is highly relevant in the context of CRMs because sustainability in their use encompasses one of the solutions to supply security risks: dependence and lack of diversity (Carrara et al., 2023). It coincides with the two ways to look at energy security and its supply as proposed by Costantini et al. (2007, p. 211): *short-term* and *long - term*. In the former case, emphasis is on the immediate effects of unanticipated supply disruptions or price spikes. In the latter case, ensuring there is enough energy to support steady and sustainable economic growth is the main concern in the long run. This research is more oriented towards the long – term supply which depends on the sustainability of use of different resources, while acknowledging some of the short – term implications of supply insecurity, such as price volatility. The following sections provide theoretical overviews of *dependence*, *political risks* and *lack of diversification* as essential variables to consider when evaluating supply security of CRMs, based on the previous academic debates.

3.2.2. Dependence and supply security: understanding the relationship

The degree to which a nation, or in this case a union of nations, is dependent on imports to satisfy its energy demands is demonstrated by its import dependence (Bluszcz, 2016, p. 1537). This implies that if an energy output is insufficient to fulfill the demand of an actor in question, it must import energy from other nations or regions to compensate. The degree of reliance on imported energy varies based on the country (or in this case a union thereof) and the type of energy in consideration (Bluszcz, 2016).

The following section will serve as a brief overview of conceptualization of dependence which is significant for understanding how supply chains work.

The Herfindahl-Hirschman Index (HHI) is one of the most important instruments used by nations, regions, or organizations to evaluate and address the security of supply of various energy resources. Blengini et al. (2017), Nygaard (2022), Wellmer et al. (2019) and Elbassoussy (2019) are just some of the authors that emphasize the relevance of HHI in evaluating supply security. The squared production shares of every supplier are added up to create the index, which gives a rough idea of the amount of market competition. The resulting value ranges between zero and 10,000, with zero indicating a well-distributed supply and 10,000 indicating that a single nation generates all of the product. When HHI is more than 2,500, it is likely that a few suppliers hold a sizable portion of the market, indicating that the industry is highly concentrated, which could threaten the stability of the market. This is especially evident when an area only receives supplies from one or two countries or when a single nation accounts for much of the supply. Even when there are alternative smaller suppliers accessible in these circumstances, the dependence on a single source may lead to supply chain risks that could cause market disruptions (Rietveld et al., 2022, p. 126; Wellmer et al., 2015, p. 55). While there is an overwhelming focus on fossil fuels, HHI is still quite important when it comes to CRMs. It offers a practical technique for evaluating supply concentration and identifying potential supply chain hazards, enabling stakeholders to take action to guarantee a steady and sustainable supply of these resources. Nygaard (2022, p. 12) applies this tool in his research and estimates that five of the essential EV minerals that are categorized as having highly concentrated markets.

De Rosa et al. (2022) and Harsem and Claes (2013) argue that energy imports are frequently characterized in public discourse in energy-consuming nations as an unwanted dependent situation. Dependence on particular resources or imports may compromise a nation's or region's energy security. In general, imported resources are much less predictable than locally sourced energy, hence the more heavily energy demands are dependent on imports, the less secure the supply will be (De Rosa et al., 2022, p. 6). Often, the stated political objective is to eliminate the need for imports and to attain energy independence (Harsem and Claes, 2013, p. 785). One of the reasons is

because the reliance stemming from nations depending heavily on international trade to meet their demands for commodities and services in today's interconnected global economy can make nations susceptible to interruptions in the supply chain. Chalvatzis and Ioannidis (2017), Riofrancos (2022), Kalantzakos et al. (2023) and Salim et al. (2022) to a similar extent argue that dependence on a limited number of suppliers leaves the importers highly vulnerable. Reliable supply of resources is the foundation of contemporary economy, making it also a major cause of dependence for modern society. Reduced dependence on other countries, especially those regarded as foreign powers, has emerged as the primary aim to be accomplished through employment of various means (Riofrancos, 2022, p. 30, Bluszcz, 2016, p. 1533). Riofrancos (2022, p. 33) goes on to argue that taking back control of supply chains is a crucial economic, but also political project which gives a more competitive edge.

Nevertheless, energy trade is one area where developed nations differ in their levels of dependence: energy exporters significantly rely on revenue from exports, whereas energy importers depend on a consistent supply (Harsem and Claes, 2013, p. 785). This is an example of complex interdependence in the energy sector. However, there is always a risk that the course of action might change in the (near) future which is why the EU began developing new strategies to diversify its sources of trade and investment and reduce its reliance on certain countries, namely China (see *Figure 2*) (von der Leyen, 2022).

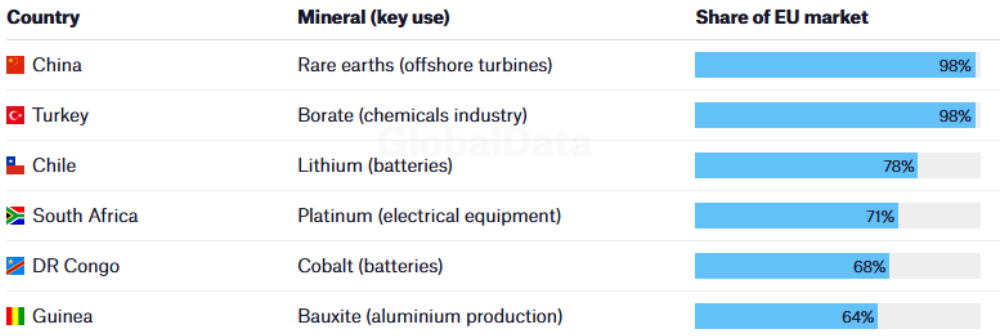

Figure 2. Selected countries by share of total EU mineral supply (%). (Keating, 2023)

The competitiveness of the EU economy is largely dependent on the import of strategically important CRMs and is extremely reliant on accessibility and unhindered access to these resources. The need for materials has expanded globally, and some producing nations have implemented protectionist policies and limitations to export (Mancini et al., 2013, p. 39). According to Elbassoussy (2019, p. 326), and in line with the previously stated, every choice a nation makes to maintain its energy supply security has the potential to affect the security of supply as well as one's independence on the international scene. Hence, it is necessary to find a balance between the factors that shape one's supply security, namely carefully evaluating the dependence on source countries in order to adequately address it. Lewicka et al. (2021, p. 1) argue that as a result of growing dependence on imports and related dangers to supply interruptions of CRMs, there is a need to promote domestic production.

Since it offers a clear indication of reliance on imported energy supplies, dependence is frequently employed as a sole measure for assessing the security of the energy supply. However, this indicator has its limits and might not give an accurate picture of the state of supply security. To thoroughly assess a country's energy security position, it is crucial to consider a variety of indicators, including political implications (Chalvatzis and Ioannidis, 2017).

3.2.3. Intersection of politics and supply security

IRENA addresses the political risks to the security of supply of CRMs. Supply chains are particularly exposed to supply risk when they are prone to political turmoil or have major social governance challenges. Political instability can interrupt the movement of commodities, including CRMs, affecting the manufacturing of goods and accessibility. Political turmoil, government changes, trade restrictions, or geopolitical tensions can all contribute to this instability. Any of these variables has the potential to interrupt the supply chain abruptly and unexpectedly. Similarly, supply chains with such major concerns are more vulnerable to supply risk. Human rights breaches, environmental degradation, and societal strife constitute some of the risks involved

(Gielen, 2021, p. 11). The political risks thus associated with supplier countries are a critical element of influencing energy supply security.

A number of scholars has recently stressed the significance of political stability as a requirement for guaranteeing steady energy supply security, although the criterion still falls short of some others in the literature. De Rosa et al. (2021, p .7) argue that the geopolitical conditions of the countries that produce and transport the resources are one of two interrelated components that make up the supply of energy. Efforts have been made to incorporate political stability into quantifiable criteria for assessing supply of energy, notwithstanding the challenge of measurement and the subjectivity of political stability. Furthermore, related to the market concentration, the supply is susceptible to interruptions brought on by political or economic problems in exporting nations, i.e., the production and supply of resources can be affected by the political unrest in the nations that source them (Mancini et al., 2013). Le Coq and Paltseva (2009, p. 4474) also argue that one key feature of the concept of supply security is that it can be influenced not only by economic considerations, but also by political objectives. State instability results in a state not being able to carry out its essential duties, such as providing social services, upholding security, and ensuring the rule of law. Reisch (2022, p. 3) nevertheless argues that although some nations that may use trade for foreign policy goals, they shouldn't be swapped for politically and economically vulnerable states as trade agreements with weak governments can be risky and carry additional risks.

The political stability of energy-supplying countries is critical to guaranteeing reliability of energy supply. This is because governments control either the actual energy supply or the terms under which third parties establish it (Kruyt et al., 2009, p. 2169). Kruyt et al. (2009, p. 2170) go on to argue, by referring to UNDP's human development indicator and Worldwide Governance Indicators from the World Bank, that resource suppliers are attributed a political stability factor and politically stable suppliers are favored because they are regarded to be more reliable and have a lower chance of supply interruptions. Stability encourages investment, promoting a diverse economy and a steady energy supply. In other words, such country - suppliers have predictable laws and regulations which in turn decreases the possibility of social and

political upheaval disrupting energy production and distribution. Additionally, well-established institutions, such as robust legal systems, strong governments, and effective bureaucracies, assure contract enforcement and the upkeep of energy infrastructure (Kruyt et al., 2009).

Furthermore, Aslantürk and Kıprızlı (2020) perceive political instability in energy-producing countries, as well as interruptions in production and distribution networks, as key concerns for energy - import dependent countries and regions. They emphasize the need for these nations to diversify energy sources, improve energy efficiency, and promote renewable energy technology in order to minimize reliance on imported energy and increase their energy security (Aslantürk and Kıprızlı, 2020, p. 355). However, in their paper, a particular emphasis is put on fossil fuels. The authors claim that renewable energy could serve as means to minimize reliance on fossil fuels and eliminate energy dependence overall as through renewable energy countries may become self-sufficient (Aslantürk and Kıprızlı, 2020, p. 368). While renewable energy sources are frequently thought to be more sustainable than fossil fuels, they are not immune to supply chain concerns. Renewable energy systems need the use of a range of CRMs, frequently found in nations with poor governance, where disruptions to supply chains, geopolitical conflicts, and human rights violations are more common. Hence, new technologies and green energy may introduce new dependencies and should not be considered a panacea - energy supply security problems are diverse and multidimensional (Rademaker, 2019).

Rademaker (2019, p. 23) through his analysis of fossil fuel supply security concludes that the political risks often come from resource nationalism, i.e., energy-producing countries' principal purpose is often to maximize the economic and political benefits of their energy resources. This shared trait is motivated by a need to generate money and prosperity for their governments and population, as well as to increase their influence and authority in the increasingly globalized world. Unlike Aslantürk and Kıprızlı (2020), Rademaker (2019) stresses that the transition to a green energy system does not always imply the end of reliance on fossil fuels. Instead, it is possible that these dependencies may simply transfer to other resources, such as CRMs utilized in the development of renewable energy systems as he talks of the *spillover effect* of

resource nationalism from oil and gas sectors to the mineral sector. Policy and practices aiming at enhancing governmental control over natural resources, notably in the energy and mining industries, are referred to as resource nationalism. This tendency has now spread into the mineral sector, with several governments attempting to enhance their control over CRMs utilized in the manufacturing of renewable energy technology and high-tech products. As a result, nations are increasingly enacting laws to restrict exports, raise taxes and royalties, and limit foreign ownership and investment in the resource industry (Rademaker, 2019, pp. 23 – 24). Moreover, resource nationalism may cause tensions and disputes between governments, compromising supply security which is why it is critical to take it into account when analyzing political risks (Ostrowski, 2023; Obaya, 2021).

Lastly, *friendshoring* is a strategy that involves shifting supply chains to nations with reduced risks of political unrest or other disruptive occurrences. The terms "reshoring" and "onshoring," which refer to moving supply chains back to a company's home nation, and "nearshoring," which pertains to moving supply networks to adjacent countries, are comparable to this idea (Kessler, 2022). This serves as an introduction to the following section which gives an overview of what *lack of friends* in the global arena implies for resource supply.

3.2.4. Absence of diversification in supply

Encapsulating both previously mentioned criteria is the lack of diversity in sourcing energy resources, in this case CRMs. According to Chalvatzis and Ioannidis (2017, p. 466) the notions of diversity and dependence are important for comprehending energy supply security, defined as a country's or region's potential to access reliable and cheap energy sources. In recent years, the prevailing security model has shifted from dependence to diversity. This change toward diversity as the primary security paradigm has significant consequences for assessing resource supply security (Chalvatzis and Ioannidis, 2017). It can be argued that such perception implies that assessing supply security necessitates not only an evaluation of the availability and accessibility of

various energy sources, but also a comprehension of the risks associated with dependence on merely one or a few sources. In the words of Chalvatzis and Ioannidis (2017, p. 470), the reliance on imports is only one element of energy supply security. Diversification of energy supplies is considered as essential in developing pathways to a resilient, decarbonized energy future. Similar narrative can be seen in Aslantürk and Kıprızlı (2020, p. 357) and De Paoli et al. (2010, p. 14) who argue that diversification of supply and the establishment of competing energy marketplaces are techniques for protecting the economic order from supply disruptions. A frequent technique for assessing energy security is to assess a country's diversification of energy or import sources. Having an extensive range of energy and trade sources decreases a country's reliance on any single source, reducing energy instability and susceptibility to supply interruptions. Diversification offers adaptability and durability in the face of changing conditions and enables the importers to enhance their supply security and reduce the risks associated with supply interruptions and price fluctuations by tracking and encouraging diversification (De Paoli et al., 2010, p. 15).

Aslantürk and Kıprızlı (2020, p. 355, 357) go along the same line of thought, stating that ensured abundance to key energy resources necessitates a holistic strategy which incorporates energy source diversification, renewable energy expansion, and energy infrastructure growth. Adopting aforementioned measures may enhance energy security and reduce susceptibility to supply disruptions and price volatility. However, the issue with Aslantürk and Kıprızlı (2020, p. 357) arises in their perception of transition to renewable energy as the key solution to mitigating supply risks related to other forms of energy resources. As it will be showed throughout this research, renewable energy and green transition introduce new dependencies and risks to supply of energy resources. The supply of CRMs, such as rare earth elements, lithium, and cobalt, is required for the manufacturing of green energy technologies including solar panels and wind turbines. Many of these materials are presently obtained from a few nations, raising worries about supply chain weaknesses and geopolitical risks. As the demand for green energy technologies grows, so will the dependence on these CRMs, generating new vulnerabilities.

The previously mentioned and discussed studies highlight the value of source diversification, albeit mostly in relation to supply issues associated with fossil fuels. Despite the encouragement of renewable energy sources, persistent analysis of issues with the availability of fossil fuels shows how important this problem still is, witnessing the trend as recently as with the 2022 Russian invasion of Ukraine. Nevertheless, the arguments expressed in these articles still apply to supply security of CRMs. The EU heavily depends on China as its primary source of CRMs (see Section 5.1.), but it is pursuing initiatives to diversify its sources both domestically and internationally to minimize the extent of such burdening dependence. Regardless of the material or industry, emphasis is put on the value of source diversification in ensuring a safe and sustainable supply chain for CRMs.

4. Methods and methodology

This research employs qualitative document analysis and SWOT analysis frameworks as the primary methods for analyzing EU policies based on its published documents. Document analysis (DA), which generally involves doing a methodical assessment and evaluation of written or recorded material such as policy papers, reports, and public remarks which are then examined and interpreted in order to acquire insight, and build empirical knowledge is the main technique for extracting meaning from relevant documents (Bowen, 2009, p. 27). SWOT analysis is then used to organize the findings accordingly by providing a holistic perspective of current state of EU energy supply efforts, emphasizing what aspects require further improvement (Markovska et al., 2009).

4.1. Document analysis

DA helps grasp EU's vulnerability to external risks to its CRMs supply chain, familiarizing the researcher with the context and the state of EU's supply chain as well as its response to it. The method offers the ability to analyze a plethora of data, learn about previous events and political changes among other by examining documents. It is an analytical approach that is particularly suitable for case studies involving qualitative investigations that produce extensive descriptions of phenomena, event, organization, or program (Bowen, 2009, p. 29). In the context of the research, it helps address and analyze risks to EU's supply of CRMs and the measures to counteract them. Research conducted by European Commission's Joint Research Centre has offered a lot of data on the state of EU's supply security: the extent of dependence on other countries, importance of relevant CRMs for different industries and renewable technologies, political implications events, such as wars and export restrictions, have had on the value chain etc. Additionally, documents are useful in the research study since they include accurate names, reference, and event data (Bowen, 2009, p. 31). It can be argued that documents offer a standardized source of information that is less impacted by the researcher's personal prejudices or viewpoints as the data is presented, most often in the terms of graphs and charts. Due to the consistency of the data, analyzing items such as policy papers can be highly valuable as throughout the interviewing process or observing, researchers may exert influence on subjects (Morgan, 2022, p. 66). Documents are often generated in a specified structure and style, making them more impartial than interviews or observations, which depend on the researcher's subjectivity and interpretation. Or as Bowen (2009, p. 31) argues: *"documents are 'unobtrusive' and 'non-reactive,' which means they are unaffected by the research process"*.

One of the main reasons for the choice of this method is that it allows for an access to enormous volumes of relevant data without the need for substantial fieldwork or data gathering activities (Bowen, 2009, p. 30). The method's efficacy makes it a perfect tool to investigate, but also navigate a large number of documents as the major objective of

this study is to present an up-to-date summary of EU policies, proposals, and initiatives. The documents analyzed in this paper are EU – published and include the following: regulations, proposals for regulations, staff working documents, research conducted by Joint Research Centre, resolutions, and communications. These constitute *primary material*, supplemented by *secondary material*, i.e., EU press releases and newsletters (Bowen, 2009; Gross, 2018).

The main challenge with analyzing the documents listed is that there is an abundance of material and many versions of the same document. When many drafts of a document or extensive research on the topic are available, the researcher can assess them in order to find and analyze changes. In the context of CRMs, this is quite important as the relevance of the raw materials has grown extensively over the years: from the first list of CRMs published in 2011 to most recently Proposal for Critical Raw Materials Act, henceforth CRMA, that came out in March 2023. This is why the time frame for selected documents is set between 2008 and present time. These documents constitute the core of this research and are vital for understanding EU policies and strategies aimed at securing a sufficient supply of CRMs and its strategic autonomy.

In addition, the frequency with which the subject appears in other documents has changed throughout time. This shows that a wider range of industries and sectors are starting to see CRMs as a topic of interest, but also helps comprehend how the issue of CRMs and supply has evolved. Hence, as Bowen (2009, p. 30) argues, documents enable the tracking of change and progress. It helps observe patterns and to what extent they change over time. For instance, the question of China and what threat it posed to CRM supply chain almost fifteen years ago is not the same as today. Narratives like this can easily be tracked in certain EU documents.

Related to the abundance of material that can be analyzed, the importance of choosing documents that are pertinent to the research issue and fit with its theoretical framework is emphasized by Gross (2018). Establishing precise standards for document selection can guarantee an accurate and representative sample, which is necessary to accomplish this. Determining *inclusionary* and *exclusionary* elements to choose which papers will be included in the study can be one of these criteria (Gross,

2018, p. 2176). In this paper the main inclusionary criteria that were used were: *reference to CRMs* and *timeliness*. With regards to the former, although the topic is quite recent and dynamic, a variety of EU documents mention CRMs. In many instances the reference overlaps, i.e., there is a same section or paragraph found in several documents, but that does not reduce the importance of a document but emphasizes the significance of CRMs for the EU. Related to the latter, timeliness is quite critical and documents that are outdated cannot be used to provide a systematic overview of the current state of EU's policies and supply security. Reasoning behind this is that CRMs list is updated every three years according to the supply risk and economic importance of the element along with some materials being added (European Commission, 2023b). This calls for new assessment of the materials, EU's dependence and the importance in industry, especially renewable sectors.

To gain comprehensive knowledge of the analyzed documents, a certain technique needs to be used. Skimming, reading, and interpretation are all parts of document analysis. Thematic analysis and content analysis are combined in this iterative procedure (Bowen, 2009, p. 32). For this specific research *thematic analysis* is employed. Emerging themes serve as the categories for investigation in a type of data pattern identification. The procedure entails rereading and reviewing the data with as the researcher examines the chosen data more closely and uses coding and category development depending on the qualities of the data to find themes relevant to a phenomenon investigated (Bowen, 2009, p. 32; Karppinen and Moe, 2012, p. 15). Thematic analysis comes in handy when investigating EU's response to external threats, i.e., second objective of this research. Overall, an overarching theme emerged when analyzing the documents: *diversification*. This corresponds to one of the criteria listed as a measurement of supply security. Simply put, EU's goal is to diversify its sources of CRMs to mitigate supply disruptions and reduce dependence on third countries. Several ways have been mentioned as means of achieving this goal, but for the purposes of this research only two have been chosen and are divided into two subthemes: *international supply* and *domestic supply*. Under the former, the most important category is that of *international cooperation* which can be observed through

subcategories of *strategic partnerships* and *Global Gateway Initiative*. Under the latter, the question of *circular economy* has garnered the most interest.

The main challenge when conducting research on topics related to energy and supply of energy resources is the volatility of the subject. Although the importance of employing renewable technology and EU dependence on CRMs isn't necessarily new, the events and circumstances that shape it are quite dynamic and unpredictable. In other words, this paper might give an overview of the current state of CRM supply security in the EU, but it is still necessary to acknowledge that a lot will either change or become redundant in the future. Another point to consider in the context of limitations is that a great deal of the documents analyzed were proposals, most notably CRMA and Net Zero Industry Act, henceforth NZIA. What this implies is that in the upcoming year or so, a lot of changes, i.e., amendments can be made to these Proposals, especially if the general public, as well as businesses keep pushing for their interests to be represented. Lastly, the subject in the EU bubble is still quite nascent – the proposals came out more as an answer to some other steps taken by states at a global level and the EU is still trying to make its way around the correct strategy to address the issues. It will probably take years until EU's policies yield tangible results, especially in the context of international cooperation and politically unstable partners.

4.2. SWOT analysis

While the document analysis helped point out the main themes and categories, SWOT analysis helps organize those findings, i.e., EU responses according to the following variables: *strengths, weaknesses, opportunities* and *threats*. This research makes use of a SWOT analysis framework in the discussion to provide a comprehensive evaluation of EU policies and efforts. Prior to using this analytical tool, analysis of the recent steps made by the EU in connection to CRMs is provided. The SWOT analysis is, in other words, used because it enables a thorough comparative analysis by looking at the strengths, weaknesses, opportunities and threats the EU faces regarding CRMs supply disruptions. It provides an overview of the data collected and

analyzed using DA, making use of benefits to examining policies using SWOT analysis. It enables a well-organized qualitative evaluation of predefined issues and is a method for strategic analysis that is change-oriented. As a result, it is more dynamic and consequently more able to detect changes that can enhance policy efficiency (Fertel et al., 2013, p. 1140). This method can help policymakers discover and assess alternative solutions in a disciplined and organized manner, making it particularly pertinent in the context of the EU's attempts to cope with the instability of its supply of CRMs. In addition, being such a dynamic tool, SWOT analysis can be of use amidst continuously evolving nature of international politics and their impact on the EU and its course of action.

The strengths and weaknesses are regarded as internal features that can be changed and controlled while threats and opportunities are exterior, uncontrollable factors (Celiktas and Kocar, 2009: p. 4960; Fertel et al., 2015, p. 1140; Chen et al., 2014, p. 320). According to Fertel et al. (2015, p. 1140) the internal and external factors need to be defined before undertaking the SWOT analysis. Hence, the discussion is divided into four subsections with each focused on a specific variable.

5. Analysis

This section highlights the key findings of DA. The method, as previously explained, is first used to map out the identified threats and weaknesses in the EU's CRMs supply chain. The coding process was guided by the existing theoretical framework and prior knowledge in the field; hence the sections are divided to correspond to the conducted literature review on the two selected criteria for measuring supply security: *dependence* and *political risks*. Sections 5.1 and 5.2, respectively, focus on the two criteria, which were regarded as the primary variables influencing supply security in the EU. Section 5.3 focuses on the EU's response to those same risks, i.e., measures for diversification, which is examined in depth through an assessment of policies and initiatives implemented by the EU in the recent past, as well as those that are in development.

5.1. Navigating dependence in EU's search for CRMs: challenges from abroad

As was shown in the literature review, crucial risk to the supply security is overdependence on a single supplier. In 2008, EU deemed raw materials as essential for a society to run sustainably and for the efficient functioning of its economy (European Commission, 2008). Fast forward fifteen years later, EU is strongly reliant on imports of certain CRMs that are often sourced from a small number of third nations that control both the extraction and processing processes (European Commission, 2023a, p. 1). *Table 3* portrays country concentration for some CRMs according to HHI. As was elaborated before, an HHI of more than 2,500 is considered a warning indication for a highly concentrated market when assessing market concentration. A limited number of countries in this case dominate across the entire CRM value chain, posing a danger to market stability, leading to a lack of competition, excessive costs, and restricted customer choice. This section will thus serve as an overview of some of the most concerning dependencies.

CRM	Concentration index (HHI) for **production**	Concentration index (HHI) for **reserves**
Nickel	1 522	1 547
Lithium	3 300	2 247
Cobalt	4 713	2 998
Graphite	4 760	1 896
Rare earth oxides	4 928	2 138
Platinum group metals	5 377	8 167

Table 3. Country concentration for some CRMs (Rietveld et al., 2022)

China has been a recurring subject in EU' reliance on imported CRMs, a problem that has received considerable attention from the EU institutions and think tanks. Its

dominance in this sector, as the world's largest producer and exporter of several of CRMs, has important consequences for EU's economic and security interests. EU significantly depends on China for CRMs at various stages of the manufacturing process for a wide range of technologies. Because there may not be other supplies from like-minded and reliable countries, reliance on China offers a major danger of supply interruptions owing to environmental and geopolitical issues. The rising demand for these resources, as well as worldwide rivalry for access to them, exacerbates the situation as reliance extends from raw materials to the whole value chain, which includes wind turbines, electric motors, and solar PV (Carrara et al., 2023, p. 12). In her State of the Union Speech in September 2022, Ursula von der Leyen, President of the European Commission, emphasized the importance of reducing reliance on China and diversifying the suppliers of these resources (von der Leyen, 2022).

In 2020, China accounted for 60% of refined cobalt, 93% of graphite active materials, 69% of refined lithium, 79% of battery-grade manganese, and 63% of nickel sulphate production capacity (Carrara et al., 2023, pp. 21 – 22). China is the leading producer of REEs, accounting for 100 % of total output. It also generates more than 85% of total lanthanum and gadolinium production. Additionally, although the DRC produces the majority of the world's cobalt (63%), it is mainly processed in China (63%). This underscores the significance of China in the various stages of the supply chain (Carrara et al., 2023, p. 30).

EU gets 97% of its magnesium from China, an element necessary for heat pumps and electrloyzers (Carrara et al., 2023, p. 144). In 2021, China experienced an energy crisis owing to coal shortages induced by geopolitical tensions in the Pacific. Some factories, including 25 magnesium facilities, ceased operations in order to minimize energy use. This caused problems in the worldwide supply chain, resulting in Chinese producers canceling orders from European corporations. As a result, magnesium prices globally surged by more than 400% in September-October 2021, creating a risk to European industry's long-term capacity to manufacture and supply magnesium, hurting downstream sectors and steel production (European Commission, 2022b, p. 27).

Heavy rare earth elements (REEs), which are found in permanent magnets of the wind turbine generators, are exclusively processed in China and show a high supply

risk (European Commission, 2023a, p.1; European Commission, 2023c, p. 50). The EU faces a substantial reliance and security danger owing to China's strong position across the REEs supply chain. China has loosened its grip on power in the initial phases of the supply chain while extending its dominance in the latter stages throughout the last decade. This shift is motivated by concerns regarding the environment, economic value addition, and strategic considerations. The risks connected with this dominating position include flooding the market with lower-priced items, imposing production limits, trade restrictions, or reducing exports, all of which can result in a lack of materials and components required for the EU's green and digital transformation. China's actions in 2010-2011, which reduced REE export quotas, caused prices to tenfold, exposing the potential repercussions of supply interruptions – a lesson for the EU which is still not too late to learn from (Carrara et al., 2023, p. 51). More recently, China's strong control over the REE magnets value chain is evident in the 28% increase in the import prices of permanent magnets during the first eight months of 2021 compared to the same period in 2019 (European Commission, 2022b, p. 26).

China is the EU's principal supplier and trading partner, and this is projected to continue in the foreseeable future. Such reliance on a single nation is a significant challenge and may impede the intended rollout of technology, as evidenced during the COVID-19 epidemic, when multiple Chinese manufacturing plants were shut down. While a few European enterprises can still manufacture small amounts of high purity gallium, germanium, boron, and indium, their numbers have been dropping over the last decade, exacerbating the problem of overdependence on China and raising the danger of supply chain problems (Carrara et al., 2023, p. 68).

EU's susceptibility to supply chain disruptions is not just attributable to its reliance on China. EU also depends largely on a few other countries for various CRMs. To exemplify, DRC supplies 63% of the world's cobalt, which is employed in batteries in electric cars and is crucial for electrification (European Commission, 2023a, p. 1). Brazil meets 92% of the EU's niobium requirements, a crucial element needed in the manufacture of iron-alloy metals for wind turbines (Carrara et al., 2023, p. 85; European Commission, 2023c, p. 53). Platinum mining is mainly concentrated in South Africa (71%), followed by Russia (12%) and Zimbabwe (8%), with South Africa being

the key supplier of rhodium (81%), and ruthenium (94%) (Carrara et al., 2023, p. 30, 85). Lastly, some CRMs depend on the production of other materials since they are obtained as by-products (indium is mostly produced as a by-product of zinc). CRM markets have become inelastic and are also distinguished by a small number of participants and imprecise information on output, pricing, trade flows, and inventories (Ragonnaud, 2023, p. 5).

As the section showed, EU exhibits a high level of dependency on other countries for a great number of CRMs. It is heavily dependent on import of both raw and processed CRMs which pertains to the lack of domestic infrastructure and capacity for extracting and refining minerals and metals. In this case, asymmetrical dependence, as defined by Keohane and Nye (2011) is apparent as the EU imports CRMs along the entire value chain, making it highly vulnerable to supply disruptions.

5.2. Political instability and national interests: impact on the EU's supply chains

The availability of CRMs has become exposed to political risks interrupting the flow of these commodities, potentially resulting in economic and security repercussions for both the exporter and importer. When analyzing the political risks to the supply of CRMs, it is of the utmost importance to keep in mind that the risks might emerge at any point throughout the supply chain. For example, political risks might impact the extraction or processing of raw materials, or even the transit or storage (European Commission, 2021a, p. 52). In the following section, some of the most important political risks that affect the availability of CRMs, as well as the possible ramifications for the EU will be analyzed.

EU’s CRMs supply chain remains overwhelmingly concentrated in a few nations. Many of these nations possess poor levels of governance, which can contribute to political concerns that threaten supply chain security. This concentration is shown by a graphic depiction (*Figure 3*) of the global supply chain for CRMs. It shows that the

majority of these resources are sourced from nations with low governance levels, i.e., states with weaker institutions, absence of the rule of law, and inadequate property rights safeguards, among other issues.

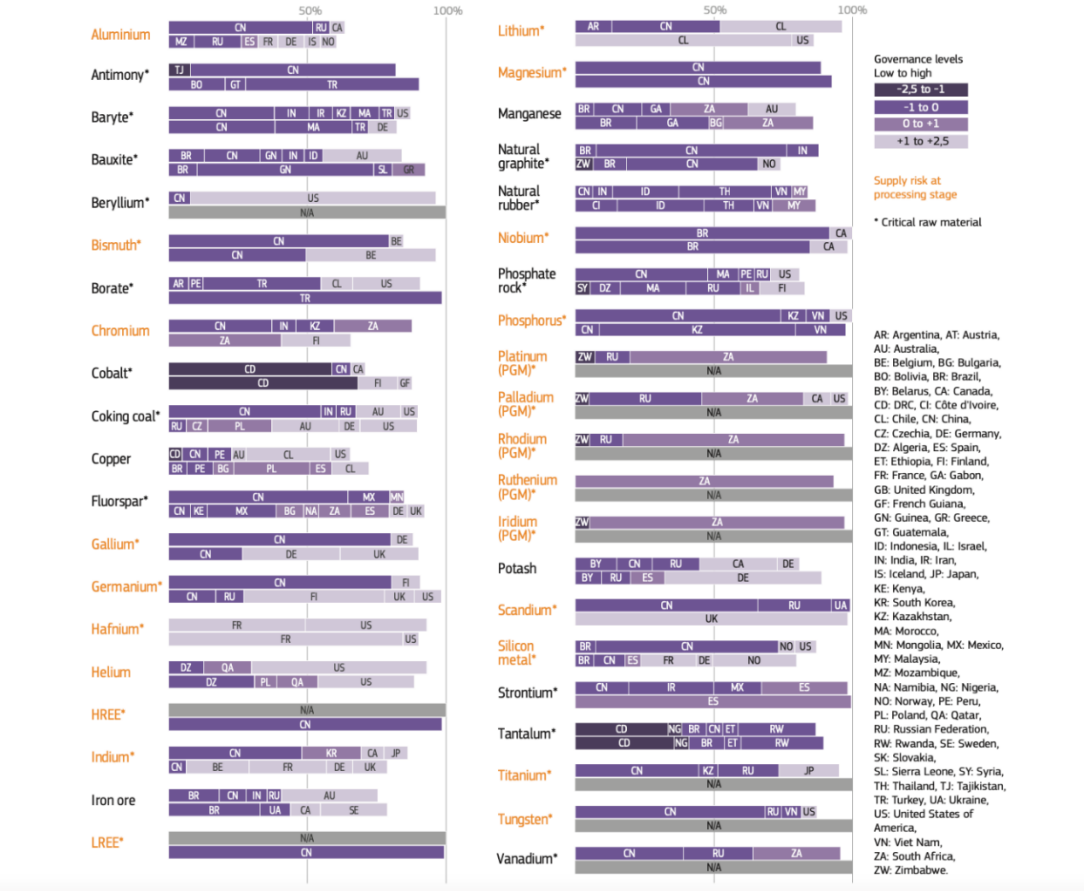

Figure 3. Geographical concentration of global production (upper bar for each material) and supply to the EU-27 (lower bars) and the corresponding governance level in producing countries (European Commission, 2021a, p. 53).

By examining *Figure 3* it becomes apparent that Iran exports a significant amount of strontium, which is required to make electrodes for electrolyzers that split water into hydrogen and oxygen (Carrara et al., 2023, p. 144). This portrays Iran's key involvement in EU's supply chain for electrolyzers and other strontium-dependent sectors. However, Iran falls under the category of countries will relatively low governance levels (between -1 and 0) and its relationship with the EU has worsened dramatically as the Union is concerned about Iran's violation of the Joint Comprehensive Plan of Action (JCPOA) by ramping up its nuclear program and failing

to fully engage with the IAEA. Additionally, the Iranian government's recourse to violence against nonviolent protestors, as well as their executions, has enraged Europeans and their supporters, drawing attention to human rights issues in Iran (Immenkamp and Clasutre, 2023). As a reaction to these tensions, the EU has implemented restrictive measures within four sanctions frameworks on a growing number of prominent Iranian individuals and businesses. Asset freezes and bans on rendering economic resources accessible to the designated people as well as companies are among the sanctions; individuals are also barred from traveling to the EU (Immenkamp and Clasutre, 2023). If the political impasse between the two sides worsens, the EU may be obliged to seek new suppliers of strontium, disrupting the current supply chain and causing price instability.

Political implications for CRMs supply chains arise from conflict in sourcing countries as well. The term *conflict minerals* refers to materials (typically tin, tungsten, tantalum, and gold, also known as 3TG) that are extracted and traded in politically unstable regions, such as DRC, and are used for funding armed group, drive forced labor and other human rights violations, as well as encourage corruption and illicit financing (Mancini et al., 2020, p. 8). The trading of these minerals was crucial in financing wars, with armed groups and militias taking advantage of the informal mining industry to extract and sell the minerals for profit. To manage the mines and harvest the minerals, these armed organizations frequently utilized violent and exploitative practices, financing the Second Congo War and ongoing follow-on conflicts (Mancini et al., 2021, p. 9). As profits from the trade of 3TG minerals have been connected to the sponsorship of armed conflicts, it prompted the EU to reevaluate the role it plays in ensuring consistent access to CRMs by deescalating conflicts (see Section 5.3.1.2.).

As another political risk, the prolonged confrontation between Ukraine and Russia has had serious consequences not just for the region's political stability, but also for the security of the EU's supply of CRMs. Supply disruptions triggered by Russia's invasion of Ukraine, as well as the resulting economic sanctions and repercussions, have significantly impacted global markets. Russia is a key trade partner for several of CRMs for the EU and contributes approximately 19% of energy raw material imports,

with the Baltic nations and Finland the most exposed to Russian supply (Unguru et al., 2022a, p. 5). Germany is grabbing the majority of Russia's mineral and metal exports throughout the EU. Metals are in addition largely imported by Italy, Poland, and Belgium, whereas minerals are primarily purchased by Slovakia and Austria (Unguru et al., 2022a, p. 8). Given that Russia is a major producer and exporter of nickel, any prospective restrictions imposed on their shipments might have a considerable impact on the worldwide market. The London Metal Exchange, a crucial hub for metal trading, temporarily halted trade in March 2022 as a result of the abrupt rise in nickel prices brought on by these worries in order to avoid market disruption (Carrara et al., 2023, p. 27). As a result of EU's imposed sanctions, businesses may find it difficult to manage quickly shifting trade rules and regulations. This volatility makes it difficult for such entities to allocate investments and build long-term supply chain plans, exacerbating supply security concerns. However, the EU hasn't introduced sanctions so far aimed at CRM import, but one could argue that has nevertheless created a sense of mistrust underpinned by other sanction packages. Avoiding trade restrictions and reducing the cost of technical barriers to trade in CRMs is an important step in ensuring the smooth functioning of value chains relying on these raw materials (European Commission, 2023d).

In the context of Ukraine, the EU is a major destination for Ukraine's exports of manganese, accounting for 54% of the country's total exports of this CRM (Unguru et al., 2022b, p. 5). Italy (35%), Poland (17%), Germany (10%), and Bulgaria (9%), accounted for the majority of EU metal imports. Minerals from Ukraine were largely imported by Austria (25%), Czechia (22%), and Poland (20%) (Unguru et al., 2022b, pp. 7- 8). Russia's invasion of Ukraine has underlined the EU's structural supply dependence and its potentially disastrous consequences in times of crisis. Because CRMs are so important for the green and digital revolutions an interruption in their supply would have a considerable negative impact on EU business. This would jeopardize the operation of the single market and harm the EU's competitiveness, as well as jeopardize jobs and job creation and have an impact on working conditions and salaries. Furthermore, without a reliable supply of CRMs, the Union will be unable to

realize its goal of a sustainable green and digital future (European Commission, 2023a, p. 1).

To summarize, political stability, as argued by Le Coq and Paltseva (2009) is one of the aspects to be considered when evaluating supply security. It is remarkably related to the issue of dependence as it could be observed that the EU heavily depends on politically unstable countries, such as Russia and DRC, for some CRMs. These two criteria for measuring supply security can have detrimental consequences for EU's access to CRMs. Hence, the following section sheds light on some of the key measures to counteract current threats to EU CRM supply chain.

5.3. Towards a more secure supply: EU's efforts to diversify CRM sources

EU's initiatives to counter external risks to the supply security of CRMs are fully summarized in this section. The focus is on the EU's measures to lessen the previously mentioned threats, i.e., addressing the second part of the research question. By examining initiatives that the EU has or is planning to implement, the aim is to illuminate the bloc's recognition of the importance of diversification, final criterion for supply security, at the international and domestic levels.

5.3.1. International cooperation

The European Commission established the Raw Material Initiative in 2008, with the goal of reducing Europe's reliance on other nations for non-energy raw materials used in industries and society in general (European Commission, 2008). The effort has three major goals: 1) to diversify Europe's primary raw material sources, 2) to boost domestic raw material sourcing, and 3) to establish more secondary raw material sources by using resources effectively and fostering circularity. Nevertheless, some

reliance on imports is inevitable, but the choice of trade partners has significant strategic consequences that must be considered (European Commission, 2020a, p. 34). This section explores EU's policies and initiatives aimed at diversifying the supply of CRMs through establishment of international partnerships and alliances as a means of ensuring the security thereof.

CRMA represents EU's commitment to extending and diversifying its investments, promoting stability in global trade, and providing legal certainty for investors. It acknowledges the necessity of strengthening its partnerships with reliable allies, i.e., *strategic partnerships*. The Union intends to form mutually advantageous partnerships with emerging markets as well as developing economies, meaning that it wishes to work with these nations to accomplish compatible aims. In essence, the EU seeks to strengthen connections with reputable trading partners to boost economic development, secure its CRMs supply chain while enhancing its global position of a leader in green transition (European Commission, 2023a, p. 2). The term strategic partnership is defined in CRMA as a commitment made between the European Union and a third nation to strengthen collaboration in the CRMs value chain and although not legally enforceable, the agreement establishes a dedication to certain actions that both parties believe would benefit them (European Commission, 2023a, p. 22). This point was also brought up in the 2021 European Union Resolution on CRMs which encourages the Commission to strengthen ties with all CRMs supplier nations and form new alliances with allies, while boosting the welfare of developing countries and involvement of small and medium-sized enterprises in addition to diversification being one of the central pillars of RePowerEU, EU's plan to make Europe independent from Russia (European Parliament, 2021, p. 15; European Commission, 2022c, p. 10).

CRMA (European Commission, 2023a, pp. 50 – 51) outlines specific standards and considerations that should be given priority when establishing strategic partnerships:

1. Priority should be given to third countries that have the capacity to contribute to supply security, i.e., countries with substantial deposits, extraction, processing, and recycling capabilities for CRMs.
2. Considering a third country's regulatory structure for environmental impact monitoring and prevention, socially responsible behaviors, transparent

corporate practices, and the influence on public administration and the rule of law.

3. Determining whether current cooperation agreements exist between the third nation and the Union. Prospective deployment of Global Gateway investment projects should also be considered for emerging markets and developing economies.
4. Determining if and how a cooperation may benefit both the partner nation and the Union, with a focus on local value addition.

In other words, EU's criteria for establishing strategic partnerships indicate its commitment to diversifying CRMs sources in a sustainable manner that goes beyond environmental and social considerations. Sustainability refers to the point brought up in the Section 3.2.1. when defining the concept of supply security – as an ability to maintain the supply of CRMs at a certain stable level. This will be accomplished through strategic partnerships, steering away from China's grip on the CRMs market, among other instruments/means.

Green Deal Industrial Plan (GDIP) which is aimed at facilitating Europe's target of achieving carbon neutrality by supporting the expansion of production capacity for net-zero technology and products, encompasses the CRMA itself (European Commission, 2023e). In the European Commission Communication on GDIP a new project nicknamed the *Critical Raw Materials Club* is introduced and set to be developed in collaboration with like-minded countries to safeguard an international supply of CRMs required for the green transition, as well as to ensure a competitive and diverse industrial base. The Club intends to unite raw material "consumers" and nations with abundant resources to formulate cooperative norms. Building on current international initiatives, this will allow resource-rich poor nations to climb up the value chain (European Commission, 2023f, p. 19; European Commission, 2023g, p. 23). The concept is mentioned in CRMA, however, remains quite vague and lacks specifics as in which countries will be included and what will its sphere of action and influence be.

According to NZIA, the EU should encourage foreign trade and investments in net-zero technology while lobbying for higher global environmental and social norms.

That should be accomplished by active engagement and partnerships with nations that share similar ideals. In addition, the EU should prioritize research and innovation efforts to accelerate the growth and adoption of net-zero technologies which can only be done in collaboration with partner nations in an open but assertive manner (European Commission, 2023g, p. 35). This encompasses collaboration on CRM – related projects as the materials underpin the deployment of many of the net – zero technologies listed in NZIA (see *Figure 4*).

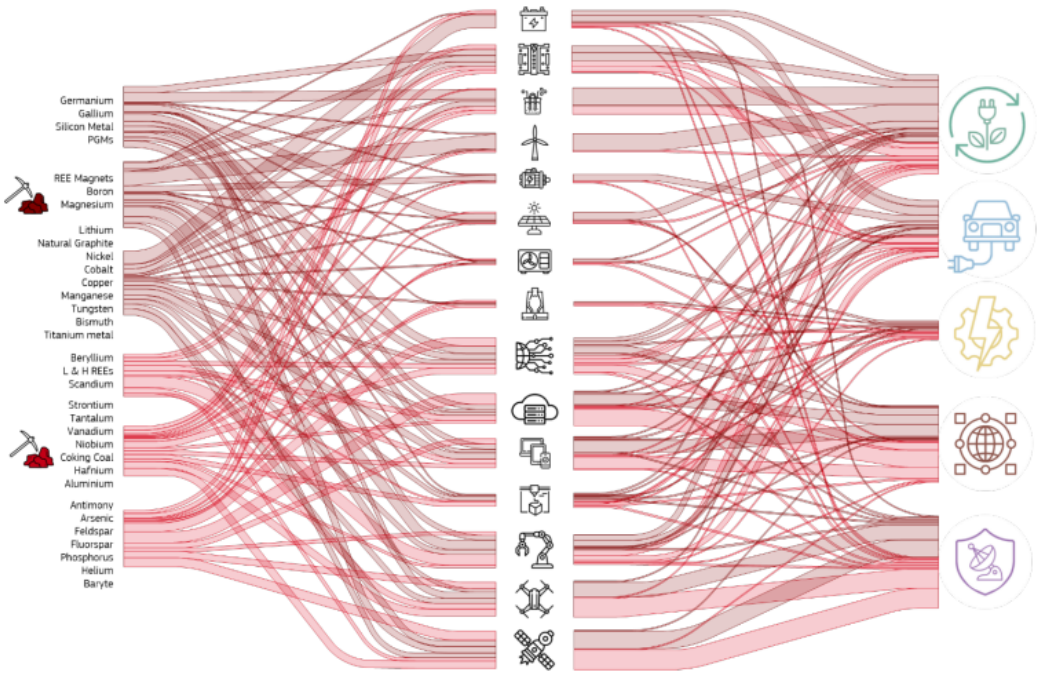

Figure 4. Flow of raw materials to the fifteen technologies and sectors (Carrara et al., 2023, p. 6)

Furthermore, the question of source diversification is brought forward in several other proposals and initiatives. The European Chips Act emphasizes the significance of the semiconductor chips which are central to energy, among other applications and infrastructures (European Commission, 2022d, p. 1). Electronic grade silicon metal, boron, germanium, gallium, indium, cobalt, graphite and lithium, are among the CRMs used in the production of semiconductor chips (Carrara et al., 2023, p. 101). Without these materials, semiconductor chip manufacture would be substantially hampered, potentially resulting in supply shortages and disruptions across a wide variety of industries and technologies. Hence, the Chips Act calls for the Union

to create strong international ties with similar partners to deal with the globalized and interconnected semiconductor value chain. This will increase collaboration and decrease competing goals as well as assist in the evaluation of other nations' policies in the sector and in jointly addressing supply concerns through mutually advantageous diversification methods (European Commission, 2022, p. 3, 11).

This section served as an overview of how multilateral cooperation is embraced in the EU circle as a means of diversifying CRMs sources. The following two sections go into more detail on different partnerships that enable EU cooperation with third countries.

5.3.1.1. Strategic partnerships

The EU considers the supply of CRMs to be one of its most sensitive areas that requires immediate action. In March 2022, a year before the publishment of CRMA, the Heads of States and Governments called for an active pursue of *international collaboration and partnership building* in order to mitigate the risks connected with CRM dependencies, one of a few instances where such issue was brought up (Council of the EU, 2022b, p. 7). The Union has developed strategic alliances with Canada, Ukraine, Namibia and Kazakhstan to achieve this aim, and is considering similar partnerships with other African nations.

The partnership with Canada intends to link the raw material value chains of the EU and Canada while also strengthening collaboration in research, technology, and innovation. The EU-Canada Strategic Partnership on Raw Materials includes upholding criteria and environmental, social and governance norms (ESG), designed to foster a sustainable and ethical approach to CRM production and usage by exchanging experience and information (European Commission, 2022b, p. 6; Council of the EU, 2021, p. 4). The objectives are gathering investors and raw material project promoters with the goal of investing in said projects, working with industries and stakeholders to enhance the sustainability and circularity of the raw material supply

chains and establishing high ESG standards in the Canada-EU value chain while promoting robust international norms (European Commission, 2023h).

Similarly, the strategic partnership with Ukraine was established by signing a MoU in 2021. The scope of the MoU incorporates the following dimensions:

- Creating supply channels for CRMs for mutual political and socioeconomic advantage.
- In mining, adding value and fostering social and economic growth.
- Contributing to the modernization of raw material value chains.
- Improving governance and mining methods to develop minerals in a more sustainable and responsible manner.
- Increasing capacity and information sharing across the raw materials and battery value chains.
- When suitable, incorporating battery value chains (European Commission, 2021b, p. 2).

As outlined in Section 5.2., the EU's strategic partnership with Ukraine has suffered a significant blow after Russia's invasion of Ukraine in early 2022. Although the supply chain for CRMs was not immediately affected, as dependence on Ukraine is relatively small compared to some other countries, the incident demonstrates the burden of dependence on energy resources. Unexpected events, such as the Ukraine-Russia crisis, place significant risks and demands on supply chains, especially if the situation intensifies. Such interruption of supply chains as a result of geopolitical tensions emphasizes the importance of diversification and investment in alternative energy sources to improve supply security and resilience.

In June 2022, the Minerals Security Partnership (MSP), also known as the CRMs Alliance, was unveiled. This collaboration includes Australia, Canada, Finland, France, Germany, Italy, Japan, South Korea, Sweden, the UK, the US, and the EU. These are consumer-oriented actors aim to enhance supply chains for CRMs by ensuring they are manufactured, processed, and recycled inside the partner nations, employing local capability and geological resources. The ultimate objective is to minimize reliance on a small number of nations for these critical commodities and secure their availability

(Carrara et al., 2023, p. 27). Whilst the MSP announcement is important, no further details on how the partnerships would function are yet available.

The EU and the US suffer from strategic dependencies, which implies they are reliant on one another for specific resources. Ongoing international cooperation is crucial for ensuring a more secure and stable supply chain of CRMs. Thus, the EU and the US created a Working Group on Secure Supply Chains within the EU-US Trade and Technology Council (TTC) in September 2021 whose top aim is to increase supply chain resilience and security. The two collaborate to promote transparency in the supply and demand for CRMs, including those needed for permanent magnets, as part of their partnership. They are interested in identifying possible vulnerabilities or dangers in the supply chain and develop strategies to reduce them by exchanging information (European Commission, 2022b, p. 28).

In summary, establishing a strategic partnership indicates a long-term commitment to collaborate on shared objectives. This collaboration entails more than a one-time agreement or a simple trade interaction; it entails a profound feeling of shared interest and understanding. Both parties have the willingness to engage in the relationship and arrive at decisions together while considering each other's interests and concerns. A high degree of trust, openness, and communication is required in a strategic partnership to guarantee that both sides profit from the cooperation and achieve their mutual goals, another proof of growing interdependence.

5.3.1.2. Global Gateway Initiative

Global Gateway Initiative is an international strategy presented by the EU to finance infrastructure initiatives and establish commercial partnerships. Team Europe, comprised of EU institutions and Member States, plans to spend €300 billion in environmentally sustainable and high-quality projects from 2021 to 2027 (European Commission, 2023i). The funds invested will benefit partner nations and local people, as well as provide possibilities for EU Member States' private sectors to participate while upholding high standards of employment and environmental protection and solid

financial management. EU's Global Gateway Initiative aims to close the global investment gap and falls in line with the G7's promise of an open infrastructure cooperation. It is also consistent with the United Nations' Agenda 2030 and its Sustainable Development Goals and the Paris Agreement (European Commission, 2023i). Under Global Gateway, EU strives to, among other issues, address the climate and energy.

Combatting climate change, however, necessitates affordable and reliable access to energy and raw materials. The initiative thus emphasizes the value of inexpensive and dependable access to energy and CRMs for economic efficiency and industry competitiveness. The EU recognizes the need of investing in infrastructure in partner nations to establish sustainable and resilient raw material value chains, decreasing its reliance on a small number of suppliers which can in the long run secure a steady supply of CRMs. As a result, the Global Gateway is considered a win-win investment in global sustainability and energy security (European Commission, 2021c, pp. 5-6; European Commission, 2023f, p. 18). Global Gateway has been mentioned under CRMA and NZIA as of great importance while discussing and making recommendations for investing in projects in other countries as means of diversifying sources of CRMs (European Commission, 2023a, p. 8, 15; European Commission, 2023g, p. 18).

The EU has put forward a €50 million investment in the DRC's crucial mining industry and infrastructure projects. This investment falls under the umbrella of the EU's Global Gateway strategy, which attempts to counteract China's BRI. Despite having roughly €22.6 trillion in untapped raw material reserves, the DRC mostly exports raw minerals. Jutta Urpilainen, EU Commissioner for International Partnerships, emphasized the need of developing the complete value chain in the DRC, including processing, refining, and manufacturing, rather than just mining. CRMs, such as cobalt, in the DRC make it a country that offers multiple opportunities for investment (Komminoth, 2023).

In addition, another example of international cooperation is deescalating conflicts in politically unstable countries. To address the issue of conflict minerals in DRC brought up earlier in the paper, the EU has enacted the so-called *Conflict Minerals*

Regulation, that encourages responsible sourcing methods and mandates financial and supply chain transparency. By mandating EU importers and smelters to follow international responsible sourcing criteria specified by the OECD, the legislation intends to limit the risks associated with acquiring minerals from conflict-affected and high-risk areas (European Parliament and the Council of the EU, 2017, p. 5). In relation to Rwanda, the EU firmly opposed the encouragement of violence against any individual or group based on race or ethnicity, condemning those guilty for such conducts while welcoming the extension of the mandate of MONUSCO, recognizing its critical role in ensuring peace in the eastern DRC and beyond (Council of the EU, 2022a). In other words, EU's regulation aims to contribute to political stability in places where relevant CRMs are imported from by promoting responsible sourcing methods while assisting local development, decreasing the risks of supply interruption caused by wars or weak governance.

Another one of Global Gateway's flagship projects concerns those in Chile on lithium and copper. On December 9th 2022 EU and Chile reached a political conclusion on EU-Chile Advanced Framework Agreement (European Commission, 2022e). As the final approval is still anticipated, the interim agreement gives an overview of the pillars of EU – Chile partnership. *Chapter 8* specifically regulates the energy and raw materials dimension of the agreement. *Article 8.14* lays the foundation of the cooperation on energy and raw materials:

- The Parties shall have a fair and open mechanism for issuing authorizations for energy commodities and raw materials exploration and production.
- The Parties must collaborate to eliminate measures that might distort energy and raw material investment as well as trade.
- The Parties commit to working together on raw material issues such as responsible procurement, sustainability, and innovation, as well as the role of raw materials to the UN SDGs. They will collaborate on research and development as well as initiatives across the whole raw materials value chain, encompassing advanced technologies, smart mining, and digital mines (European Commission, 2022f, pp. 8 - 10).

At the COP27 in Egypt, Commission President Ursula von der Leyen and Namibian President Hage Geingob reached a MoU defining a strategic partnership between the EU and Namibia. The two parties agreed on establishing the partnership as one of the crucial projects under the Global Gateway Initiative (European Commission, 2022g). The two parties aim to, wherever feasible, incorporate raw materials and renewable hydrogen value chains and encouraging trade and investment, provide raw material and renewable hydrogen value chain capacity building, training, and development of expertise and coordinate research and innovation especially on circularity of materials (European Commission, 2022g).

EU's goal of diversifying its supplies of CRMs through international cooperation emphasizes the interdependence of actors in the global supply chains. Interdependence encompasses the connections and relationships that exist between various actors and systems. Yet it is more than just being interconnected. It refers to a relationship in which a number of parties interact in a system of action in such a manner that changes in one party have a major impact on the fulfillment of needs, values, and expected outcomes in the others. Simply said, the attainment of each party's needs and ideals is contingent on the actions of others (Coate et al., 2015, p. 2). Considering the fact that EU cannot in the near future escape being dependent on other countries for CRMs along different steps of the supply chain: extraction, processing and recycling, it needs to shift its focus on transforming the dependence into strength rather than a weakness. As a disruption at any stage of the value chain can have cascading effects, the EU is aiming turn the strategic partnerships and Global Gateway flagship projects into *win – win arrangement* where both parties can benefit from the agreement. However, in addition to fortifying its international access to CRMs, EU needs to evaluate its domestic capacities as well.

5.3.2. Domestic supply

EU is concentrating on expanding its own domestic sources of CRMs, complementary to its attempts to assure a reliable supply thereof through partnerships

and international initiatives. The Union recognizes the need for maintaining a trustworthy and sustainable domestic supply of CRMs, notwithstanding the necessity of international collaboration. By 2030, the EU has established specified goals to be met in relation to domestic CRM supply:

- 10% extraction capacity
- 15% recycling capacity
- 40% processing capacity (European Commission, 2023a, pp. 2 – 3)

To emphasize the significance of the set benchmarks, CRMA introduces the concept of *strategic projects* during the extraction, processing, and recycling phases to advance the EU's value chain concerning CRMs (European Commission, 2023a, p. 9). Strategic projects are to be perceived as serving in the public interest by the appropriate permitting authority considering their role in guaranteeing the Union's security of supply of CRMs, as well as their importance to the Union's strategic independence and the green transition (European Commission, 2023a, p. 6). In this context, a peculiar phrase is mentioned in the Proposal: *overriding public interest*. In such circumstances, the permitting entity in charge may give authorization if it judges, on a case-by-case basis, that the project will benefit the public more than it will have a negative impact, provided that all applicable requirements outlined in the aforementioned Proposal are fulfilled (European Commission, 2023a, p. 6). The following section analyzes one of the domestic areas of EU's interest where commitment to ensure a stable supply of CRMs has garnered a lot of attention.

5.3.2.1. Circular economy

The primary objective of strengthening domestic supply in EU is to advance circular economy which refers to the *recycling* benchmark. Circular economy places an emphasis on re-using resources, minimizing waste and adverse environmental effects. *Secondary CRMs* or *resources* are materials that are acquired through recovery and processing of waste and byproducts under the scheme of the circular economy and recycling (European Commission, 2023a, p. 4). These elements are in contrast with

primary CRMs, which are extracted directly from the nature and are unaltered. Nevertheless, there is no universal definition of circular use of raw materials, and various industries and organizations may have different meanings of the phrase. This lack of agreement can make developing and implementing guidelines and procedures that promote circularity and sustainable resource management difficult (European Commission, 2018a, p.10). Increasing the circular use of resources while reducing consumption represents one of the top concerns for the EU. This is essential since the EGD acknowledges that the EU's strategic security concerns relate to resource availability. Nearly all facets of the global economy depend on natural resources, which additionally generate important materials for everyday use (European Commission, 2020b, p.3).

The concept of circular economy has been referenced in several EU proposals, initiatives, and adopted regulation, attesting to its importance in EU policymaking. EU has acknowledged the significance of boosting circular economy in production and consumption patterns, enhancing energy efficiency, and strengthening contingency planning for supply security. With a growing emphasis on certain sectors like the recycling of composites and the substitution of CRMs, the focus on innovation will move to circularity and recycling (European Commission, 2023c, p. 52). In the new sustainable products initiative, calls have been made for promoting sustainable and circular business models as a possible approach to maximizing the use of goods and raw materials. To achieve carbon neutrality by 2050, decoupling economic development from resource usage, and ensuring long-term competitiveness without leaving anybody behind, the circular economy may be scaled up from *front-runners to mainstream players*. In order to move the industry towards carbon neutrality and sustainable competitiveness and to open up opportunities for economic growth, the circular economy is essential. It will result in significant material savings throughout value chains and manufacturing processes (Council of the EU, 2022b, p. 6; European Parliament, 2021, p. 11; European Commission, 2020c, p. 2, 6).

The possibility of endless recycling of CRMs, of which are mostly metals, makes the shift to a circular economy within the larger context of the green transition feasible. In the beginning, new technologies will still primarily come from primary

extraction, i.e., mining, and processing, but as the demand rises, recycling may mitigate the necessity for primary extraction and its corresponding environmental effects (European Commission, 2023a, p. 12). Considering the substantial number of CRMs used in electrical equipment and renewable technologies, it is no surprise the focus of recycling is directed towards those same components. Products like wind turbine and EVs rely on permanent magnets which contain CRMs, such as neodymium, praseodymium, dysprosium, nickel or cobalt, that are recyclable but are presently only done so on a limited basis or in research projects within the EU. Therefore, to increase circularity, permanent magnets are among top recycling – related priorities (European Commission, 2023a, p.13). Additionally, semiconductor chips possess a great opportunity for recycling. European Chips Act calls for the manufacturers to take into account ways to prolong the life of equipment and chips as well as techniques to recycle key materials used in order to boost the sustainability of electronic devices starting at the design stage. This implies that during the product creation process, producers should investigate and use circular design ideas, such as planning for disassembly, reuse, and recycling, as well as employing sustainable materials (European Commission, 2022h, p. 49).

Reducing global effects and resource dependence may be accomplished by implementing circular product techniques and improving resource extraction. The implementation of suitable technology or management techniques is essential since mining has major local implications and the demand for some raw materials is anticipated to increase in the future as a result of a renewed emphasis on green energy and climate neutrality. The tremendous potential for greater resource efficiency through circular use is evidenced by the large number of inefficient or underused sectors of resource utilization (European Commission, 2020b, p. 15). An example of this is waste recycling. Improvements must be made in the recovery of CRMs from landfills and mining waste, according to the Circular Economy Action Plan (European Commission, 2020c). The strategy contains an obligation on exchanging efficient methods for the recovery of CRMs from these sources to address the issue of landfills and accumulating mining waste. As both efforts seek to improve resource efficiency and decrease waste, they have a strong connection to the action on EU's extractive

waste management plans. Existing EU-funded programs in Belgium and France that are relevant for this step are underway, demonstrating that some effort has already been taken to address this issue. The ProSUM project, which is supported by Horizon 2020, intends to establish an expert network of secondary sources of CRMs across Europe. To assess their potential as secondary sources, the research collects information on waste materials such vehicles, batteries, electrical equipment, and mining waste (European Commission, 2018b, p. 17). EU can lessen its dependence on primary raw materials by recovering and recycling CRMs from landfills and mining waste, which will help the transition to a circular economy (European Commission, 2018b, pp. 29, 33; Gauß et al., 2021, 19). Microchip components can be found in electronic waste and retrieved through recycling. Yet, only very little compound semiconductor waste is currently recycled from electronic waste (European Commission, 2022d, p. 7).

It is important to emphasize that the EU may profit from the circular economy in a variety of ways, including financial and employment benefits that shouldn't be understated. The raw materials sector contributes significantly to the EU economy, supplying about 30 million jobs in the production sector, sustaining over 350,000 jobs. Nevertheless, the significance of waste recycling in electrical and electronic equipment is highlighted by the rising demand for raw materials and a shortage of CRMs. By 2030, the shift to a more sustainable, circular economy could generate 700,000 additional jobs, mostly in repair and recycling facilities. Disassembly and material recycling provide important chances to reintroduce manufacturing jobs to the EU. Additionally, the expansion of recycling capabilities may help meet future demands for raw materials. Applying circular economy concepts to the whole EU economy may boost GDP by an extra 0.5%. The implementation of closed-loop models can also increase a company's profitability by lowering its sensitivity to changes in resource prices (European Commission, 2020c, p. 2; European Parliament, 2021, p. 7).

6. Discussion

This section serves as a discussion of key findings after conducting a document analysis of relevant EU – produced documents. As mentioned earlier, SWOT analysis will be employed in the upcoming sub – sections. It will assist in evaluating EU's current and planned policies and initiatives in a more concise and representable manner. *Table 4* serves as a brief overview of the findings of the SWOT analysis:

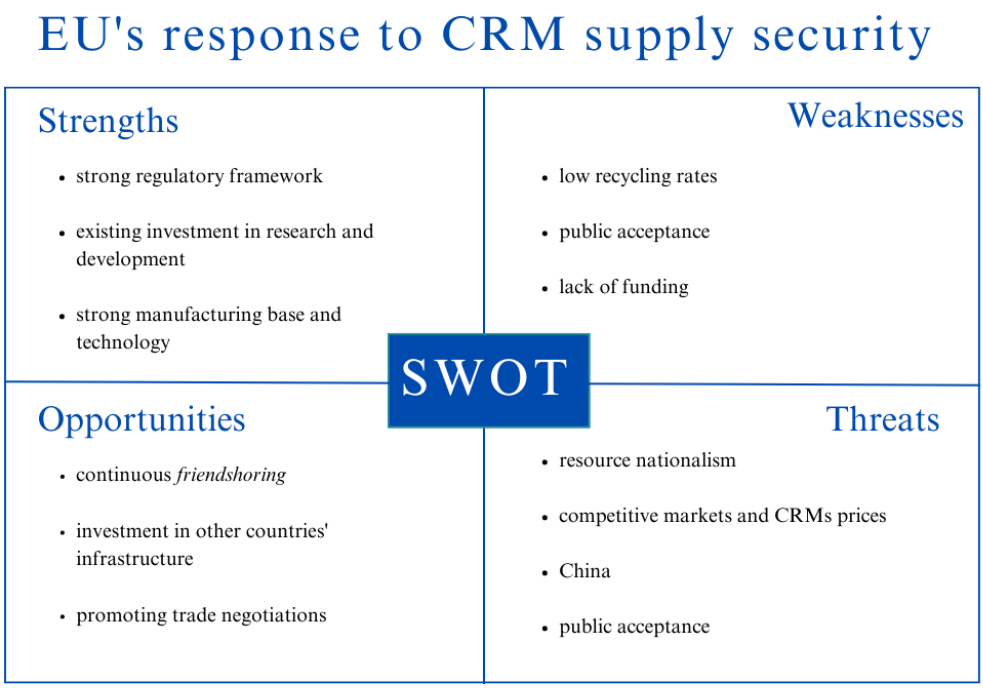

Table 4. SWOT analysis findings.

The discussion is thus divided into four sub – sections, with each focused on one variable: *strengths, weakness, opportunities and threats*.

6.1. Strengths

EU has always boasted with a strong regulatory framework which instilled the sense of upholding high standards of democratic governance and accountability. The

Union's policies reflect that commitment which can be interpreted as a means of establishing common norms that ensure an equal playing field for all the actors. By calling for impact assessments to be done, i.e., allowing input and feedback on strategic projects, providing the stakeholders with a voice on decision – making processes (European Commission, 2023a, p. 9). Impact assessments are mentioned in CRMA, NZIA and the Chips Act. Such participatory approach can be seen as one of the hallmarks of democratic governance which enhances the credibility of its policies and the Union overall. In addition, cooperation between EU Member States is a requisite for successful implementation of policies and initiatives which is facilitated by the fact that CRMA and NZIA will be Regulations, once adopted. In other words, the legislative will be universally applied in all Member States, surpassing national law and ensuring that the targets set are worked towards.

EU is known for its innovative technology and design which are the necessary foundation it can be built its renewable technologies (van Dyke, 2023). To do that, it needs to satisfy its CRMs needs. However, it has already invested in domestic projects regarding recycling and waste management under the Circular Economy Action Plan. Recycling and waste management provide a substitute supply for these resources and can lessen the EU's reliance on imports from abroad.

6.2. Weaknesses

CRM recycling rates tend to be quite low, while the technology and methods employed to recycle these materials are frequently unsuitable for their special properties. As a result, effort is required to solve the different issues that limit possibilities for advancing circular economy. This entails creating recycling equipment and processes that are specifically designed to meet the needs of individual materials as well as enhancing collecting, sorting, and processing techniques to boost recycling rates (European Commission, 2023a, p. 12).

Another point that needs to be given due attention is the extraction within the EU which has already set in motion a wave of public criticism and opposition to mining

activities. For example, Portuguese government made the decision to abandon a contentious lithium mining project that had received criticism from locals and environmentalists. A group of businesses had put forth the idea, which was meant to assist in securing the mineral's supplies for use in the manufacture of electric vehicle batteries. A protected habitat for an endangered species and the displacement of nearby populations were two issues that had aroused worries about the project's possible environmental and social effects (Hernandez – Morales and Diogo Mateus, 2021).

Furthermore, funding for projects, especially those classified as strategic, i.e., necessary for achieving the set benchmarks, has been explained in too little detail or omitted overall in the analyzed documents and it remains unclear how to finance the endeavors at the European level. Although the European Commission's proposals are significant, their success depends on funding. EU faces a significant obstacle in achieving its lofty objectives because there is presently no clear plan for financing this green economic effort. As a result, there is an urgent need to address this problem and identify practical means of funding the shift to a more environmentally friendly, sustainable sector in Europe (Noyan and Bourgery – Gonse, 2023). The establishment of EU Sovereignty Fund, as announced by von der Leyen in her State of the Union Speech in September 2022, is a significant and decisive step toward guaranteeing that Europe remains the center of global trade and investment. The Fund may play a key role in tackling crucial dependencies or offering extra assistance to initiatives currently supported by IPCEIs, speeding up their implementation and increasing Europe's sovereignty (von der Leyen, 2022). However, no details have been provided on the question on EU Sovereignty Fund as the discussions will possibly start in the summer, in addition to the assessment of the EU multiannual financial framework for 2021–2027 time period. Hence, EU should identify new financing sources and make sure that the European Investment Bank and other public development banks and financial institutions in Europe can develop more sustainable investments in order to remain competitive, especially in the context of China's BRI.

6.3. Opportunities

EU has encountered an unequal level playing field in the context of access to CRMs, reminded by recent political unraveling on its own soil and abroad. Its *friendshoring* is just one example of seeking a connection, actors such as China and the US have already accomplished, through BRI and NAFTA respectively. New challenges prompted the EU to reconsider the political dimension of CRMs supply chains. Thus, while still quite nascent, its strategic partnerships form a firm foundation for future collaboration in resource supply. The introduction of these initiatives heralds the emergence of a phenomenon known as "joint industrial policy," which refers to international cooperation in the creation of supply chains and industrial planning. In order to assist net-zero sectors in their individual countries, governments collaborate in order to build markets and obtain the necessary technologies (Allan et al., 2023). In addition, EU places great attention to its partner countries' welfare, especially in Africa. To do this, the EU's Global Gateway Initiative places a strong emphasis on promoting human and labor rights and investing in local infrastructure in its flagship initiatives. This is also evident in the Conflict Minerals Regulation, which aims to prevent the trade of minerals that finance armed conflicts and human rights violations and further reinforces the EU's commitment to upholding these principles. Contrarily, the BRI has been criticized for promoting authoritarian regimes, eroding independence and sovereignty of partner countries. In addition, there have been allegations of labor exploitation and violations of human rights in BRI-funded projects. These charges have raised questions about whether the BRI's emphasis on economic growth comes at the expense of environmental and human rights standards (Faiz, 2019).

EU's dedication to supporting human and labor rights while fostering local infrastructure can be seen as a political effort to improve ties with partner nations in Africa, but also the political stability in some countries. As was seen throughout the paper, political risks pose a great challenge to EU’s supply of CRMs and through its policies and initiatives, the bloc positioned itself as a bearer of political change. The EU is aligning itself with the values and aspirations of these countries by putting a

priority on sustainable economic development and social justice, increasing the EU's geopolitical power in the region and witnessing complex interdependence - actors are dependent on one another because of their connections on the economic, social as well as political levels.

Despite established partnerships and trade agreements, EU needs to continue seeking for new opportunities. The highest possible diversification of CRMs sources is a necessity and EU shouldn't find itself in a position in which it replaced one dependency with another. Moving from strategic autonomy to strategic interdependence is a must in the early stages of development of its own CRM supply chain. It cannot achieve the set benchmarks without relying on other export countries for certain CRMs. Turning dependence into an advantage can ensure the EU remains a relevant player in the CRMs race – geopolitically strong and economically resilient.

6.4. Threats

Possibly the biggest threat is that of resource nationalism, a growing global issue. Countries may seek to maximize the value of their natural resources in a number of ways, such as raising the government's revenue share, enacting windfall taxes, amending contracts to strengthen the state's involvement in the sector, or even nationalizing the sector entirely. These actions are motivated by a desire to exert more control over natural resources and increase the state's economic gains. They may, however, also be contentious and give rise to disputes with other actors on the global level (Robinson, 2022).

CRM market is very competitive and will only become more so. While competition inherently isn't bad, it does pose a threat to those who cannot leverage the opportunities provided by a competitive market. As was argued before, China is seen as a growing concern for the EU and its supply of CRMs, dominating the global market across all stages of the value chain. Supply disruptions can cause price instability, especially for CRMs whose prices are expected to skyrocket. Besides that, political instability can also be seen as a source of price volatility, shown by the impact Russian invasion of

Ukraine has had on the prices of some CRMs, such as nickel. Resource supply chains are very delicate and sensitive and in order to avoid the disruptions caused by sudden price surges, EU needs to build a strong domestic supply chain through stockpiling and recycling.

7. Remaining challenges

EU has taken noteworthy efforts, such as promoting recycling and fortifying international alliances to address the supply security of CRMs. However, despite these steps, there are still a few crucial areas that require further focus in order to guarantee a consistent and long – lasting supply of CRMs. Sections 6.2 and 6.4 served as overviews of *weakness* and *threats* respectively, observed in EU – published documents and initiatives. This second to last section of the research, serves as a succinct but comprehensive review of those difficulties the EU must overcome in order to pursue its objectives.

EU's strategy of *friendshoring*, although applauded, does need to be applied carefully as it can quite easily run into a dead end and backfire. For instance, Jerez et al. (2021) explore the concept of green electromobility, lithium extraction and occurring injustices in Chile. According to their arguments, the Global North's rising demand for lithium has predominantly caused local hydro-social systems to be disrupted, causing socio-environmental harm and water inequalities in the Global South. The ecosystems and indigenous communities that exist in these areas have suffered as a result of this upheaval, framing it as an extension of colonialism (Jerez et al., 2021, pp. 1 – 2). If EU is seen as too aggressive or being exploitative for only its own benefit, it may cause a counter effect in partner countries. This calls for ensuring the public acceptance and upholding environmental and social standards abroad the same way the bloc plans to do at home.

One of the repercussions of *friendshoring*, if not thought through properly, is resource nationalism. Gabriel Boric, the left-leaning president of Chile, has suggested the creation of a state-owned lithium production company. If accepted in the coming

months, this proposal would obligate private enterprises to form joint ventures in which the state corporation would own a majority stake. The action is representative of a larger regional trend in which newly elected left-wing administrations want to learn from the errors made in the past when the country's raw material riches were transferred abroad or only benefited a select group of a few (The Economist, 2023). Latin America has become an attractive option for nations looking to acquire resources for their energy transition and diversify their supply chains because the continent is home to more than half of the world's lithium reserves in addition to other significant materials like copper and nickel. However, governments in the region are regaining power through resource nationalism that is motivated by the need to boost state income and economic clout, generate employment, and keep riches from raw materials in the nation (The Economist, 2023). In other words, the EU's supply of CRMs is subject to interruption due to worldwide competition for these materials, as well as export limitations imposed by some of the primary manufacturers. The EU's reliance on imported commodities puts it at danger of shortages, which might have serious consequences for its economy and industry CRMs as international trade has become increasingly politicized (Theodosopoulos, 2020, p. 2).

Carefully evaluating the political context of the prospective partner state as well as the implications projects might have, is crucial for establishing long – lasting alliances. Every project and partnership thus call for individual assessment of the potential risks and opportunities. The EU's foreign policy and initiatives will elicit a range of reactions from countries abroad. While some will work together to enact necessary complementary climate change initiatives, others will attempt to competitively reroute trade and investment flows (Leonard et al., 2021, p. 4). Additionally, apart from the political entities, the EU needs to consider other stakeholders, i.e., industries. Multilevel discussions also take place with the industry and its representatives which leaves place for either alignment or gaps in interests (van Dyke, 2023). This also proves that CRMs supply can cause interdependence in myriad ways, necessitating coordination among different actors.

China will remain a growing concern. The G7 nations and their allies, including the EU, may be at risk from China's ability to dictate the export of CRMs for the

manufacture of clean energy technologies. However, the option to completely decouple from China is not feasible, especially considering the fact that EU still aims to import CRMs to a large scale – the benchmark for extraction in the EU is set at merely 10%. Hence, it is crucial for the EU and its like - minded partners to have a clearly established and integrated approach. Such a plan would assist in coordinating efforts to ensure a steady supply of necessary inputs, i.e., CRMs, for the creation of renewable energy (Allan et al., 2023).

Public criticism towards mining is part of the larger global trend of increased scrutiny and opposition to mining operations, particularly in regions with delicate ecosystems and communities, raising the possibility of future disputes of a similar nature. This is directly related to one of the main problems of EU policies mentioned earlier – the concept of *overriding public interest*. Due to the inherent contradictions between economic development and environmental conservation, overriding public interest in extraction activities in the EU is a contentious issue. Growing opposition from the local communities and NGOs will call for more sustainable activities and public scrutiny resulting in evaluating the concept of public interest. Also, as a prerequisite of the global climate policy and its 1.5°C target, the obstruction of European mining projects of CRMs even jeopardizes the EU's own energy and climate objectives of the European Green Deal and will only contribute to rising world emissions (Umbach, 2022). Additionally, mining is an extremely risky sector and money intensive activity which doesn’t contribute to the public opinion on it (van Dyke, 2023).

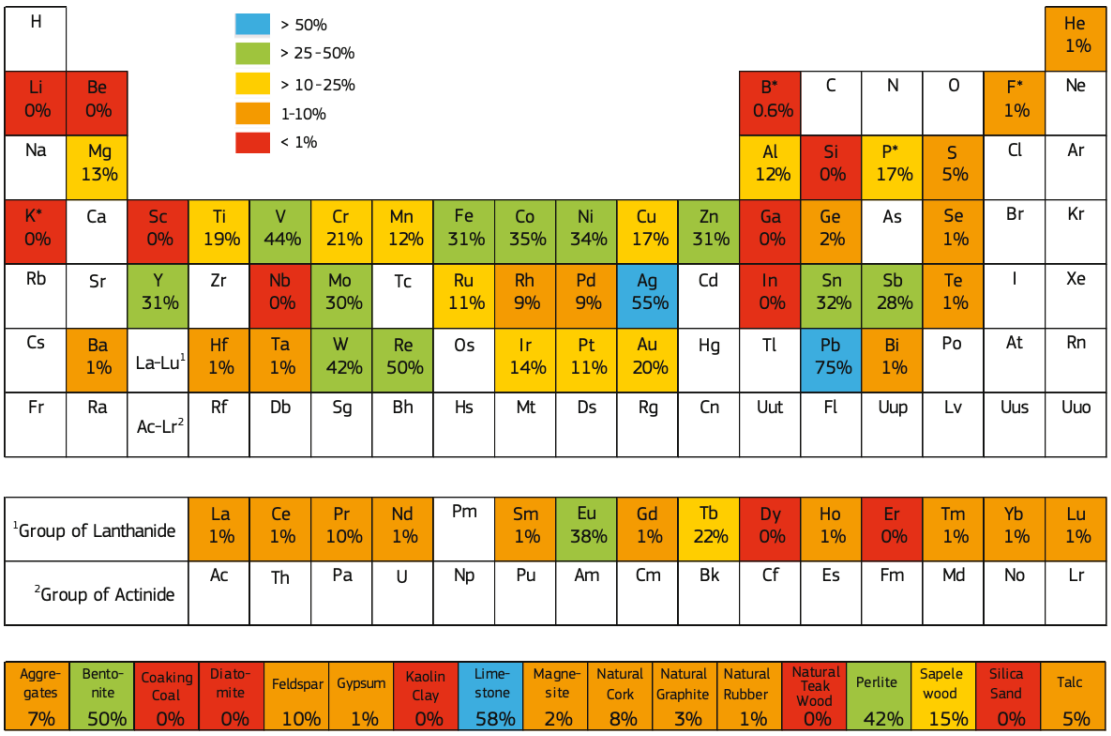

Figure 5. End of life recycling rates (European Commission, 2018b, p. 24)

Figure 5. illustrates the percentage of recycled materials relied on to provide the demand for various CRMs. Even though several of these materials have rather high recycling rates, recycled materials only make a small contribution to satisfying the overall demand for these elements. This is because there is a considerably greater demand for these resources than there is accessible supply of materials that have been recycled. Additionally, it is not possible to recycle in an economically viable manner through functional means in some cases (European Commission, 2018b, p. 24). In order to fulfill the rising demand for these materials, it is imperative to look into novel and creative ways to raise recycling rates and enhance the effectiveness of the recycling process while also considering how achievable the set benchmark for recycling – 15%, is.

Lastly, more is to be seen on the unraveling of current global events. The question of whether the Russia – Ukraine war will further escalate and what kind of repercussions that might have on EU's climate change mitigation objectives and inadvertently on its supply of CRMs. Another point that has been raised in recent times

is whether US IRA and its subsequent actions, partially shaping EU's policies, will lead to a subsidy race which might have a further impact on CRMs market distortion and trade tensions (Knittel, 2023).

The complex interdependence theory, which holds that actors in the global arena are interconnected and interdependent on each other, can be used to understand the findings of the previously conducted analysis and consequent obstacles facing the EU's supply security of CRMs. The need for a transition to a carbon-neutral economy, as well as economic growth and technological advancement, are some of the drivers that are fueling the demand for CRMs in the EU. However, the availability of these resources is constrained and influenced by a variety of geopolitical and environmental variables, from conflict between Russia and Ukraine to the growing opposition to mining operations. In addition to having an impact on the EU, these variables also have an impact on other players in the international system, witnessing the interdependence on a much larger scale as the case of EU and CRM supply security is not an isolated one (for instance, US IRA). Nevertheless, the EU must navigate these intricate interdependencies and strike a balance between conflicting interests as it works to overcome the difficulties of securing a consistent supply of CRMs. For instance, it must strike a balance between the need to respect local populations and preserve the environment and the need to provide a steady supply of metals and minerals. The partner countries, especially developing ones are also energy dependent and cannot merely be exploited for EU's needs. EU must also take into account how its actions may affect other states in the international system

8. Conclusion

Securing the supply of CRMs, requisite for EU's green transition, has proven to be of paramount importance. The past couple of years have witnessed a quite rapid rollout of policies, more notably following the Russian invasion of Ukraine in February 2022 threatening Europe's peace and stability, exacerbated by USA passing its IRA in August 2022 while China looms large with its CRMs leverage. This has prompted the

EU to reevaluate its competitiveness in CRM supply chains, but also reinforce itself as one of the world's leaders. While the question of acquiring CRMs is, economically speaking, crucial for achieving strategic autonomy EU so relentlessly wants, it is also a political concern. EU's relations with Russia, USA and China create a very complex interplay that includes first and foremost *flexing political muscles*, turning the green transition into a race for resources. Thus, it is difficult not to frame this as a competition between EU and other countries.

The paper's overall goal is to give a thorough review of the issues associated with supply security of CRMs and the EU's reaction to them, but also shed light on the remaining challenges that will most likely appear on EU agenda soon. To maintain an adequate supply of CRMs, the EU must take efforts to expand its strategic autonomy in relation to other key actors on the global stage, but also in its own backyard. The research aims to contribute to the existing literature on this topic especially since the subject is quite novel and a lot of scholarly articles are still focused on analyzing the supply of fossil fuels.

The world is changing quite quickly and the EU only touched the tip of the iceberg with its proposals and regulations aimed at stabilizing its supply of CRMs. However, more is to be done and this paper provided some insights on what is to yet be addressed. EU needs to adopt a multifaceted strategy to address these issues which includes collaboration, funding for research and development of innovative technologies that lessen the dependence on imported CRMs and advocacy for sustainable mining and recycling methods as this will enable the EU to successfully navigate complex interdependencies. Researching this topic can thus assist the EU policy makers in handling problems brought on by geopolitical unrest and interruptions in the world's supply chains by not taking for granted the evolving and dynamic state of supply chains.

9. Bibliography

Allan, B., Gordon, N. and Wang, C. (2023). *Friendshoring Critical Minerals: What Could the U.S. and Its Partners Produce?* Carnegie Endowment for International Peace.

Aslanturk, O. and Kıprızlı, G. (2020). *The role of renewable energy in ensuring energy security of supply and reducing energy - related import*. International Journal of Energy Economics and Policy, 10(2), pp.354–359. doi:https://doi.org/10.32479/ijeep.8414.

Azzuni, A. and Breyer, C. (2017). *Definitions and dimensions of energy security: a literature review.* Wiley Interdisciplinary Reviews: Energy and Environment, 7(1). doi:https://doi.org/10.1002/wene.268.

Bazilian, M.D. and Brew, G. (2022). *The Inflation Reduction Act Is the Start of Reclaiming Critical Mineral Chains*. [online] Foreign Policy. Available at: https://foreignpolicy.com/2022/09/16/inflation-reduction-act-critical-mineral-chains-congress-biden/. [Accessed 22 March 2023].

Blengini, G.A., Nuss, P., Dewulf, J., Nita, V., Peirò, L.T., Vidal-Legaz, B., Latunussa, C., Mancini, L., Blagoeva, D., Pennington, D., Pellegrini, M., Van Maercke, A., Solar, S., Grohol, M. and Ciupagea, C. (2017). *EU methodology for critical raw materials assessment: Policy needs and proposed solutions for incremental improvements.* Resources Policy, 53, pp.12–19. doi:https://doi.org/10.1016/j.resourpol.2017.05.008.

Bluszcz, A. (2016). *European economies in terms of energy dependence*. Quality & Quantity, 51(4), pp.1531–1548. doi:https://doi.org/10.1007/s11135-016-0350-1.

Bowen, G.A. (2009). *Document Analysis as a Qualitative Research Method*. Qualitative Research Journal, 9(2), pp.27–40. doi:https://doi.org/10.3316/QRJ0902027.

Carrara, S., Bobba, S., Blagoeva, D., Alves Dias, P., Cavalli, A., Georgitzikis, K., Grohol, M., Itul, A., Kuzov, T., Latunussa, C., Lyons, L., Malano, G., Maury, T., Prior Arce, Á., Somers, J., Telsnig, T., Veeh, C., Wittmer, D., Black, C., Pennington, D., Christou, M., (2023). *Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study*, Publications Office of the European Union, Luxembourg. doi:10.2760/386650, JRC132889

Celiktas, M.S. and Kocar, G. (2009). *A quadratic helix approach to evaluate the Turkish renewable energies*. Energy Policy, 37(11), pp.4959–4965. doi:https://doi.org/10.1016/j.enpol.2009.06.061.

Chalvatzis, K.J. and Ioannidis, A. (2017). *Energy supply security in the EU: Benchmarking diversity and dependence of primary energy*. Applied Energy, 207, pp.465–476. doi:https://doi.org/10.1016/j.apenergy.2017.07.010.

Chen, W.-M., Kim, H. and Yamaguchi, H. (2014). *Renewable energy in eastern Asia: Renewable energy policy review and comparative SWOT analysis for promoting renewable energy in Japan, South Korea, and Taiwan.* Energy Policy, 74, pp.319–329. doi:https://doi.org/10.1016/j.enpol.2014.08.019.

Coate, R.A., Griffin, J.A. and Elliott-Gower, S. (2015). *Interdependence in International Organization and Global Governance*. Oxford Research Encyclopedia of International Studies. doi:https://doi.org/10.1093/acrefore/9780190846626.013.110.

Costantini, V., Gracceva, F., Markandya, A. and Vicini, G. (2007). *Security of energy supply: Comparing scenarios from a European perspective*. Energy Policy, 35(1), pp.210–226. doi:https://doi.org/10.1016/j.enpol.2005.11.002.

Correljé, A. and van der Linde, C. (2006*). Energy supply security and geopolitics: A European perspective.* Energy Policy, 34(5), pp.532–543. doi:https://doi.org/10.1016/j.enpol.2005.11.008.

Council of the EU (2021). *European Union-Canada summit 2021 – Joint statement.*

Council of the EU (2022a). *Democratic Republic of the Congo: Statement by the High Representative on behalf of the EU on the publication of the recent UN Group of Experts report*. [online] Available at: https://www.consilium.europa.eu/en/press/press-releases/2022/12/31/democratic-republic-of-the-congo-declaration-by-the-high-representative-on-behalf-of-the-eu-on-the-publication-of-the-recent-un-group-of-experts-report/. [Accessed 4 March 2023].

Council of the EU (2022b). *Informal meeting of the Heads of State or Government: Versailles Declaration.*

De Paoli, L., Commerciale, U., Bocconi, L., Milan, M., Sacco, U., Commerciale, L., Bocconi, N. and Pochettino (2010). *Evaluating Security of Energy Supply in the EU: Implications for project appraisal*. [online] Available at: https://institute.eib.org/wp-content/uploads/2016/04/2010BocconiStarebei.pdf. [Accessed 2 February 2023].

De Rosa, M., Gainsford, K., Pallonetto, F. and Finn, D.P. (2022*). Diversification, concentration and renewability of the energy supply in the European Union*. Energy. 253, p.124097. doi:https://doi.org/10.1016/j.energy.2022.124097.

Domaracka, L., Matuskova, S., Tausova, M., Senova, A. and Kowal, B. (2022). *Efficient Use of Critical Raw Materials for Optimal Resource Management in EU Countries*. Sustainability, 14(11), p.6554. doi:https://doi.org/10.3390/su14116554.

Elbassoussy, A. (2019). *European energy security dilemma: major challenges and confrontation strategies*. Review of Economics and Political Science, 4(4), pp.321–343. doi:https://doi.org/10.1108/reps-02-2019-0019.

European Commission (2008). *Communication from the Commission to the European Parliament and the Council: The raw materials initiative – meeting our critical needs for growth and jobs in Europe.* COM(2008) 699 final.

European Commission (2011). *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*. COM(2011) 25 final.

European Commission (2018a): *Report on Critical Raw Materials in the Circular Economy*. Publications Office of the European Union. doi:10.2873/167813

European Commission (2018b). *Commission Staff Working Document: Report on Critical Raw Materials and the Circular Economy.* SWD(2018) 36 final. Part 2.

European Commission (2019). *A European Green Deal*. [online] European Commission. Available at: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en. [Accessed 30 January 2023].

European Commission (2020a). *Study on the EU's list of Critical Raw Materials - Final Report*. Publications Office of the European Union. doi: 10.2873/11619

European Commission (2020b). *Commission Staff Working Document: Leading the way to a global circular economy: state of play and outlook*. SWD(2020) 100 final.

European Commission (2020c). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A new Circular Economy Action Plan - For a cleaner and more competitive Europe.* COM(2020) 98 final.

European Commission (2021a). *3rd Raw Materials Scoreboard: European innovation partnership on raw materials*, Publications Office. Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. https://data.europa.eu/doi/10.2873/567799

European Commission (2021b). *Memorandum of Understanding between the European Union and Ukraine on a Strategic Partnership on Raw Materials.*

European Commission (2021c). *Joint Communication to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: The Global Gateway.* JOIN(2021) 30 final.

European Commission (2022a). *EU-China: A stable global economy is a shared responsibility*. [online] European Commission Press Corner. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4547. [Accessed 11 pril 2023].

European Commission (2022b). *Commission Staff Working Document: EU strategic dependencies and capacities: second stage of in-depth reviews*. SWD(2022) 41.

European Commission (2022c). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: RePowerEU Plan*. COM(2022) 230.

European Commission (2022d). *Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act).* COM(2022) 46 final.

European Commission (2022e). *Towards an EU-Chile Advanced Framework Agreement*. [online] Policy and trade. Available at: https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/chile/eu-chile-agreement_en [Accessed 17 April 2023].

European Commission (2022f). *Interim trade agreement between the European Union and the Republic of Chile. Chapter 8.*

European Commission (2022g). *COP27: European Union concludes a strategic partnership with Namibia on sustainable raw materials and renewable hydrogen*. [online] Press corner. Available at: https://luxembourg.representation.ec.europa.eu/actualites-et-evenements/actualites/cop27-european-union-concludes-strategic-partnership-

namibia-sustainable-raw-materials-and-renewable-2022-11-08_de [Accessed 20 February 2023].

European Commission (2022h). *Commission Staff Working Document: A Chips Act for Europe*. SWD(2022) 147 final.

European Commission (2023a). *Proposal for a Regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020.* COM(2023) 160 final.

European Commission (2023b). *Critical raw materials*. [online] single-market-economy.ec.europa.eu. Available at: https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en#:~:text=The%20list%20of%20CRMs%20was [Accessed 19 January 2023].

European Commission (2023c). *Commission Staff Working Document: Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity.* SWD(2023) 68.

European Commission (2023d). *Technical Barriers to Trade*. [online] policy.trade.ec.europa.eu. Available at: https://policy.trade.ec.europa.eu/help-exporters-and-importers/accessing-markets/technical-barriers-trade_en#:~:text=Technical%20Barriers%20to%20Trade%20result. [Accessed 11 March 2023].

European Commission (2023e). *The Green Deal Industrial Plan: putting Europe's net-zero industry in the lead*. [online] European Commission Press Corner. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_23_510. [Accessed 1 May 2023].

European Commission (2023f). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: A Green Deal Industrial Plan for the Net - Zero Age.* COM(2023) 62.

European Commission (2023g). Proposal for a *Regulation of the European Parliament and of the Council establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act)*. COM(2023) 161 final.

European Commission (2023h). *Policy and strategy for raw materials*. [online] single-market-economy.ec.europa.eu. Available at: https://single-market-economy.ec.europa.eu/sectors/raw-materials/policy-and-strategy-raw-materials_en [Accessed 12 March 2023].

European Commission (2023i). *Global Gateway*. [online] commission.europa.eu. Available at: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/stronger-europe-world/global-gateway_en. [Accessed 12 March 2023].

European External Action Service (2022). *EU - China Relations Factsheet*. [online] Available at: https://www.eeas.europa.eu/sites/default/files/documents/EU-China_Factsheet_01Apr2022.pdf. [Accessed 11 February 2023].

European Parliament and Council of the EU (2017). *Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017: Laying down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high-risk areas*.

European Parliament (2021). *European Parliament resolution of 24 November 2021 on a European strategy for critical raw materials* (2021/2011(INI)). P9 TA(2021)0468

Faiz, A. (2019). *Is China's Belt and Road Initiative Undermining Human Rights?* [online] The Diplomat. Available at: https://thediplomat.com/2019/06/is-chinas-belt-and-road-initiative-undermining-human-rights/ [Accessed 7 May 2023].

Fertel, C., Bahn, O., Vaillancourt, K. and Waaub, J.-P. (2013). *Canadian energy and climate policies: A SWOT analysis in search of federal/provincial coherence.* Energy Policy, 63, pp.1139–1150. doi:https://doi.org/10.1016/j.enpol.2013.09.057.

Gauß, R., Burkhardt, C., Carencotte, F., Gasparon, M., Gutfleisch, O., Higgins, I., Karajić, M., Mäkinen, M., Schäfer, B., Schindler, R. and Veluri, B. (2021). *Rare Earth Magnets and Motors: A European Call for Action*. European Raw Materials Alliance.

Gielen, D. (2021). *Critical minerals for the energy transition*. International Renewable Energy Agency.

Gross, J.M.S. (2018). *Document Analysis*. In: B.B. Frey, ed., *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*. SAGE Publications.

Harsem, Ø. and Harald Claes, D. (2013). *The interdependence of European–Russian energy relations.* Energy Policy, 59, pp.784–791. doi:https://doi.org/10.1016/j.enpol.2013.04.035.

Hernandez - Morales, A. and Diogo Mateus, S. (2021). *Portugal to scrap lithium mining project*. [online] POLITICO. Available at: https://www.politico.eu/article/portugal-lithium-mining-project-scrap/ [Accessed 30 April 2023].

Immenkamp , B. and Claustre, J. (2023). *EU relations with Iran*. [online] Epthinktank. Available at: https://epthinktank.eu/2023/02/01/eu-relations-with-iran/ [Accessed 12 February 2023].

International Energy Agency (2023). *Energy security Ensuring the uninterrupted availability of energy sources at an affordable price*. [online] IEA. Available at: https://www.iea.org/about/energy-security#:~:text=The%20IEA%20defines%20energy%20security [Accessed 10 January 2023].

Kalantzakos, S. (2020). *The Race for Critical Minerals in an Era of Geopolitical Realignments.* The International Spectator, 55(3), pp.1–16. doi:https://doi.org/10.1080/03932729.2020.1786926.

Kalantzakos, S., Overland, I. and Vakulchuk, R. (2023). *Decarbonisation and Critical Materials in the Context of Fraught Geopolitics: Europe's Distinctive Approach to a Net Zero Future*. The International Spectator, 58(1), pp.3–22. doi:https://doi.org/10.1080/03932729.2022.2157090.

Karppinen, K. and Moe, H. (2012*). What We Talk about When We Talk about Document Analysis*. In: N. Just and M.P. Puppis, eds., *Trends in Communication policy Research: New Theories, Methods and Subjects*. Intellect.

Keating, D. (2023). *Should Europe mine more to secure its clean energy future?* [online] Energy Monitor. Available at: https://www.energymonitor.ai/sectors/industry/europe-critical-raw-materials-rio-tinto-interview/ [Accessed 2 May 2023].

Keohane, R.O. and Nye, J.S. (2011). *Power and interdependence*. 4th ed. Pearson.

Kessler, S. (2022). *What Is 'Friendshoring'?.* The New York Times. [online] 18 Nov. Available at: https://www.nytimes.com/2022/11/18/business/friendshoring-jargon-business.html. [Accessed 2 March 2023].

Kleimann, D.Z., Poitiers, N., Sapir, A., Tagliapietra, S., Véron, N., Veugelers, R. and Zettelmeyer, J. (2023). *How Europe should answer the US Inflation Reduction Act*. Bruegel.

Knittel, C. (2023). *The geopolitics of the energy transition: Is strategic autonomy the solution or the problem?,* The State of the Union 2023: Building Europe in times of uncertainty. Florence.

Komminoth, L. (2023). *EU pledges €50m investment in DRC infrastructure and minerals*. [online] African Business. Available at: https://african.business/2023/03/trade-investment/eu-pledges-e50m-investment-in-drc-infrastructure-and-minerals [Accessed 1 April 2023].

Kowalski, P. and C. Legendre (2023), "Raw materials critical for the green transition: Production, international trade and export restrictions", OECD Trade Policy Papers, No. 269, OECD Publishing, Paris, https://doi.org/10.1787/c6bb598b-en.

Krickovic, A. (2015). *When Interdependence Produces Conflict: EU–Russia Energy Relations as a Security Dilemma*. Contemporary Security Policy, 36(1), pp.3–26. doi:https://doi.org/10.1080/13523260.2015.1012350.

Kruyt, B., van Vuuren, D.P., de Vries, H.J.M. and Groenenberg, H. (2009). *Indicators for energy security*. Energy Policy, 37(6), pp.2166–2181. doi:https://doi.org/10.1016/j.enpol.2009.02.006.

Jasiūnas, J., Lund, P.D. and Mikkola, J. (2021). *Energy system resilience – A review.* Renewable and Sustainable Energy Reviews, 150, doi:https://doi.org/10.1016/j.rser.2021.111476.

Jerez, B., Garcés, I. and Torres, R. (2021). *Lithium extractivism and water injustices in the Salar de Atacama, Chile: The colonial shadow of green electromobility.* Political Geography, 87(1). doi:https://doi.org/10.1016/j.polgeo.2021.102382.

Le Coq, C. and Paltseva, E. (2009). *Measuring the security of external energy supply in the European Union*. Energy Policy, 37(11), pp.4474–4481. doi:https://doi.org/10.1016/j.enpol.2009.05.069.

Leonard, M., Pisani-Ferry, J., Shapiro, J., Tagliapietra, S. and Wolff, G. (2021). *The Geopolitics of the European Green Deal*. European Council of Foreign Relations.

Lewicka, E., Guzik, K. and Galos, K. (2021). *On the Possibilities of Critical Raw Materials Production from the EU's Primary Sources*. Resources, 10(5). doi:https://doi.org/10.3390/resources10050050.

Mancini, L., De Camillis, C. and Pennington, D. (2013). *Security of supply and scarcity of raw materials - Towards a methodological framework for sustainability assessment* . [online] Luxembourg: European Commission, Joint Research Centre, Institute for Environment and Sustainability, Publications Office of the European Union. Available at: https://eplca.jrc.ec.europa.eu/uploads/RawMat-scarcity-of-raw-materials.pdf. [Accessed 4 April 2023].

Mancini, L., Eslava, N. A., Traverso, M., Mathieux, F. (2020). *Responsible and sustainable sourcing of battery raw materials*. Publications Office of the European Union, Luxembourg, doi:10.2760/562951, JRC120422.

Markovska, N., Taseska, V. and Pop-Jordanov, J. (2009). *SWOT analyses of the national energy sector for sustainable energy development*. Energy, 34(6), pp.752–756. doi:https://doi.org/10.1016/j.energy.2009.02.006.

McBride, J. and Chatzky, A. (2019). *Is 'Made in China 2025' a Threat to Global Trade?* [online] Council on Foreign Relations. Available at: https://www.cfr.org/backgrounder/made-china-2025-threat-global-trade. [Accessed 22 February 2023].

Morgan, H. (2022). *Conducting a Qualitative Document Analysis*. The Qualitative Report. 27(1). doi:https://doi.org/10.46743/2160-3715/2022.5044.

Noyan, O. and Bourgery-Gonse, T. (2023). *Industrial policy: Will the EU have the money to finance its ambitions?* [online] Euractiv. Available at: https://www.euractiv.com/section/economy-jobs/news/industrial-policy-will-the-eu-have-the-money-to-finance-its-ambitions/ [Accessed 2 May 2023].

Nygaard, A. (2022). *The Geopolitical Risk and Strategic Uncertainty of Green Growth after the Ukraine Invasion: How the Circular Economy Can Decrease the Market Power of and Resource Dependency on Critical Minerals*. Circular Economy and Sustainability. doi:https://doi.org/10.1007/s43615-022-00181-x.

Obaya, M. (2021). *The evolution of resource nationalism: The case of Bolivian lithium*. The Extractive Industries and Society, 8(3), p.100932. doi: https://doi.org/10.1016/j.exis.2021.100932

Ostrowski, W. (2023). *The twilight of resource nationalism: From cyclicality to singularity?* Resources Policy, 83, pp.103599–103599. doi: https://doi.org/10.1016/j.resourpol.2023.103599

Proskuryakova, L. (2018). *Updating energy security and environmental policy: Energy security theories revisited*. Journal of Environmental Management, 223, pp.203–214. doi:https://doi.org/10.1016/j.jenvman.2018.06.016.

Rabe, W., Kostka, G. and Smith Stegen, K. (2017). *China's supply of critical raw materials: Risks for Europe's solar and wind industries?* Energy Policy. 101, pp.692–699. doi:https://doi.org/10.1016/j.enpol.2016.09.019.

Rademaker , M. (2019). *The Geopolitics of Materials: How Population Growth, Economic Development and Changing Consumption Patterns Fuel Geopolitics*. In: *World Scientific Series in Current Energy Issues: Critical Materials Underlying Causes and Sustainable Mitigation Strategies*. World Scientific Publishing. pp.13–31. doi:https://doi.org/10.1142/9789813271050_0002.

Ragonnaud, G. (2023). *Securing Europe's supply of critical raw materials: The material nature of the EU's strategic goals*. European Parliamentary Research Service.

Rana, W. (2015). *Theory of Complex Interdependence: A Comparative Analysis of Realist and Neoliberal Thoughts*. International Journal of Business and Social Science, 6(2), pp.290–297.

Reisch , V. (2022). *The Race for Raw Materials.* Stiftung Wissenschaft und Politik Journal *Review*. doi:https://doi.org/10.18449/2022JR01.

Reuters (2023). U.S. lays out possible critical raw materials agreement with EU - Handelsblatt. *Reuters*. Available at: https://www.reuters.com/business/us-lays-out-possible-critical-raw-materials-agreement-with-eu-handelsblatt-2023-03-23/ [Accessed 2 April 2023].

Rietveld, E., Bastein, T., van Leeuwen, T., Wieclawska, S., Bonenkamp, N., Peck, D., Klebba, M., Le Mouel, M., Poitiers, N. (2022). *Strengthening the security of supply of products containing Critical Raw Materials for the green transition and decarbonization*. Publication for the committee on Industry, Research and Energy (ITRE), Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament. Luxembourg.

Riofrancos, T. (2022). *The Security–Sustainability Nexus: Lithium Onshoring in the Global North*. Global Environmental Politics, 23(1), pp.1–22. doi:https://doi.org/10.1162/glep_a_00668.

Robinson, M. (2022). *How the global pandemic has shaped resource nationalism*. [online] EITI. Available at: https://eiti.org/blog-post/how-global-pandemic-has-shaped-resource-nationalism [Accessed 2 February 2023].

Russel, D.R. and Berger, B.H. (2020). *Weaponizing the Belt and Road Initiative*. The Asia Society Policy Institute.

Salim, H., Sahin, O., Elsawah, S., Turan, H. and Stewart, R.A. (2022). *A critical review on tackling complex rare earth supply security problem*. Resources Policy, 77. doi:https://doi.org/10.1016/j.resourpol.2022.102697.

Sattich, T., Freeman, D., Scholten, D. and Yan, S. (2021). *Renewable energy in EU-China relations: Policy interdependence and its geopolitical implications*. Energy Policy, 156, p.112456. doi:https://doi.org/10.1016/j.enpol.2021.112456.

The Economist (2023). *The green revolution will stall without Latin America's lithium*. [online] The Economist. Available at: https://www.economist.com/the-americas/2023/05/02/the-green-revolution-will-stall-without-latin-americas-lithium [Accessed 6 May 2023].

Theodosopoulos, V., (2020). *The Geopolitics of Supply: towards a new EU approach to the security of supply of critical raw materials?* Institute for European Studies, 5.

Umbach, F. (2022). *Critical Raw Materials for the energy transition: Europe must start mining again*. [online] Energy Post. Available at: https://energypost.eu/critical-raw-materials-for-the-energy-transition-europe-must-start-mining-again/. [Accessed 3 May 2023].

Unguru, M., Georgitzikis, K., Ciupagea, C. and Garbossa, E. (2022a). *Russian trade in non-food raw materials*, Publications Office of the European Union, Luxembourg, doi:10.2760/837284, JRC129611.

Unguru, M., Georgitzikis, K., Ciupagea, C., Garbossa, E. (2022b). *Ukraine's trade in non-food raw materials - Focus on EU-Ukraine trade relations*, Publications Office of the European Union, Luxembourg, doi:10.2760/816082, JRC130392.

van Dyke, A. (2023). *Second ECFR Forum on Strategic Raw Materials – Strategic Partnerships for Investment and Impact*. European Council on Foreign Relations.

van Wieringen , K. and Fernández Álvarez, M. (2022). *Securing the EU's supply of critical raw materials*. [online] Epthinktank. Available at: https://epthinktank.eu/2022/07/08/securing-the-eus-supply-of-critical-raw-materials/. [Accessed 13 April 2023].

von der Leyen, U. (2022). *2022 State of the Union Address by President von der Leyen*. [online] Available at: https://ec.europa.eu/commission/presscorner/detail/en/speech_22_5493. [Accessed 12 January 2023].

Wang, F., Harindintwali, J.D., Yuan, Z., Wang, M., Wang, F., Li, S., Yin, Z., Huang, L., Fu, Y., Li, L., Chang, S.X., Zhang, L., Rinklebe, J., Yuan, Z., Zhu, Q., Xiang, L., Tsang, D.C.W., Xu, L., Jiang, X. and Liu, J. (2021). *Technologies and perspectives for achieving carbon neutrality*. The Innovation. 2(4), p.100180. doi:https://doi.org/10.1016/j.xinn.2021.100180.

Wellmer, Friedrich-W., Buchholz, P., Gutzmer, J., Hagelüken, C., Herzig, P., Littke, R. and Thauer, R.K. (2019). *Raw Materials For Future Energy Supply.* S.L.: Springer.

Zhao, H. (2019). *Energy Security: From Energy Independence to Energy Interdependence.* In: *The Economics and Politics of China's Energy Security Transition*. Elsevier, pp.99–120.

Zhao, Y., Liu, X., Wang, S. and Ge, Y. (2019). *Energy relations between China and the countries along the Belt and Road: An analysis of the distribution of energy resources and interdependence relationships.* Renewable and Sustainable Energy Reviews. 107, pp.133–144. doi:https://doi.org/10.1016/j.rser.2019.03.007.