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The European Union
and
The Geopolitics of Rare Earth Elements

Prof. Raffaele Marchetti

SUPERVISOR CANDIDATE

Riccardo Cefis

CANDIDATE

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Introduction

Rare Earth Elements have become one of the most discussed topics in the current affairs panorama, it seems that none was aware of their relevance in the public opinion.
Why is Rare Earth Elements'(from now on REEs) importance shown only now?
REEs are fundamental components in the building process for numerous high-tech, decarbonization processes, and in the defence industry. Their applicability is well known for a while, but they remained hidden from public opinion for decades.
Their first popularity explosion rises in the Chinese Japanese accident of 2010; where the PRC blocked, despite not taking an official position, de facto the REEs' exportation to Japan, setting a precedent that generated diffused fear in other importers of REEs and the international community.
The prices rose and remained high for several months. This treated the efficiency of the market, forcing numerous factories to be transferred to Chinese soil to avoid interruption in the supply chain and high prices caused by the culling on import quantities level imposed by China's government.
The EU, USA and Japan opened a dispute through the World Trade Organization (WTO) against Chinese Policies, asking China to retire all the restrictions. In the meanwhile, the market started to correct itself, the prices decreased, and the policymakers decided to focus their attention on more "relevant issues".
In 2014 the WTO rejected the Chinese appeal declaring the export restriction as an unfair practice.
The world forgot the crisis despite China remaining technically the only supplier of REEs.
However, in the sequent decades, multiple development projects and trends focus on the implementation of REEs in multiple applications such as fostering decarbonisation, military industries, automation, and digitalisation.
In this scenario, the EU is the most prominent actor in promoting the green transition with a variety of projects which the entire European ecosystem.

In the last 7 years, the EU's position on China became more assertive. The European Union's position is clearly outlined in the 2019 strategic outlook which set the strategy for the future of EU-China relations, considering China as a strategic partner in the fight for environmental sustainability and human rights, a commercial competitor, and a systematic rival.
REEs are and will play a key role in the development of the international relation with China.
The high Chinese production concentration in combination with the rising global political tensions and a growing Chinese domestic market demand result in a high supply risk for these materials from a European perspective.
These Elements are considered so vital for the European ecosystem to have been defined by the European Commission to be among the most resource-critical of all raw.
For these reasons, this thesis aims to research and analyse why the Rare Earth Elements supply chain is important to the EU and its Member States.
To furnish a complete and exhaustive answer the thesis will be organized in three chapters.
Chapter 1 will provide an introduction to the various theoretical perspectives within the field of International Relations and their application to the study of strategic resources.
After having depicted the diverse theoretical frameworks that shape our understanding of the dynamics surrounding strategic resources in the international arena, to grasp the significance of resources in the context of International Relations will be of interest to delve into the notion of mineral scarcity. The first Chapter will be concluded with an analysis of the EU's and Chinese Economic Diplomacy.
Chapter 2 will introduce the REEs. will analyse which are the current categorization for REEs, which are the methods in REEs extraction, inquiring about the complications that surround mining, processing, and importing REEs, and finally the chapter identifies the different REEs' applications.
Chapter 3 focuses on examining the European Union's dependencies on rare earth elements and, consequently, its reliance on the Chinese supply chain. The initial section aims to identify the sectors that are particularly vulnerable to these dependencies. Additionally, an in-depth exploration of various technologies that rely on REEs will be conducted, highlighting the bottlenecks within the value chain and identifying the causes of associated risks.
Furthermore, this study will shed light on the countermeasures and ongoing initiatives undertaken by the European Union to secure industries that are dependent on REEs. Special attention will be given to the exploration of potential solutions through recycling, research and development efforts, and the opportunities presented by the exploitation of lunar resources.

Ultimately, this chapter concludes with a comprehensive analysis of potential strategies and measures that can be implemented to address the challenges posed by the European Union's dependencies on REEs, thereby contributing to a more robust and sustainable resource management framework.

Chapter 1
Explaining the international competition for strategic resources

In ecology, the use of the same resource by individuals of the same species (intraspecific competition) or of different species (interspecific competition) is when the supply of the resource is insufficient for the combined needs of all individuals. It is a major factor in natural selection. Also called struggle for existence.

Abstract:
This first chapter will inquire into the main International Relations theory which represents the different positions taken on strategic resources.
International Relations theories jointly with a geopolitical approach, have always seen strategic resources as a central tool to achieve wealth and technological innovation, but also the catalysts of disputes solved by conflicts or cooperation.
To fully understand why resources are one of the key factors in IR, it is mandatory to explain what mineral scarcity means. Consequently, will be of our interest to briefly summarize the main thinkers' theory about scarcity, to be aware of the behaviours of the international actors.
Economic Diplomacy will be the final paragraph. Strategic resources often became an instrument in the hand of policymakers to achieve political goals.
Economic Diplomacy is the core of the EU statecraft and is the most used tool in international relations to achieve and spread European values and principles. In the last decade also, China developed its own way of conducting Economic Diplomacy and as in the crisis of 2010 often uses its Champions in strategic sectors to achieve its goals.
The EU and the Chinese way of conducting affairs in the international realm may differ and come in contrast, the differences will be analysed to understand why in a possible scenario the EU must be aware of its vulnerabilities which China can rely on.

1.1 Historical Examples

Resources have always driven multiple dilemmas inside International Relations theories, securing access to vital resources represented and representing a crucial topic in the argumentations of the different theories and approaches.

History is full of examples where the necessity of resources drove conflicts, explorations, and political agreements exciting international politics.

For example, the European imperial expansion, such as the late-nineteenth century ‘scramble for Africa’, was closely linked to the need to obtain the raw materials required for the European states' industrialization and great power ambitions. The Cold War had its resource-related fights over access to the Persian Gulf's oil reserves and crucial strategic minerals like chromium, whose reserves are in the Soviet Union and South Africa.

The process of decolonization that followed World War II was usually related to international warfare over control of the natural resources available in these countries. From the 1970s onwards, ‘energy security has been used in redefining international politics and entered integrally in the ‘high politics’ debate.

International Relations and Geopolitics are intimately linked to the concept of resource scarcity and security for three principal reasons.

The first one is defined as physical and describes the fact that resources are distributed unevenly around the world, consequently, some countries and regions are evidently more resource-rich than others.

The second is defined by the critical importance that resources cover for global economic development and growth and the value that represents the international trade of commodities.

Thus, the high level of rent that possession of these resources can provide contributes significantly to international competition.

The third is the anarchical structure of the international political realm where, due to the absence of an authoritative global government, the risk of seeing states acting to determine political and economic outcomes more than regional and international governance institutions and international law exists.
The central focus of International Relations is to analyse and explain the anarchical realm of international politics.
IR ambition is the possibility to construct general theories that can identify the significant regularities and patterns of interaction in the realm of international politics.
Consequently, IR is classically divided into three general theories: realism, liberalism and radicalism, every theory explains resource competition with dissimilar and complementary approaches.

1.2 Realism

For the realist tradition, human nature is pessimist, in one of Hobbe's most important books, De Cive, the quote "Homo homini, lupus" perfectly explains. Translating this assumption in politics realists are sceptical that there can be progress in international politics, and it is comparable to that in domestic political life, but with the fundamental assumption that there is a disjuncture between the internal and external political realm, where the latter lacks a supervisor able of ensuring a rigid scheme of rules that can repress the mordacious thirst for power and the natural tendency towards violence in the human nature.
Indeed, they operate with a core assumption that world politics consists of international anarchy of sovereign states which settle the agenda around the primacy of security as the strategic priority of the state.
It is a logical consequence to imagine that realists believe in a state that should be deeply involved in ensuring the security of provisions of vital strategic resources.

Finally, Realists see international relations as basically conflictual with mutual distrust between parties, and they see international conflicts as ultimately resolved by war.

Realism has the longest-lived tradition in IR theories. Indeed, we can discover its origin rooted in ancient Greek with Thucydides, the political thinker Machiavelli, the philosopher Hobbes and how the tradition of *realpolitik* conducted international relations of the nineteenth and mid-twentieth centuries, highlighting the need for statesmen and politicians to promote the interests of the state and to place strategic calculation over moral obligation if survival and success are to be ensured.

During the twentieth century, Realism developed as the contrapose ideology to idealism and all the optimism that believed in the newborn institution League of Nations and the proposal of resolving disputes through International Law.
Classical realists of the twentieth century embrace these pessimistic and unhopeful views.
During the inter-war and Cold War periods liberal theories become less and less appropriate to analyse reality, proving that realism has tended to be the dominant theory in IR.
Realism also draws on the influential geopolitical tradition that developed with the discipline of political geography beginning at the end of the nineteenth century.
This tradition underlines the important relation that intercurred between state power and interstate competition for critical geographical and geopolitical spaces, whether can be the Eurasian heartland illustrated by Mackinder or the sea power as elucidated by Mahan.
Many examples can be found in the approaches taken by leaders, politicians, analysts, and journalists to describe international politics for minerals and gas.

Realism and geopolitics tend to be associated because the resources we are dealing with are considered vital for economic development, for example, the development plans for a sustainable European economy (see Chapter 3) which review minerals at risk, are in some of the most unstable parts of the world and are the catalyst for self-interest and nationalist sentiment for states and its leaders, two additional significant assumptions can be made to understand the interrelation between a realist geopolitical approach.
The first is having preferential access and control over fossil fuels and several minerals, which leads to national power and national interests. Indeed, lacking a safe supply chain and being dependent on third countries for the procurement of commodities and energy is considered a significant strategic vulnerability, as is shown by the decision taken under the Biden administration in February 2021, (*executive Order 14017*) directed the secretaries of Commerce, Energy, and Defense to submit reports within 100 days identifying risks in the supply chain for critical minerals and other identified strategic materials including rare earth elements, as determined by the Secretary of Defense, and policy recommendations to address the risks.

The second is that critical resources are commonly perceived as scarce and with the incrementation in production the probability to reach the 'peak' (Hubbert 1956,1971) in the extraction of minerals, oil and gas is getting closer, a similar approach was firstly deducted by the English economist Malthus, that interpose the population growth with the outpace of the supply of food (Malthus, 1806). Malthusianism become popular between the 1940s and 1960s and had a significant comeback after the 2008 economic and oil crises becoming the starting point in the development of the new Malthusianism or limits to growth approach, which combined Malthus' idea of absolute limits on resources as an impediment to economic growth. These two key assumptions are the impulse for the increases in state-to-state competition for access and control over these vital resources. Consequently, armed conflict and war over these resources are becoming more likely if not inevitable.

More recently, the realist perspective has driven the framework in which Michael Klare (2001,2004,2008) describes how the struggle for access and control over valuable resources replaced the ideological struggles of the Cold War, he also believes in an increase in the demand from the fast-growing countries of Asia, e.g. China and India, who are adopting a clearly mercantilist and geopolitical approach to resources access, making resources as the reasons to conduct wars.

Two great examples are the confrontations between China and the US on the supply of resources: for the United States, China's external actions are aiming to 'lock up' resources supply through acquisitions in Latin America and South Africa, increasing a 'cauldron of anxiety' about Chine's geopolitical intentions (Butler, C. J. ca. 2014) (Global Resources, 2013), while China, with the 'Malacca Dilemma', considers U.S. Maritime presence in the Chinese south Ocean as a triggering Chine's energy vulnerability obliging China to search for new energy corridors (Hu Jintao, CCP economic work conference, 2003).
In conclusion, to explain the geopolitics of mineral resources and energy the realist approach continues to exercise a strong application by journalists, leaders and government officials, and this to some extent contributes to the creation, even if it is deemed to be flawed, a widespread belief that it is capable to describe what is happening in the world creates, to some extent, that reality.

1.3 Liberalism

The liberal approach is extremely sensitive to how unrepresented sectional interests can hijack policy. Indeed, is of central interest to liberals the individual plus the different collectives of individuals.

Historically, liberalism came up after the First World War as a counter-realist approach believed to have caused and promoted the war consequence of the way the political and military elite, shaped the international political realm, without regard for public opinion and civil society, in the nineteenth and first half of the twentieth century the international realm was pursuing realist policies such as the obsession with the balance of power, military expansion, secret diplomacy, and nationalist xenophobia, and the lack of respect for international legal norms and institutions.

In the liberal approach, the core assumption of realism is rejected, the states do not represent the only decisive actors which interface with one another in distrust, conflict, and war states represent only one actor among many others within the international realm.

For liberals, diverse actors such as companies, non-governmental organizations, and regional and international institutions drive the development of international relations. This led to redefining the realist's 'billard ball' model of inter-state interaction with a more diffuse web-like structure where states are in continual engagement with a multiplicity of other, often independently powerful, actors (Keohane and Nye 1977).

In the liberal approach, this web-like structure is not just a simple description of reality but is also something to be promoted on actively work on. It is a danger to have extremely powerful states because they can undermine the effectiveness of the global economy through geopolitical manoeuvres. The real role of the state is to preserve the autonomy of the international market and consolidate the rules and institutions that grant its operation in the most efficient way possible.

Neo-liberalism during the 1970s and 1980s, defines liberal assumption in a more scientific and rigorous social scientific theory, arguing even though the international realm is anarchical through international regimes and international norms, which rely on principles of transparency and legally binding norms, can induce formerly antagonist actors to adopt cooperative behaviours and promote positive-sum results (Keohane 1984; Baldwin 1993).

The paradigmatic example is the European Union which perfectly explains how such a supra-national institution could develop to promote economic and political interdependence and, in so doing, make war inconceivable in Europe (Hass 1958).
Liberalism in IR also rejects the realists' assumption of disjuncture between domestic and external politics and the different moral and practical principles that must be applied to these two realms.

The liberal approach believes in the obligation to respect individual autonomy (human rights) and institution developed to ensure those rights (democracies), furthermore, the democracies pursue these same obligations in domestic as well as international politics.
This approach led democracies to be formidable in setting peaceful contentious, hence, avoiding fighting wars against each other, as Russet defines the democratic peace thesis.
Liberalism rejects the realist view of the repetitiveness of historical events, which creates a deterministic and pessimistic attitude in International Relations. Instead, liberals believe in the real chance that progress can be made; universal human rights can be promoted and defended; countries with authoritarian regimes can transition to democracy; international economy and politics can be more effective and efficient if conducted between democracies; regional and international norms, regimes, and institutions conducive to increased cooperation can be developed; global prosperity is best assured if markets are left open and trade is liberalized; and that anarchy can be overcome as war avoided (Global Resources, 2013).
The liberal approach to energy and mineral security takes into account the global market, an aspect that realists tend to underestimate and be strictly subjected to the mercantilism between states.

Non-fossil fuels minerals market is global, highly competitive and is dominated mostly by private companies (Humphreys, 2013), for example, the REEs market is controlled mostly by China, with around 95% of the market establishing itself as the sole supplier, which is clearly demonstrated by analyzing the import flow of REEs in the USA, the 2020 presidential decree (*executive order 13953*) notified how the 80% of REEs was directly imported from China and the remaining 20% through third countries indirectly from China. The gas market on the opposite has remained anchored to long-term bilateral deals, even after the outbreak of the war in Ukraine and the "interruptions" in the flow of gas from Russia, where it is shown an attempt by the importing countries to diversify the procurements chain. For example, the United States increased sales of their LNG to Europe by 140%. But in reality, Moscow has also seen its exports of liquefied gas to EU countries grow. They do not seem willing to reduce this type of supply, at least for the moment (Prestigiacomo, 2023).

For the realism approach, this seems to be the perfect scenario that explains the capacity of the states to influence and control the operation of this market, but if deeply analysed is clear that between Russia and the EU exists a mutual interdependency which constrains Russian predilection for geopolitical manipulations. Furthermore, the EU wants to take advantage of the mutual interdependency, but it seems to be not very effective. The European Union is currently banning the purchase, import or transfer of seaborne crude oil and certain petroleum products from Russia to the EU but giving special exemption to the member states that due to their geographical position suffer from specific dependence. Consequently, only in February, according to Greg Molnar, analyst of the International Energy Agency (IEA), EU countries would have received from Moscow 2 billion cubic meters of liquefied gas. 80% of these purchases were made by France, Belgium, and Spain.

Another issue on which liberal economist tends to highlight is overemphasizing scarcity with the whole issue of 'peak' minerals, oil, and gas. The point stands in the geological determinism does not consider how the markets work and how technological advances with the continually discover of new reserves, define market prices, and undermine the prediction of peak.
In conclusion from the liberal market approach perspective, states need to put much effort into building and promoting a more liberal and cooperative regime, developing, and strengthening international institutions, such as the International Energy Agency and the World Trade Organization, working through liberal norms and strengthening mutual trust between international actors.

1.4 Radicalism

Marxist-inspired approaches, such as the dependency theory and the critical IR theory start as a critique of liberal and realist approaches. For Marxist-inspired theories, realism is self-fallacious because does not believe in the possibility of radical change condemning the structural injustice to be perpetual. Their challenge to the liberal approach leads to the claim that the primary causes of resource-driven conflict are promoted by the Western states and companies which prolong relations of coercion and structural injustice to producing countries. Furthermore, for Radical's approach Liberalism represent a more dangerous threat, as we described earlier, liberals pretend to challenge the unfair and injustice practices through reforms and policies for change that fictitiously promotes universal rights and freedom when in reality they only serve to perpetuate the underlying deeply unjust structures of international power and dominance, in classical Marxism approach this is because liberalism rather than condemn, support capitalism, which increase the domination of the North oppressing the South. This led to the dependency theory which defines the relationship between rich and poor countries as some sort of imperialism.

The critical IR theory, which the most prominent exponent is Robert Cox, miscredit the liberal approach for the problem-solving approach that liberalism adopts, they criticize the choice of solutions such as the adoption of transparency or the promotion of corporate responsibility rather than a more profound critic that inquiry the moral and political legitimacy of the international system.

1.5 The Critical Approach

In the fields of economy and geography fields have grown different numbers of academic critics of the liberal conceptualization of the politics of minerals and energy.

One of the most prominent is the post-structuralism theory.

This approaches more theoretically and methodologically complex and nuanced than the simple dependency theory. Moreover, they all share a common critique of the lack of attention to the complex structures of powers that much liberal analysis on natural resources put.

The traditional liberal paradigm is excessively deterministic and too narrowly focused on the predations of the producing nations, ignoring the role of other players such as the different types of firms that actively participate in the diverse bargaining processes that not only include states but also other firms.

Furthermore, for the Critical Approach Liberal solutions for promoting 'good governance' fail to account for the wider historically and globally established constraints that stymie progressive political reform.

The exclusion of some firms in the conceptualization of the international political realm can consequently be noticed in the local and subnational communities, for example in more research-rich African states, there are some enclaves of mineral extraction protected by private army firms in a context of weak, insecure states or on-going civil wars.
This shows how complex the social interlinkages between international and national companies, national states, foreign states subnational and local communities are.

Now that we have concluded the examination of the theoretical framework, it is necessary to delve further into the concept of resource and mineral scarcity, comprehending the fundamental causes that contribute to scarcity and examining the endeavours undertaken by states and firms to address this issue. Given that the purpose of this dissertation is to discuss REEs, the focus will primarily be on analyzing the concept of mineral scarcity. However, a concise overview will also be provided to contextualize the challenges associated with the scarcity of energy resources.

1.6 What does mineral scarcity mean?

Minerals are defined as any organic or inorganic substance, solid or fluid, chemically and physically homogeneous, with a clearly identifiable chemical composition, forming part of the Earth’s lithosphere as well as other planetary solid bodies (Treccani, n.d.).
But they are classified as resources only after they become useful for technology applications. Accordingly, arise questions on the minerals’ availability and their economic and physical abundance.

Key factors which express effective mineral scarcity are availability and abundance.
A specific mineral can be defined as scarce for two principal reasons: for the extinguishing of the mineral’s stocks, or by the interruption of its procurement flux.
Other variables that help us calculate the level of risk of a given mineral are the historical and estimated future demand, the lifetime of distributions, the end-of-life and recycling rates and the losses of tailings and slag and from other processes, or the political stability, absence of violence and terrorism, environmental risks and risk triggered by factors of applicability (Graedel et al., 2012).

Anyway, in history, we never faced a mineral crisis triggered by the end of its stock, on the other hand, supply chain disruption is way more common and occurred several times.
If the demand exceeds the supply, then the market replies rocketing the prices.
The interruption of the supply chain can have diverse causes, a temporary stop in production or an unforeseeable growth in demand that largely surpass the production.
But could also be driven by political decisions and use "scarcity" as a coercion tool, like the embargo e.g. the United States of America with Cuba.
Industries and markets have different practices to solve and restore the equilibrium between supply and demand in a situation of scarcity.

Investment for new research and exploration can be the first impetus for production, or they can try to replace raw materials by placing investments in R&D to drive innovation and be able to substitute certain materials or at least reduce the required amount to lower the addiction to single inputs. Other possible paths could be the implementation of new recycling schemes or more efficient production processes to limit the impact of scarcity.

The private actors have undoubtedly a diverse number of solutions, but also governments have a core role to minimize the effect of scarcity in the economic realm. Indeed, governments can intervene through economic policy to control and stabilize prices.
For example, the EU settled a price cap on Russia's premium-to-crude products, such as diesel, kerosene, and gasoline, to respond to market developments and to avoid distortion.
Others can store stock of the critical minerals to be immitted later on the market if the necessity arises. Governments as firms can invest in innovative solutions to face scarcity by targeting funds on Research & Development.
For example, to correct these imbalances and strengthen its value chains, the EU through the Critical Raw Materials Act aims to boost trade agreements with commodity-rich countries such as Canada, Japan, and Vietnam. Additional resources will then be allocated to the development of new mines on European territory and the reopening of old mining sites using new technologies (re-mining).
For example, the USA is trying to revitalize their domestic production of REEs, by re-mining the Mountain Pass mine (Drobniak & Mastalerz, 2022).
In Chapter I we have already seen some theories that try to conceptualize the idea of scarcity being in the middle of a heated debate between economists and geologists.

The debate for the interpretation of physical reserves was and is polarized between the 'peak' and the opportunity cost theory.
One of the first to theorize the relationship between resources and economy was Thomas Malthus economist who lived between the XVIII and the XIX century. His theory had assumed the finiteness of resources that would be reached by the growing rate of population and that will consequently grow the consumption rates of resources. During the 1970s, the oil crisis resuscitates the paradigm, just for a decade after which there was a fall in oil prices.
In the 1990s, due to environmental degradation raised new questions about extinguishing resources.

In the words of the geologist Kesler, the scarcity is led by physical exhaustion.
We are facing two threats that can limit our increasing growth of wellness. First, the number of mineral resources that we are consuming is drastically increased, second we are facing an increasing environmental crisis caused by the extraction and consumption of mineral resources.
For an economist, Simon, scarcity is an economic matter.
Simon believes in the market's ability to regulate scarcity, this is because looking back in history whenever a crisis driven by scarcity arose just temporarily last, furthermore, analysing the economic trends resources seem to be increased rather than decreased.
There are two opposing theories, the first of the fixed stock assumes that the availability of mineral resources is finite and that therefore sooner or later, as consumption is growing, they will end.
Although they consider that technical development and price increases do not believe that it is sufficient to solve the potential catastrophes that will arise.
The continuous and uninterrupted extraction of minerals will lead to scarcity; therefore, the perspective of the fixed stock is associated with the physical scarcity.
The paradigm of the opportunity cost instead, believes in the irrelevance of the fixed stock argument. In this vision the resources do not conclude their vital squeak once consumed, they remain and depending on the price they can be recycled and reused. Moreover, when a shortage of material occurs, its price goes up and brings new discoveries and new technologies.
Thus, the cornucopian, such as Boserup, Simon, Lomborg, Juul, and Mortimore, believe that it is hardly possible to arrive in a situation of scarcity, for three main reasons: international trade, technological innovation, and substitution.
In short, the Cornucopians argue that the growing demand for resources can be met through continuous technological advances.

As a result, population growth is not considered to be a constraint since the resources will be sufficient when necessary.

Homer-Dixon calls the third group in the debate the ‘distributionists’. This group assumes that the fundamental issue is the unequal and insufficient distribution of resources and wealth, and that poverty and inequality should be viewed as causes of population expansion and resource depletion rather than their consequences.
Furthermore, the critics of Thomas Homer-Dixon, opera Cornucopians and New Malhtusians stressed 6 principles that Cornucopians have not taken into account.
For him, scarcities are vaster and grow at faster rates. Consequently, economic, technological, and social adjustment capacity is less effective (Nebbia, G. 2002).
Furthermore, Homer-Dixon underlines how the free market is not the right tool to measure scarcity. Finally, the market responses can be better off in richer than poorer countries, as the latter will face more stressful environmental problems.

In conclusion, the author believes in the incapability to escape scarcity in the long run because societies are not able to adapt as fast as the Corucopians believe.
For others the current situation, an economy based on consumer goods which are used until the end of the life cycle and then transformed into waste is unsustainable (Graedel et al., 2004).
Mineral scarcity can also occur through the temporary interruption of the supply chain, outlining the ‘contingent scarcity’. Restrictions on the supply of minerals can lead to a thin market situation, where demand exceeds the quantity made available by the market. The thin market situation can be induced by situations where the concentration of production, prevailing production with joint products, and shortage of scrap available for the recycling of the infrastructure available for recycling. Another key point in the long term is the continuous flow of investments in the extraction and processing of minerals while continuing the formation of and the research of geologists, engineers, and miners.
Consequently, dependence on a single source of supply creates a strategic vulnerability, as defined in the 2008 National Research Council report ‘Minerals, Critical Minerals and the US Economy’, “it arises when a small group or even an exporting nation with high political risk or in a country with a sometimes-significant growth in domestic demand that exported minerals may be redirected inward.”

In Critical Raw Materials Act of 2023 is clearly delineated what is the vulnerability of the EU, stressing how China guarantees 98% of the EU's supply of rare earth elements (REE), Turkey ensures 98% of borate supplies and South Africa provides 71% of the EU's platinum needs and seems to be perfectly represented by the aforementioned definition (*European Commission, Study on the Critical Raw Materials for the EU 2023 – Final Report*).

Interesting is the possibility that policymakers have through economic diplomacy induce scarcity. For example, the embargo of mineral resources is often chosen to coercively induce an increase in prices or for the renegotiation of the distribution of goods.

Historically, embargos supply interruption common in wartime periods, for example, in 1940 to induce Japan to a less aggressive policy in South-East Asia United States first imposed an embargo on aviation gasoline and high-grade scrap iron, which did not have any positive response the USA strengthened the embargo expanding to continue to expand its embargo, extending it to tools, iron, steel, copper, bronze, and many other critical metals.

Consequently, the USA applied a full embargo on all Axis countries (*World War Ii – Embargoes and Sanctions*, n.d.).

One phenomenon we are increasingly seeing is resource nationalism.

Because we live in a world that pushes towards trends that can delineate situations of scarcity, such as the growing population, the disproportionate economic growth of the developing world and the increasingly complex technologies requiring more and more inputs associated with the great interconnectedness of the globalized world, ensure that states often and willingly decide to use once again the techniques of economic diplomacy; such as more onerous taxes on exports, nationalization and compulsory participation to secure at least the resources of its territory.

For example, is Chinese economic diplomacy which not only imposes restrictions on exports since 2010 but obliges companies willing to open plants in China to create joint ventures with Chinese partner companies.

Moreover, China has been moving for years in the purchase and conclusion of agreements for mining in developing countries. The mines directly or indirectly controlled by China in Africa branch out into 7 countries and cover all raw materials necessary for the development of clean energy, Lithium in Niger, Ivory Coast, Namibia, and Congo, DRC for Cobalt in Congo DRC for Niobium Tanzania for Neodymium in Malawi and for Graphite in Mozambique (Il Sole 24 Ore, 2018). Moreover, China is extremely present also in South America, where invested $16 billion in the 'lithium triangle' in the region, between Argentina Bolivia, and Chile, is also the largest investor in Peruvian's mining sector controlling seven of Peru's largest mines, 100% of Peru's iron production, and 25% of their copper output, plus other projects in Ecuador and Chile (Ellis, 2022).

As we have already analysed in the theoretical approach the internal realm of a country as political stability can bring scarcity. The competition for strategic resources and the political instability of the developing world creates vicious circles where civil war and failed states, end exacerbate relations between the richer and stronger states.
Furthermore, in countries rich in resources local population frequently suffer from environmental degradation that induces violent migration and encourages the emergence of new catalysts of violence and internal stability.

This is well explained in the 1995 research paper by Jeffry Sachs and in numerous research papers that address the luck of being rich in natural resources as the "Resource Curse". Moreover, other negative factors that contribute to generating instability are low salaries and extremely prohibitive conditions for workers.
To address the issue of scarcity, there are alternative possibilities, such as international cooperation. Agreements on mining properties would involve sharing information, production, and trade, which are all crucial aspects.
The joint workshops between the EU, USA and Japan are for example a response to the issue of scarcity of REEs. Furthermore, the European Union, the United Nations, the World Trade Organization, and other international organizations have a common goal of finding solutions that resolve disputes between parties and ultimately lead to mutual agreements.

In conclusion, scarcity of minerals is not always due to their physical absence. Rather, it is often the result of various factors that hinder easy access to resources. Additionally, these factors are frequently intentionally induced, which further intensifies and asserts competition for access to certain resources.

1.7 Resources and Economic Diplomacy
EU and China

We have analyzed and come to understand that resource scarcity is not only physical, but can also arise through supply interruptions. In this situation, policymakers and industries are faced with a variety of questions that rely on the uncertainty of the possibility of multiple strategic resource scarcities.

Despite the uncertainty that comes with an extremely interconnected world, the tools in the hands of policymakers are numerous.

The most direct and drastic instrument can be military conflict, but exist also other channels that try to solve problems in less dramatic ways, for example through diplomatic, scientific, and economic cooperation.

The reason international actors undertake such solutions is always the search for security combined with continuous and durable access to resources with which to pursue economic growth and development.

In this tangled situation, countries can resort to statecraft, literally the art or skill of conducting government affairs (*Statecraft Definition & Meaning | Britannica Dictionary*, n.d.).

The statecraft's instruments are not limited to war and diplomacy but are also comprehensive of coercive measures of economic nature namely: economic statecraft.

The economic statecraft meaning: the use of economic means to pursue foreign policy goals Baldwin (1985), the recent literature investigates the implications of the economic statecraft in a globalized world, where security, technology and innovation are all deeply interrelated (Farrell and Newman,2019). While the traditional literature focuses on economic statecraft and tools such as sanctions with security objectives, more recent research has broadened the perspective to include the capability of economic statecraft to address security externalities (Aggarwal & Reddie, 2021).

For example, the EU's economic statecraft is commonly dedicated to ensuring its member state from coercion and aggression of third countries (*A European Approach to Economic Statecraft*, 2023), consequently, economic statecraft includes several tools that can be used to compel other countries or as a retaliatory instrument. As a result, it can also act as a deterrent.

When policymakers want to pursue an objective for commercial relations through economic statecraft, they can rely on several practices such as embargoes, boycotts, increases in border

fees, financial discrimination, revocation of most favoured nation status, blacklists, import or export quotas, revocation of import or export licenses, dumping, and preclusive purchasing.
In terms of capital, policymakers have various options such as freezing assets, suspending aid, imposing import or export controls, expropriating property, implementing taxes, cutting off funding to international organizations, and ultimately threatening to take any of the aforementioned actions (Kalantzakos, 2021).
The common aims for the economic statecraft are weakening, strengthening or ultimately the change in leadership of another country. Could also work to attract new allies or partners in another country. Lastly could be used to mitigate or stop a war.

For example, in 2020 the EU delivered a pack of sanctions against Russia aimed to weaken its capacity to continue the war against Ukraine.
Sanctions include targeted restrictive measures (individual sanctions), economic sanctions and visa measures.
Furthermore, to ensure the sanctions' effectiveness to reach their goals, the EU also sanctioned Russia's allies, that participated in the illegal aggression of Ukraine, such as Belarus, and Iran in relation to the manufacture and supply of drones (European Council, n.d.).

This example leads us to the comprehension of the EU economic statecraft.
EU's realm of action for economic statecraft can be summarized in four main pillars to protect the level playing field between the internal market and third countries; to ensure reciprocity; to deploy assertive instruments against coercion and aggression and build partnerships.
EU's economic statecraft seems to be more focused on internal safeguards rather than imposing its model on third countries, this is because EU economic diplomacy is strictly linked with the EU's values and principles. Consequently, when the economic statecraft is applied to third countries usually aims to defend and discourage illegal action or to build and develop liberal trade(*A European Approach to Economic Statecraft*, 2023). Furthermore, the EU strongly believe in operating inside the legal framework of international law and in respecting its mechanism for dispute settlement and resolution as part of the Sources and scope of European Union law (*Sources and Scope of European Union Law | Fact Sheets on the European Union | European Parliament*, n.d.).

In the past three decades globalization and particularly the EU, have promoted a positive way of conducting economic state crafts. Greater interconnectedness means that countries are now benefitting from more opportunities, but in the meanwhile, they are more exposed than ever to risks linked to the decision made in other countries (*The Use and Misuse of Economic Statecraft on JSTOR*, n.d.).

The statement introduces the link to describe how Chinese economic statecraft is pursued and how can easily be interpreted as a threat.

China's embrace of comprehensive and aggressive economic statecraft as part of its grand strategy (Yang&Liang,2019).

China has gone from being cautious in its participation in the World Trade Organization (WTO) to becoming adept at navigating the system and using it to achieve its industrial policy objectives. While complying with WTO rulings, China also implements measures that prioritize sectoral development, allowing its domestic companies to thrive and protect them from foreign competition. China has carefully examined its legal obligations under the WTO and has identified loopholes, such as the broad interpretation of the notion of "strategic regulations" due to the lack of an international definition, particularly in key sectors such as finance, banking and mining industry (Rühlig, 2018).

Alongside this, China is pursuing the Belt and Road Initiative, which links purchasing diplomacy with the goal of developing Chinese companies into global champions. In addition to using economic leverage to achieve its goals, China is not afraid to resort to exclusionary diplomacy, which can lead to discrimination against foreign competitors in the Chinese market, while promoting the development of domestic players.

When linked together, these factors, alongside its authoritarian institutions and assertive nationalism, can be used together to weaponize trade, disrupt global supply chains, and undermine confidence in economic interdependence, to further its strategic goals (Aggarwal & Reddie, 2021).

The fear of weaponizing trade is precisely what scares Western policymakers. In the previous paragraph (1.6), we discussed how to induce contingent scarcity, while in this paragraph, we have described and analyzed what economic statecraft means and the tools used by states to achieve their political objectives. Why can't the tools of economic statecraft be used to create a situation of contingent scarcity to achieve a political goal?

In September 2010, China effectively blocked the exports of rare earths to Japan due to a maritime incident in disputed waters, without taking an official position (Bradsher, 2015).

In 2010 Japanese enterprises relied on 97% of China's REEs export.
Consequently, Japanese enterprises halted production for several months due to a soar in the REEs' prices.
The ability of China to assertively and efficiently use its monopoly, through the economic statecraft instruments, to its advantage in resolving a territorial dispute has set a precedent that has alarmed many countries dependent on Chinese exports of REEs. Furthermore, in line with the recently implemented "Export Control Law", which came into effect on 1 December 2020, the nation is actively monitoring its domestic requirements and strategically ensuring access to rare earth sources globally (*Export Control Law of the People's Republic of China*, n.d.). This includes securing access to deposits in various locations such as California, Madagascar, and Greenland (Roland Gauß et al., Berlin 2021).

Even if the unofficial embargo lasted for a few months (BBC News, 2010), generated a resonance of uncertainty in the international community. Consequently, the USA, the EU and Japan cooperated through economic diplomacy channels to face China and to rebalance the market's prices. Moreover, they are jointly cooperating in different workshops to face REEs procurements risks by recycling and diversifying suppliers.

In conclusion, having analysed the notion of economic statecraft, and the instruments provided resulted to be extremely useful to policymakers to influence and reach political goals, it has been possible to screen the EU and Chinese economic statecraft and grasp how they diverge in their application.
The EU's economic statecraft is often used as a defense mechanism, or as the catalyst to build economic ties through spreading European values and principles.
Otherwise, China uses economic statecraft in a more functionalistic way, and 2010 territorial raw with Japan is a clear example.
Bearing in mind the aforementioned example, why China will not use the European vulnerability to achieve its political goals?

Acquiring an initial understanding of why REEs have become a subject of interest for international actors, may prove advantageous to understand which role is currently REEs playing.

Chapter 2
What are Rare Earth Elements?

Abstract:

Rare earth elements play a significant role in shaping the modern lifestyle, albeit often overlooked by many individuals who are unaware of their profound impact. Remarkably, these elements have been employed as a potent tool by China during trade conflicts with other nations, notably exemplified by the trade war between China and the United States in 2019.
Within this chapter, a comprehensive examination will be conducted to explore the current categorization of REEs and delve into the various methods employed for their extraction. Furthermore, intricate complexities surrounding mining, processing, and the importation of REEs will be thoroughly investigated, taking into account the associated challenges.

Moreover, a critical analysis will be undertaken to scrutinize the diverse applications of REEs, with particular emphasis on their utilization in the military and sustainable industries. By shedding light on these areas, a deeper understanding of the strategic significance and broad-ranging implications of REEs will be achieved.

In conclusion, this chapter will contribute to an enhanced academic understanding of the categorization, extraction methods, complications, and multifaceted applications of rare earth elements. By exploring these facets, we can better comprehend the intricate dynamics and implications associated with these vital resources in the contemporary global landscape.

2.1 Rare Earth Elements

It is important to clarify that Rare Earths are not actually rare, despite their name(*Rare Earth Elements—Critical Resources for High Technology | USGS Fact Sheet 087-02*, n.d.). The name is a misnomer and does not accurately reflect their qualities. The discovery of Rare Earths can be traced back to 1788 when a miner found a peculiar black rock in Ytterby, Sweden. It was later identified in 1794 as a new type of "earth," which referred to acid-soluble elements during that time. The mineral was discovered to be composed of cerium, lanthanum, yttrium, and iron ore. Due to their limited discovery at the time, it was assumed that these elements were scarce (Klinger, 2015). Consequently, the name rare earth.

REEs form the largest chemically coherent group in the periodic table. It refers primarily to 15 elements in the lanthanide series ranging from lanthanum (atomic number 57) to lutetium (number 71), plus scandium (atomic number 21) and yttrium (atomic number 39), which are grouped with the lanthanide family because they exhibit similar properties. The implication of rarity has legitimated the ruthless pursuit and capture of these elements over the past century, and perhaps that is why the antiquated name persists over 125 years after this misnomer was identified (Levy,1915,2).

They are used in a variety of high-tech applications across industries such as electronics, medical, automotive, and renewable energy.
Even if the needed quantity is exiguous, they are indispensable to let the applications work.
For example, in the Critical Raw Materials Act for Strategic Sectors in the EU of 2023 focuses on 6 technologies that rely on REEs, in three strategic sectors such as Renewables, e-Mobility, Defence and Space.

2.2 Rare Earth Elements categorization: *Light Rare Earth Elements* (LREE) and *Heavy Rare Earth Elements* (HREE)

Based on their electron configuration, rare earth elements are divided into two categories, light and heavy. The LREEs include lanthanum, cerium, praseodymium, neodymium, and samarium (atomic numbers 57-60 and 62). They are more abundant than the HREEs, which are more valuable. The HREEs include europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium (atomic numbers 63-71) plus yttrium (atomic number 39).
To evaluation of a potential mining project is based on the quantity of heavy rare earth deposits it contains, considering that these are often harder to find compared to materials rich in light rare earths.
Has we already discovered, REEs are less rare than what their name suggest. They can find almost everywhere on small concentration in the Earth surface or in high percentage in several mineral deposits. Rare earths are often separated and sold in the form of oxides, and in this case, they are called light rare earth oxides (LREO) or heavy rare earth oxides (HREO).
When researcher want to assess rare elements' concentration in a sample, they report it in part per million (ppm). It indicates the number of units of a particular substance per million units of the sample. Earth's crust accounts for 169.1 ppm of total abundance of REEs, including 137.8 ppm of LREEs and 31.3 ppm of HREEs (Dushyantha et al., 2020).
Rare Earth Elements are commonly found in all the rock formation on Earth, the real issue is to find a deposit that has the right percentage needed to be economically exploited.
Although REEs can be easily found in pretty much all the rock formation, usually the only deposits that can be economically exploited are the ones associated with the bastnaesite and the monazite. LREE are usually more abundant in the bastnaesite with small percentage of HREE. HREE percentage are two or three times more in the monazite deposits (nota 9).
Exist a third mineral which contain the major quantity of HREE, the xenotime, and usually it is found in the same areas of Monazite's deposits (Kalantzakos S.,2021).

The largest percentage of world's economic REEs resources is considered as the bastnaesite deposits distributed in China and the USA.
Bastnaesite does not contain U or Th and it is considered as the primary source of LREEs .This mineral contains approximately 70% of Rare Earth Oxids (REOs) Bastnaesite is often found in geological environments, such as vein deposits, contact metamorphic zones and pegmatites.

The bastnasite's deposits in China and USA constitute the major share of REEs' resources that can be economically exploitable in the world.

The second largest category of rare earth deposits is found in Monazite, which can be found in many countries including Australia, Brazil, China, India, Malaysia, South Africa, Sri Lanka, Thailand, and the USA. Monazite is a common mineral that is typically found in beach sands, as well as in granite, gneiss, and other igneous and metamorphic rocks as a minor mineral (Voncken, 2015). It can also be found in complex ores containing iron oxides, aluminosilicates, and apatite(Ferron..,1991). Because of its high specific gravity and resistance to chemical weathering, monazite is often found alongside heavy minerals like ilmenite, magnetite, rutile, and zircon (Long, 2011).
Monazite is a significant source of cerium and LREEs. It contains approximately 70% REO, similar to bastnaesite. However, monazite also contains thorium and uranium, which bastnaesite does not have. The amount of thorium and uranium (both radioactive) in monazite from placer deposits is higher than in monazite from carbonatite deposits. Inland monazite placer deposits were estimated to be around 10.21 million tonnes in 2005, and China, USA, and India are the top three countries possessing 36%, 13%, and 3% of these deposits, respectively(Dushyantha et al., 2020).

Monazite was the principal choice for industries to produce lanthanoids, but due to his high quantity of thorium and the difficulties derived from it, in 1960 monazite was replaced by bastnaesite. The decrease in interest in thorium as a nuclear fuel has directly catalyzed the diminishing in usage of monazite. Although Monazite is presently used for the extraction of REEs, with an ongoing debate on how to recycle Thorium for Nuclear reactor (Kalantzakos S.,202). Thorium is a radioactive metal that present is complexity in the difficult extraction of his latent energy value in an efficiency way. Consequently, only few parts of Thorium are used leading the majority to be or stocked to further implementation waiting for R&D (Kalantzakos S.,2021)

World Mine Production and Reserves

Tab1

	Mine production		Reserves
	2021	2022e	
United States	42,000	43,000	2,300,000
Australia	e24,000	18,000	4,200,000
Brazil	e500	80	21,000,000
Burma	e35,000	12,000	NA
Burundi	e200	—	NA
Canada	—	—	830,000
China	168,000	210,000	44,000,000
Greenland	—	—	1,500,000
India	e2,900	2,900	6,900,000
Madagascar	e6,800	960	NA
Russia	e2,600	2,600	21,000,000
South Africa	—	—	790,000
Tanzania	—	—	890,000
Thailand	e8,200	7,100	NA
Vietnam	400	4,300	22,000,000
Other countries	60	80	280,000
World total (rounded)	290,000	300,000	130,000,000

eEstimated. E Net exporter. NA Not available. — Zero.

Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2023

Currently in Europe REEs are not mined, but in 2023 Sweden announced to have found a deposit of REEs that could probably be the biggest in EU.

The LKAB (Swedish state-owned enterprise) announced to have found a deposit that amount to 1 million tons of REO. The deposits will aloud EU to fulfill a section of his internal demand for LREE particularly praseodymium and neodymium, which are indispensable component for the batteries' production.

The starting day of the extraction activities is set between the 2024 and 2026.

Finally, for the moment the LKAB is waiting to receive the legal permission to explore the mineral deposit (*Terre Rare: Dal Nord Una Svolta per L'Europa? | ISPI*, 2023).

This discovery can be the incipit to build the EU independence for the battery and permanent magnets sector.

2.3 REEs industries

Until 1948, the vast majority of REEs came from India and Brazil. During the 50' South Africa became the first producer. Subsequently, in 1949 is discovered the Mountain Pass deposits in California, which became the primary source for the world, until 1980 when cease their activity. From this moment the USA became dependent on external procurements of REEs. Significant are the data from 1999 to 2000 from the U.S. Geological Survey, which has reported that U.S. imported more than 90% of REEs from China (*Rare Earth Elements—Critical Resources for High Technology | USGS Fact Sheet 087-02*, n.d.-b).

The EU has always been dependent on imports of REEs, but for a few years, the EU start to launch several projects such as EURARE, and ATER, to investigate various steps along the REEs supply chain (Goodenough et al., 2016).

Finally, in current times China remains (see Tab1) the undisputed leader in REEs production.

The process of separating is considered to be very difficult and expensive, due to the chemical proprieties that REEs share.

Although in 1940-1960 big steps were made, particularly in large-scale production and in the REEs purity, leading to be undiscovered more commercial applications.

Furthermore, every deposit differs from its geochemical components, meaning that a specific chemical process to separate REEs, is requested for different resources.

Aware of this critical characteristic, in time Chinese have mastered the metallurgic industry of his primary REEs deposits.

REEs are crucial components in the renewable, defense and electronics high-tech industry thanks to their electronic, magnetic optical and catalytical properties.

Consequently, REEs are considered facilitators because they are used in the production of alloys and compounds that are then utilized in complex technological systems (Dushyantha et al., 2020).

The main stages through which rare earth oxides are processed are the separation and extraction of the host material into acidic or alkaline solutions, the separation of REOs through solvents or ion exchange, and the reduction of individual REOs into pure metals (EPA,2012).

The process for bastnasite and monazite is different due to the different geological compositions.

For bastnasite, the process begins with the traditional procedures of the mining industry. Bastnaesite is divided from other materials, that usually do not have value.

The overall process of bastnäsite enrichment includes crushing and grinding, followed by separation using the flotation method. When the material becomes fine like sand or silt, the various minerals are separated from each other. During the flotation process, air bubbles and other agents are introduced to promote the attachment of bastnäsite to the rising bubbles, which then emerge on the surface. (Balachandran, 2014).

Once the bastnäsite is collected, it needs to be further broken down into different rare earth it contains, using acid and multiple stages of solvent extraction. As mentioned earlier, since the chemical processes for collecting REEs and achieving a certain level of purity differ, specific extraction and chemical processes are required. The process may need to be repeated multiple times (Kalantzakos S.,2021).

Once the process is completed, the REEs become oxides. They can then be dried, stored, and subjected to further treatments to reduce them into metals.

In some cases, such as magnets, neodymium is mixed with iron and boron to create an alloy.

They can be used for a variety of applications in the high-tech industry.

Complete the whole process, from the extraction to the production of oxides, are required 10 days. The process is highly expensive in energy and uses highly toxic chemical agents, consequently, is important to have the process under severe control (Kalantzakos S.,2021).

For monazite, the process is different. The most common processes in the treatment of monazite are acid digestion (using sulfuric acid) and alkaline digestion (Kumari et al., 2015).

As mentioned earlier, in monazite there is thorium. To separate it from the lanthanides, the mineral is heated for several hours while being mixed with sulfuric acid at temperatures between 120 and 150 degrees Celsius (*Rare Metal Technology 2014*, n.d.).

This process can vary because is based on the acid-mineral relationship. Furthermore, the methods which use acid result in the loss of phosphoric acid content, the low solubility of the sulfates formed, poor separation of Th and REs and high cost of maintenance (Kumari et al., 2015).

Alkaline digestion involves the use of a sodium hydroxide solution (73%) at a temperature of 140 degrees Celsius. This procedure allows for the recovery of the valuable phosphate content of the mineral.

Both procedures for monazite are considered to be costly, both economically and in terms of time. This makes the practices difficult to implement outside of China because a sufficiently large production scale is required, which involves expensive separation equipment and stringent environmental controls (Nickels, 2010).
The production of rare earths demands substantial energy and water resources. The study of Koltun and Tharumarajah (2014), which utilised the Bayan Obo, one of the largest Chinese REEs industrial plants, operation as a reference, estimated the energy and water consumption involved in the production of REEs. As per the study, the production of 1 kg of REO consumes approximately 4.64 MJ of electricity, 10.11 MJ of heat, and 3.24 kL of water during the mining and beneficiation process. The subsequent stage, which involves the extraction of REOs from monazite, requires nearly ten times more electricity (5.6 MJ for bastnaesite and 55.6 MJ for monazite). Furthermore, an additional 15.5 MJ of electricity may be needed in the final stage. The heat energy consumption is estimated to be around 90 MJ for the second stage of REO extraction from bastnaesite and 11.9 MJ from monazite. Water consumption during the second and third stages of REO extraction amounts to an extra 20-30 kL (Ganguli & Cook, 2018).
According to some data, it is estimated that approximately $500 million is required to establish a separation unit (Kalantzakos S.,2021).

After having analysed the full process of the REEs, from the extraction, and the separation between minerals to the environmental issues, will be logical to investigate the REEs' industrial applications.

2.4 REEs ductility

The REEs applications can be found in numerous technologies that generally fall into two macro-categories, REEs used as catalysts for materials or as components inside technical material.
The applications of some REEs as catalysts can be found in the process of crude oil to gasoline, in vehicle emission control, catalytic converters or particulate filters, and in polishing tools.
REEs as components for technical products are used in permanent magnets, able to maintain their proprieties even in high temperatures, typically in Eolic and electric vehicles sectors. Another application is for the construction of energy storage cells mainly batteries.

For phosphates, in liquid crystal display (LCD) or plasma, and for the light emitting diode (LED), the REEs application made these technologies more efficient than the previous letting the demand from the market increase.
Lastly, the adoption of REEs in the glass industry enabled to reduce the UV penetration and the deletion of non-requested colours from car glasses. furthermore, increasing the refraction index for glasses lens.

To correctly understand the role of REEs in any sector, as suggested by the Critical Material Strategy 2011 of the U.S. Department of Energy, is useful to analyse it separately.
Consequently, I will focus on the application requested by the European Strategic Energy Technology Plan, the Net Zero strategy, the European Green Deal, and the defence Industry applications.

The rare earth elements (REEs) and some of their main applications.

Table 2

Element	Symbol	Applications
Scandium	Sc	Metal alloys for the aerospace industry
Yttrium	Y	Capacitors, metal alloys, lasers, sensors, superconductors
Lanthanum	La	Ceramics, batteries, car catalysts, phosphors, pigments, X-ray
Cerium	Ce	Catalysts, polishing, metal alloys, UV filters
Praseodymium	Pr	Pigments, lightning, lenses, glasses
Neodymium	Nd	Permanent magnets, lasers, catalysts, infrared filters
Promethium	Pm	Beta radiation source, fluid-fracking catalysts, phosphors
Samarium	Sm	High-temperature magnets; nuclear reactor control rods
Europium	Eu	Liquid crystal displays, fluorescent lighting, glass additives, phosphors
Gadolinium	Gd	Magnetic resonance imaging contrast agent, glass additives
Terbium	Tb	Phosphors, electronics
Dysprosium	Dy	High-power magnets, lasers, guidance systems
Holmium	Ho	High-power magnets, nuclear industry
Erbium	Er	Lasers, glass colorant, optical fibers, ceramics
Thulium	Tm	High-power magnets
Ytterbium	Yb	Fiber-optic technology, solar panels, alloys, lasers, radiation source for portable X-ray units
Lutetium	Lu	X-ray phosphors, single crystal scintillators

Sources: (Hu et al., 2018)
The EU launched several plans to decarbonise its industry with the goal of decreasing emissions to reach climate neutrality, meaning net zero emissions in 17 years.

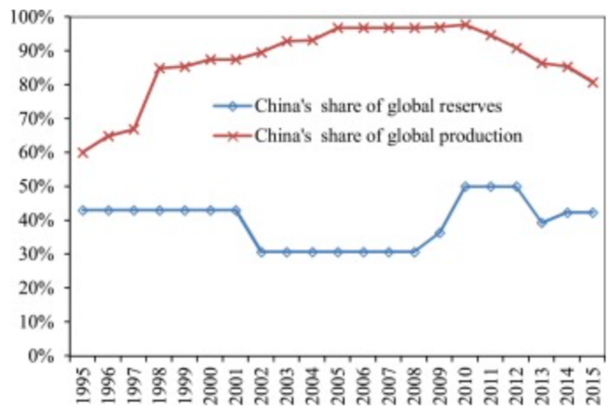
To reach this objective as already mentioned the REEs occupies a crucial role in the green transition.

Since the end of 2016, rare earth products have begun a new round of soaring price. In 2016 is shown an increase of 26%in 2017. The price of the Praseodymium-Neodymium Oxide, used for permanent magnet making, has increased by 72% during this period (Chen et al., 2018). Furthermore, China currently produces primary RE products, such as permanent magnets, catalysts, luminescent and polishing materials, targeting the high-tech industries, especially the global renewable energy industry which has a promising future for RE applications.

In 2002 for the first time in Chinese history, the percentage of REEs exported reached the quota needed for the internal market. From this point, China starts reducing the quantity of REEs for the global market.

China’s share of global REEs production and reserves, 1995–2015.

Tab3



Source: United States Geological Survey (USGS) Mineral Commodity Summaries.

Chinese policies constituted the mining and refining of rare earth to be monopolized by six major state-owned enterprises (SOEs) and where non-SOEs only have access to downstream industries such as the production and application of rare earth materials (Ltd, n.d.),

These policies enabled Chinese industry to rise as the global leader in extraction and production.

China is actually the major leader in the production of permanent magnets, which affects the production of the defence industry and the challenge of sustainable transition.

For example, powerful permanent magnets containing REEs, such as Nd and Dy are employed in synchronous generators in direct-drive wind turbines magnets, which allow more lightweight designs and compacted direct-drive wind turbines compared to the gearbox[*The gearbox enables the coupling of the rotor's shaft with that of the generator* (Da Rosa & Ordóñez, 2022)] wind turbines, resulting in a more efficient way of producing green energy.

Instead, for the defence industry REEs are applicated to guided ammunition, lasers, communication systems, radar, night watch systems and satellites.

For example, the thank M1A2 Abraham uses a system of navigation with permanent magnets (Kalantzakos S.,2021), also the Eurofighter and the French Rafael need Dysprosium Samarium Neodymium Yttrium Praseodymium and the other 11 REEs in diverse applications and technologies.

All these data show the volatility of the REEs prices that with a single producer, increasing the direct risks of the supply chain.

After investigating what REEs are, exploring the cost of the extraction process, and analyzing their various applications, the next chapter will examine EU projects and the position of Rare Earth in the geopolitical arena.

Chapter 3
EU dependence on REEs

Abstract:

This chapter is dedicated to the analysis of the EU dependencies on REEs, consequently the dependence of the EU on the Chinese supply chain.

The first paragraph aims to explore which sectors are considered at risk, consequently.

Will be deepened the different technologies that rely on REEs, analysing the bottleneck of the value chain and pointing out the risk causes.

Consequently, will be depicted the European Union's countermeasures and ongoing projects to secure the industries dependent on REEs.

The chapter will be concluded with an analysis of the possible solution via research & development and recycling.

3.1 Decarbonisation as a raison d'être

In 2008 the EU deployed the Strategic Energy Technology Plan (SET Plan) setting the guidelines to boost the transition towards a climate-neutral energy system through the development of low-carbon technologies in a fast and cost-competitive way (*Strategic Energy Technology Plan*, n.d.).

In the same year, the EU published the Raw Material Initiative, which set out a strategy for tackling the issue of access to raw materials in the EU.

The 2008 initiative is linked to the Decarbonisation goals because as already mentioned, energy transition relies on raw materials to be implemented.

Following this initiative in 2011 the EU settled the Raw Materials Act, with the objective of reporting and updating the list of high-risk materials every 3 years and setting a strategy.

Furthermore, in february 2011, the European Council affirmed the European Union's objective to reduce its greenhouse gas (GHG) emissions by 80-95% compared to 1990 levels by 2050. This target aims to limit the global average temperature increase to below 2 °C, on the condition that other regions of the world also implement significant emission reduction measures.

In March 2011, the European Commission, released the "Roadmap for moving to a competitive low-carbon economy in 2050" (Capros et al., 2012).

In 2015 United Nations adopted 17 sustainable development goals (SDGs) targets to be achieved in the next 15 years.

One year later the EU Commission pledged to apply the principles of the SDGs to be applied in all EU policies and initiatives.

On 12 December 2019, the EU Council, following the footsteps of the SET Plan, discussed the Climate change policies, renewing the objective of reaching climate neutrality by 2050, also known as European Green Deal (*European Council, 12-13 December 2019*, 2019).

In 2020 the EU Parliament decided to support the European Green Deal.

The EGD is constituted of 8 goals: increasing the EU’s climate ambition for 2030 and 2050, supplying clean, affordable, secure energy, mobilising industry for a clean and circular economy, building and renovating in an energy and resource-efficient way, zero pollution ambition for a toxic-free environment, preserving and restoring ecosystems and biodiversity, a fair, healthy and environmentally friendly food system and accelerating the shift to sustainable and smart mobility (*Parliament Supports European Green Deal and Pushes for Even Higher Ambitions | News | European Parliament*, n.d.), moreover, it will be financed by one-third of the €1.8 trillion investment from the NextGenereationEU Recovery found and by the EU's seven-year budget. (*A European Green Deal*, 2021).

The acknowledgement of the European Union's decision and action gives us the perfect picture to introduce one of the core topics of this paper.

As stated by the Critical Raw Materials Act of 2023, raw materials are indispensable for the EU's industry and stand at the very beginning of each value chain.

Some of them are categorized at risk even if they are often produced and used in relatively small quantities because they have special characteristics that make them essential ingredients for products in strategic areas such as renewable energy, digital, aerospace and defense technologies.

In fact, to forecast the net-zero 2050 are indispensable the REEs, which are found in the permanent magnets used to manufacture wind turbine motors.

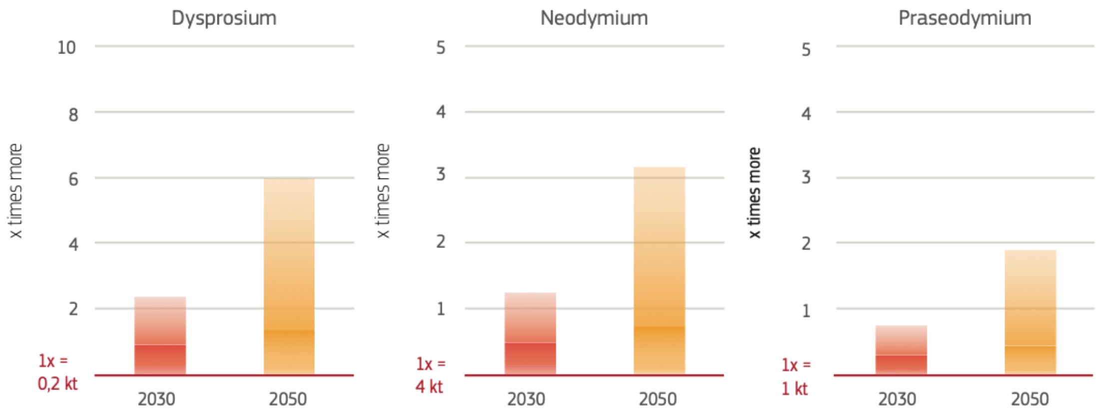
Following the European Commission classifications for wind turbines are considered the most cost-effective technologies for climate-change mitigation, furthermore, its industry is a growing sector in the EU industrial base. Although to be efficient and applicable in a cost-effective way should be evaluated the risk factors along the supply bottlenecks of the value chain.

In the *2023 Foresight Study for Critical Raw Materials for Strategic Technologies and Sectors in the EU* is reported that wind turbines, especially the ones that use permanent magnets, are subjected to metal prices.

The risk factor is recognized in the supply of REEs because cannot be sufficient to meet the growing demand for the global transition, see Tab4, furthermore, the concern has grown since the 2011 REEs crisis that underlined how near-monopolistic China can easily affect the REEs supply by imposing export restrictions.

Additional REEs consumption for REEs' wind turbine in 2030/2050 compared to current EU consumption of the material in all applications.

Tab4



Sources: *"European Commission, Critical materials for strategic technologies and sectors in the EU - a foresight study, 2020".*

To conclude on wind turbines, the supply risk of rare earth elements (REEs) in permanent magnet (PM) generators for wind turbines is considered high, while the price of REEs has decreased to levels like those before the 2011 crisis, the increasing global demand for these materials could have significant implications for the wind energy sector. There are additional concerns regarding the industry's dependence on a single market, as China currently holds a near monopoly on both the production of REEs and PM manufacturing. The risk of price fluctuations and potential consequences of trade disputes between China and the US further contribute to the uncertainty.

Similar concerns and risks are shared with the traction motors technology, which shares with wind turbines the application of permanent magnets as one of its core components.

Currently, there are approximately 8 billion electric motors being utilized in the European Union (EU), consuming almost 50% of the electricity produced within the EU. These motors are employed in a wide array of applications, ranging from small electronic devices to e-bikes, as well as large motors used in electric drivetrains for vehicles and heavy transportation. It is anticipated that the number of motors in the EU will experience significant growth in the future, primarily due to the widespread adoption of traction motors in electric vehicles (EVs). Electric motors used in e-mobility necessitate high-performance features such as high torque densities, lightweight construction, and high efficiencies.

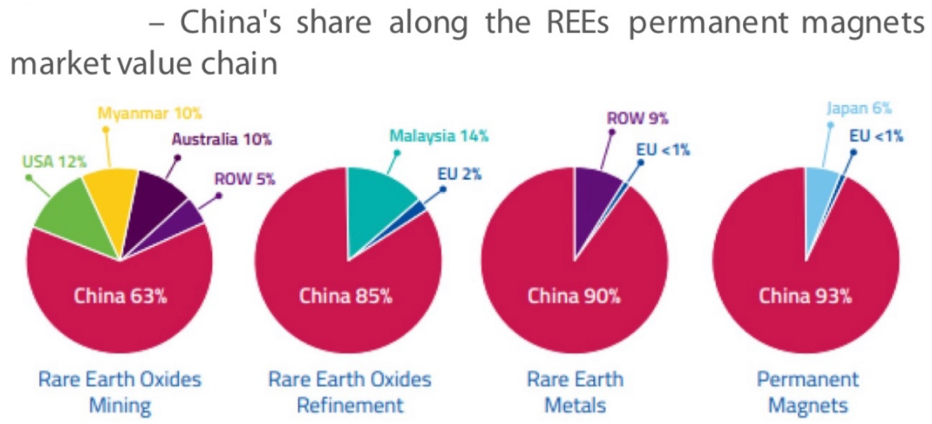
Most hybrids and EVs use permanent magnets for their motors. The demand for permanent magnets is intensifying due to the two trends that are driving the industry through change.

Consequently, the EU automotive is at a crossroads as must face two great trends: the Green and the Digital transition.

Following the twin transition, it is projected that Neodymium magnet (NdFeB) technology will have a significant presence in the market. By 2025, it is estimated that approximately 90% to 100% of hybrid and EVs could utilize synchronous motors equipped with NdFeB magnets (Leader & Gaustad, 2019).

As stated for wind turbines Permanent magnets (PMs) contain notable amounts of rare earth elements (REEs) such as dysprosium, neodymium, and praseodymium. These REEs are associated with high supply concentration in China, as well as concerns regarding environmental and social practices throughout the supply chain. According to the 2020 Critical Raw Materials (CRM) list evaluation, dysprosium, neodymium, and praseodymium have the highest supply risk values among all the materials assessed. The European Union (EU) is 100% reliant on imports for these REEs with a concentration from a single supplier, China (*European Commission, Study on the Critical Raw Materials for the EU 2023 – Final Report*). Moreover, shares competition for these materials from the wind energy sector and other industries that utilize motors. Furthermore, China maintains its leadership also in the production of NdFeB magnets with an overall of 85-90% of the global production *(European Commission, Critical materials for strategic technologies and sectors in the EU - a foresight study, 2020)*.

Tab5



Source: "*EU strategic dependencies and capacities: second stage of in-depth reviews, European Commission, 2022*".

Considering that the European Union's automotive industry holds a crucial position within its economy, providing employment to over 6% of the EU's total workforce, and its turnover contributes to more than 7% of the EU's Gross Domestic Product (GDP) and that the 80% of global automotive industry growth will occur outside Europe (Ecorys, *The future of the EU automotive sector*) it is possible to assume that EU must develop resilience and new business model to face a possible crisis in the procurement of such raw materials.

To conclude the analysis of the whole of the renewable energy system, we must be aware that it is not just about renewable electricity production.

Other technologies are required to let the whole system positively work, from energy storage to the development of new infrastructure that will comply with the new technologies of automation and digital.

Unfortunately, the EU is 100% dependent on imports from China, particularly 100% of HREE and 85% of LREE for these reasons are high supply risk. Furthermore, considering the ambitious goals of the EGD it is possible to predict that the demand will increase significantly by 2050, principally in the wind turbines industry, Tab4, is expected to increase by up to six times in 2030 and up to 15 times in 2050 in addition to current EU consumption in the most severe scenario *(European Commission, Critical materials for strategic technologies and sectors in the EU - a foresight study, 2020)*.

In conclusion, the European Union policies are hardly pushing the transition to renewables energy, the transition is not costly and risky free because the EU is highly dependent on imports mostly from China’s raw materials, opening a strategic vulnerability for the EU’s goals and industries, see Chapter 1-1.7 (*Resources and Economic Diplomacy EU and China*).

3.2 EU in Action for Strategic Resources

Since 2008, the European Union has been committed to tracking raw materials and compiling a report on their criticality, with particular attention to their supply chain.
In 2019 the EU upgraded the 2016 Elements for a new EU strategy on China with the new Strategic Outlook. The 2019 Strategic Outlook was delivered to answer the need for a new strategy on EU-China relations.
Consequently, analysing the joint communication between the EU Parliament and Council the EU underlined how the relationship with China possesses a threefold nature as a "partner" (e.g. environment and climate change), an "economic competitor" (e.g. technology, trade and economy affairs) and a "systemic rival" (insomuch as China promotes an alternative model of governance) (*EU-China Strategic Outlook: Commission and HR/VP Contribution to the European Council, 21-22 March 2019*).
Following the 2019 strategic outlook in the 2020 Critical Raw Materials (CRM) Act, considering the economic importance and supply risks as the two main parameters used to determine criticality for the EU, REEs reached the highest risk grade.
The economic importance aspect examines the detailed allocation of raw materials to specific industrial applications. It analyzes how raw materials are used in various industries. On the other hand, supply risk focuses on the concentration of global production of primary raw materials at the country level and their sourcing to the European Union. It also considers the governance practices of supplier countries, including environmental aspects. Furthermore, it takes into account factors such as the contribution of recycling and substitution, the level of import reliance by the EU, and any trade restrictions imposed by third countries.
(*EUR-Lex - 52020DC0474 - EN - EUR-Lex*, n.d.).
The 2020 CRM Act set the path for a new industrial strategy following the steps of the European Battery Alliance which has the scope to cover the 80% of Europe's lithium demand being supplied from European sources by 2025. Indeed, the new industrial strategy proposes to develop a new industrial alliance: the European Raw Material Alliances.
This can be considered the first European action to countermeasure the criticality mined by an untrustful supply chain.
The first aim of the ERMA, as stated in the 2020 CRM Act, is focusing on the most pressing needs, which is to increase EU resilience in the rare earths and magnets value chain, as this is vital to most EU industrial ecosystems (including renewable energy, defence and space).

Furthermore, it can be considered a choral action, because the participants include industrial actors along the value chain, Member States and regions, trade unions, civil society, research and technology organisations, investors, and NGOs.
Moreover, the ERMA is supported by the European Investment Bank following its new energy policy. This opens chances to invest and support projects relating to fostering the supply of critical raw materials needed for low-carbon technologies, which should help de-risk projects and contribute to fostering the EU's strategic economy and resilience in a resource-efficient and sustainable manner. Furthermore, this should help to mobilise support for compliant exploration, mining, and processing projects for critical raw materials.
The EU considers rare earths to be amongst the most resource-critical raw materials.
In 2021 ERMA alliances and the European Institute of Innovation and Technology alliances implemented a call-to-Action report that pave the way for the common response to increase Europe's strategic autonomy in rare earths.
The Call-to-Action plan identifies some solutions that must be implemented to foster the EU capacities for the REEs industries.
More than 180 stakeholders from industry, academia, government organisations and NGOs participated and defined action items to achieve different solutions: Risk sharing across the value chain, by long-term supply contracts or off-take agreements, diversification of supply chains by investing in European facilities that must be improved by numbers, collaborative R&D (e.g. materials processing, reduction of REE content, use of process waste and of recycled material, i.e. closing loops) which represent the most trivial objective as the recycling process in costly inconvenient, lastly to joint Public-Private Investments and promote awareness for REE and permanent magnets to the public (Roland Gauß et al., Berlin 2021).
In conclusion, collaborative efforts within Europe to innovate in the field of rare earth materials would enable the European bloc to capitalize on an expanding market, enhance its resilience against supply disruptions, and generate a significant number of direct and indirect employment opportunities. This would be particularly beneficial for industries undergoing transformation, such as automotive, energy, and machinery sectors.
European Union has a long story in monitoring the EU's REEs extractive capacities.
In 2013 was launched an assessment for the sustainable exploitation of Europe's rare earth ore deposits.
The project was concluded in 2017 and has been participated by both EU and private industries (*CORDIS | European Commission*, n.d.).

Allying with the new European investment banking policy the EURARE assessment can be the starting point for investing in new research projects that promote the re-mining in a more sustainable way.
Moreover, REEs European Union and private Research and Development projects are working to promote a more cost-efficient and sustainable economy.
They are currently investing in research focused mostly on reducing the REEs' content through increasing material efficiency in magnet production and by optimising the EVs motor design, enabling high technical performance while using less NdFeB magnet.
This will help in a scenario where REEs demand is predicted to rise.
Furthermore, some research studies the possibility of the replacement of rare earth magnets by other magnetic materials.
In conclusion, the EU and its member states are actively working to build a new European ecosystem where public and private institutions in the REEs sector work jointly to de-risk the supply chain vulnerability while laying the foundation of European strategic autonomy for raw materials.
Another attractive opportunity that the EU considered to stabilize, and de-risk is recycling.

3.3 The recycling REEs dilemma

Recycling has emerged as a precondition for the EU to achieve enough security of supply.
The re-emission of REEs within the value chain would allow for the fulfilment of a portion of the demand reducing the risks associated with supply chain dependencies on China.
In the ERMA call to action report, the necessity of a sustainable end-of-life cycle is stressed, as stated by Frédéric Carencotte, CEO of CARESTER, EU partner for the extraction and exploitation of rare metals: "Our target is to recover all kinds of end-of-life magnets which contain rare earth elements and to produce separated rare earth oxides. We will produce raw materials from magnets of the same quality as the virgin material. It means we can recycle as much as we want without compromising on the quality".
Although, different problems arise when recycling and REEs are associated.
Firstly, the separation of individual elements from mixed materials requires sophisticated and specialized techniques which generally make recycling difficult and not costly-efficient, consequently advantageous.

The two main limitations, which diverge by the type of raw materials and chemical composition, reside in the costs required to mitigate the process' significant environmental footprint and the low cost of virgin ore.

Furthermore, to accomplish recycling well, a single method is considered expensive and unable to carry out optimal recycling transformation, then combined processes are suggested.

Low environmental hazards, minimal energy consumption, and closed-loop processes are the main goals to be achieved in the recovery process (Xiao et al., 2023).

Since the recycling process is still in the developmental stages the EU is investing in order to create a market for used magnets and ensure a steady supply for recycling companies.

Furthermore, it is committed to reviewing its current waste directives and related laws, in addition to new measures to enforce the establishment of systems for collecting, extracting, and processing permanent magnets within the EU.

For the moment only two requests for opening recycling facilities by the investment of the EU have been submitted one by France and the other one by Belgium (Roland Gauß et al., Berlin 2021), moreover, Germany results to be recycling effectively only the 1% of its internal REEs (Kirschbaum, 2010).

In conclusion, recycling REEs is considered a crucial step in the adoption of the EU's de-risking policies for the supply chain, but unfortunately for the moment is not a feasible choice for its high costs and negative environmental footprint.

Conclusion

The European Union has set different objectives that have to be fulfilled by 2050, first of all, the green transition.
The sustainability challenge defined by the SET plan and the EGD imposes on the EU ambitious challenges from the regulatory framework to the industrial ecosystem.
REEs play a key role in the creation of a more sustainable world, laying at the beginning of different technological applications. Indeed, REEs application on sustainability transition embraces a large variety of technologies such as wind turbines, electric vehicles, and bicycles, and for the construction of energy storage cells, mainly batteries.
In the past three decades, China became the global leader in the production of REEs along the entire value chain covering 100% of the EU demand, particularly 100% of HREE and 85% of LREE.
The highly concentrated production makes them resource-critical and opens strategic vulnerability in the EU industrial ecosystem.
Furthermore, Chinese Economic Diplomacy jointly with a high understanding of the WTO rules made China able to impose export quotas following the notion of strategic regulations. Moreover, the REEs industries are State-Owned Firms, which follow the principal agent and orchestrated practices making Economic Diplomacy tools more efficient. Consequently, in line with the recently implemented "Export Control Law", which came into effect on 1 December 2020, China is actively monitoring its domestic requirements and strategically ensuring access to rare earth sources globally.
Notable to mention is the relationship between the EU and China, in which following the 2016 and 2019 strategic outlook the EU has become more assertive identifying China as an economic competitor and a systemic rival.
The strategic outlook and the 2020 CRM Act set the foundation to create an independent and self-sufficient REEs industry to de-risking from the single supplier.
The de-risk measures consist of multiple investment initiatives to promote the creation of a European supply chain, by re-mining or opening new mines, R&D projects focus on diminishing the REEs’ quantity or possibility to substitute with other elements.

Furthermore, the 2020 CRM institutes the ERMA, alliances between more than 180 actors that work jointly to make REEs and connected ecosystem more resistant to supply shocks and secure the transforming automotive and machine industries.

ERMA also is creating a line of investment to build recycling firms, promoting a circular usage of REEs and covering part of the internal demand.

In conclusion, the European Union has undertaken various initiatives and mobilized efforts to address a longstanding gap in its strategic approach towards rare earth elements.

The initiatives have been taken with a consistent delay as the vulnerabilities in the supply chain have been well-known since 2011.

However, the EU can use its vulnerabilities to tie Member States' relationships and create a more cohesive internal front able to foster new international partners, opening new markets and opportunities, consequently increasing its international prestige and relevance as a valuable international actor with its own identities, principles and values.

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The gearbox*The GB reduces rotation speed from the input shaft to the output shaft by a factor of about 30:1 and increases available torque by about the same amount. It is designed to not to be overloaded. The unit most be maintained fairly well balanced (weights adjusted to keep motor and GB loads about the same on up/downstroke) to make sure the GB is not overloaded in opeation. Also maintenance includes checking the condition of the lubricant in the GB. Older GB's may need the addition of a wiper if they are to turn less than about 5 SPM (strokes per minute). Newer GB's are sold with the wiper already installed.*

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Italian Summary

Le terre rare guidano il progresso, hanno una vasta varietà di applicazione comprendendo diversi campi e industrie, dall'alta tecnologia militare alle tecnologie per l'innovazione e la transizione ecologica. Nonostante questo, la maggior parte delle persone non è a conoscenza della loro esistenza e delle applicazioni che ogni giorno passano sotto i loro occhi.

In realtà sono entrate nel dibattito pubblico per la prima volta nel 2010, quando a seguito di una disputa territoriale tra Cina e Giappone, la prima impose un blocco alle esportazioni di terre rare.

Questo generò sgomento nella comunità Internazionale, creando un precedente che lascia ancora spazio a incertezze.Lo scopo di questa tesi è proprio quello di speculare sopra queste incertezze per fornire una analisi del perché le terre rare siano un elemento chiave per l'Unione Europea e di come stia gestendo i rischi connessi alla catena di approvvigionamento.

Il primo tema importante da chiarire è la scarsità.

La scarsità può essere di due tipi: una fisica, che contempla il completo esaurimento delle riserve fisiche di un minerale, e una contingente. La scarsità contingente è indotta da fattori terzi, e spesso sono i governi stessi che utilizzano strumenti della diplomazia economica per l'imitare l'accesso a una data risorsa per raggiungere obbiettivi politici.

Per raggiungere i dati scopi politici, possono fare affidamento su diverse pratiche come embargo, boicottaggio, aumento delle tasse alle frontiere, discriminazione finanziaria, revoca dello status di nazione più favorita, liste nere, quote di importazione o esportazione, revoca delle licenze di importazione o esportazione, dumping e acquisti preclusivi.

Per quanto riguarda i capitali, i responsabili politici hanno a disposizione diverse opzioni, come il congelamento dei beni, la sospensione degli aiuti, l'imposizione di controlli sulle importazioni o sulle esportazioni, l'esproprio di proprietà, l'imposizione di tasse, l'interruzione dei finanziamenti alle organizzazioni internazionali e, in ultima analisi, la minaccia di intraprendere una qualsiasi delle azioni sopra citate.

Gli obiettivi comuni dello statecraft economico sono l'indebolimento, il rafforzamento o, in ultima analisi, il cambio di leadership di un altro Paese. Potrebbe anche funzionare per attirare nuovi alleati o partner in un altro Paese. Infine, potrebbe essere utilizzato per mitigare o fermare una guerra.

Ad esempio, nel 2020 l'UE ha emanato un pacchetto di sanzioni contro la Russia con l'obbiettivo di indebolire le capacità economiche Russe, e con l'obbiettivo di boicottare e diminuire i tempi del conflittoLe sanzioni comprendono misure restrittive mirate (sanzioni individuali), sanzioni economiche e misure in materia di visti.Inoltre, per garantire l'efficacia

delle sanzioni nel raggiungimento dei loro obiettivi, l'UE ha sanzionato anche gli alleati della Russia che hanno partecipato all'aggressione illegale dell'Ucraina, come la Bielorussia, e l'Iran in relazione alla produzione e alla fornitura di droni.

Attraverso l'analisi dell'Economic Diplomacy dell' EU e della Cina è possibile evidenziare la postura con cui vengono perseguiti propri obbiettivi politici.

Lo statecraft economico dell'UE è spesso usato come meccanismo di difesa o come catalizzatore per costruire legami economici attraverso la diffusione di valori e principi europei. Al contrario, la Cina utilizza lo statecraft economico in modo più funzionalistico, inoltre una legge passata nel 2020, "Export Control Law" La Cina ossiede totale controllo su i propri depositi ritenuti strategici.

Per capire come gli strumenti della Diplomazia Economica si possano intrecciare con le terre rare bisogna, per prima cosa, capire che cosa siano le terre rare.

Innanzi tutto, le terre rare nonostante il nome possa ingannare, non sono veramente rare. Tutt'altro, sono presenti in un po' dappertutto, la vera caratteristica che le rende "rare" e che per sfruttare economicamente un giacimento è necessario che vi sia un'alta concertazione di terre rare.

Le terre rare costituiscono il più grande gruppo chimicamente coerente della tavola periodica. Si riferisce principalmente a 15 elementi della serie dei lantanidi che vanno dal lantanio (numero atomico 57) al lutezio (numero 71), oltre allo scandio (numero atomico 21) e all'ittrio (numero atomico 39), che sono raggruppati con la famiglia dei lantanidi perché presentano proprietà simili.

Sono utilizzati in una varietà di applicazioni high-tech e in diversi settori quali l'elettronica, la medicina, l'industria automobilistica e le energie rinnovabili.

Anche se la quantità necessaria è esigua, sono indispensabili per far funzionare le applicazioni. Proprio questa duttilità consente alle terre rare di essere estremamente richieste.

L'Unione Europea ha fissato diversi obiettivi da raggiungere nel 2050, primo fra tutti la transizione verso un'economia sostenibile.

La sfida della sostenibilità definita dal piano Strategic Energy and Technology (SET) e dall' European Green Deal (EGD) impone all'UE sfide ambiziose, del quadro normativo all'ecosistema industriale.

Le terre rare giocano un ruolo chiave nella creazione di un mondo più sostenibile, ponendosi all'inizio di diverse applicazioni tecnologiche. In effetti, le applicazioni delle REE nella transizione verso la sostenibilità abbracciano una grande varietà di tecnologie, come le turbine eoliche, i veicoli elettrici e le biciclette, e per la costruzione di celle di accumulo dell'energia, soprattutto batterie.

Negli ultimi tre decenni, la Cina è diventata il leader mondiale nella produzione di terre rare lungo l'intera catena del valore, coprendo il 100% della domanda dell'UE, in particolare il 100% di HREE e l'85% di LREE.

La produzione altamente concentrata li rende risorse critiche e vulnerabilità strategiche nell'ecosistema industriale dell'UE.

Inoltre, la diplomazia economica cinese, unita a un'elevata conoscenza delle regole del World Trade Center, ha permesso alla Cina di imporre quote di esportazione secondo il concetto di regolamentazione strategica. Inoltre, le industrie che posseggono la produzione di terre rare sono imprese statali, che attraverso il principio dell'agente principale e dell'orchestrazione, rendendo più efficienti gli strumenti di diplomazia economica Cinesi. Inoltre, in linea con la recente "Legge sul controllo delle esportazioni", entrata in vigore il 1° dicembre 2020, la nazione ha la possibilità di monitorare attivamente i propri requisiti interni garantendo strategicamente l'accesso alle fonti di terre rare a livello globale.

Degno di nota è il rapporto tra l'UE e la Cina, in cui in seguito alle prospettive strategiche del 2016 e del 2019 l'UE è diventata più assertiva identificando la Cina come un concorrente economico e un rivale sistemico.

Le prospettive strategiche il CRM Act del 2020 pongono le basi per la creazione di un'industria delle ETR indipendente e autosufficiente, al fine di eliminare il rischio del fornitore unico.

Le misure di de-rischio consistono in molteplici iniziative di investimento per promuovere la creazione di una catena di approvvigionamento europea, attraverso la ri-estrazione o l'apertura di nuove miniere; i progetti di ricerca e sviluppo si concentrano sulla diminuzione della quantità di elementi di terre rare (ETR) o sulla possibilità di sostituirli con altri elementi.

Inoltre, la CRM 2020 istituisce l'European Raw Material Alliance (ERMA), un'alleanza tra più di 180 attori che lavorano congiuntamente per rendere le ETR e l'ecosistema collegato più resistenti agli shock di approvvigionamento e per garantire la sicurezza delle industrie automobilistiche e meccaniche in transizione ecologica.

L’ERMA sta inoltre creando una linea di investimento per la creazione di imprese di riciclaggio che promuovano un uso circolare delle REE e coprano parte della domanda interna.

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Tuttavia, l'UE può utilizzare le sue vulnerabilità per legare le relazioni degli Stati membri e creare un fronte interno più coeso in grado di favorire nuovi partner internazionali, aprendo nuovi mercati e opportunità, aumentando di conseguenza il suo prestigio internazionale e la sua rilevanza come attore internazionale di valore con identità, principi e valori propri.