

# Rare Earths

Challenges and solutions in the transition to clean and renewable energies and in the development of emerging technologies due to the dependence on rare earths



**IDHUS**  
Institute for the Development  
of Human Societies

**Dossier #3**



---

# Challenges and solutions in the transition to clean and renewable energies and in the development of emerging technologies due to the dependence on rare earths





## Introduction

The imperative shift towards cleaner and renewable energy sources constitutes a pivotal endeavour in the quest to combat climate change and establish a sustainable trajectory for our societal development. However, this profound transition confronts a formidable impediment in the form of prospective crises pertaining to the supply of rare metals. These rare metals, of which neodymium, dysprosium, lithium, and cobalt are prominent examples, play a pivotal role in the fabrication of environmentally benign technologies such as wind turbines, solar panels, and electric vehicle (EV) batteries. The present age is marked by geopolitical fluctuations that intensify the precariousness of the supply chain for these indispensable materials. Consequently, any disruption in the availability of these elements could exert a significant deleterious influence on the advancement of renewable energy adoption, potentially undermining the societal metamorphosis catalysed in recent years as we steer away from fossil fuels and their derivatives.

## The Terminology of "Rare Metals"

In this context, it is imperative to elucidate the precise connotation of the term "rare metals." Alternatively designated as rare earth elements, these entities encompass a group of seventeen chemical elements occupying distinct positions in the periodic table. Paradoxically, their nomenclature notwithstanding, these elements are not inherently scarce within the Earth's crust. This cluster encompasses scandium, yttrium, and the fifteen lanthanides, all characterized by analogous chemical and physical attributes such as

elevated melting and boiling points, substantial densities, and noteworthy magnetic and electrochemical properties.



The appellation "rare" bestowed upon these elements is primarily attributable to their tendency to disperse unevenly in natural deposits, rendering them infrequently encountered in concentrations that facilitate their economically viable extraction and processing.

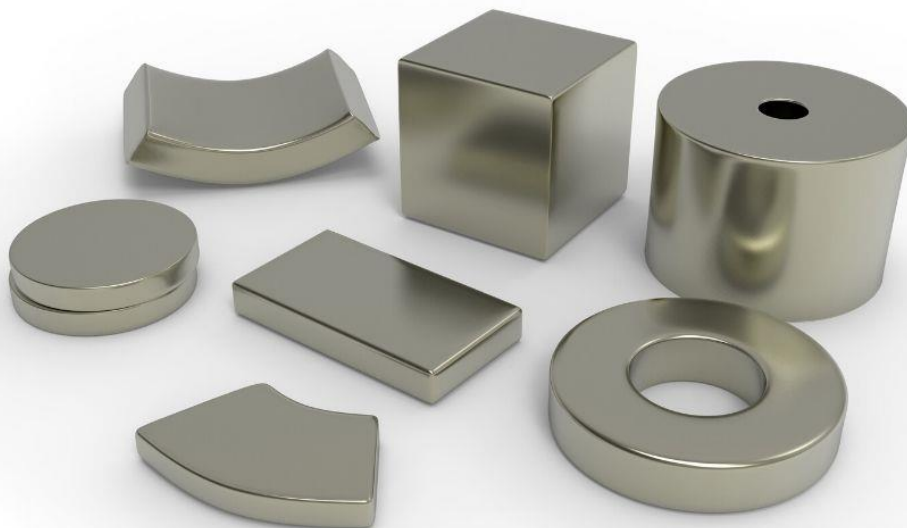
Nevertheless, rare metals constitute indispensable components in a diverse spectrum of industrial and technological applications, ranging from the fabrication of electronic devices and communication equipment to the production of green technologies exemplified by wind turbines, solar panels, and batteries for electric vehicles. The strategic and economic significance of these elements has witnessed exponential growth in recent decades, mirroring the escalating demand for high-efficiency, environmentally conscious products and technologies. Consequently, this heightened demand has engendered concerns surrounding the security of supply and

---


sustainability throughout the extraction and production phases of these invaluable resources.

## Exemplary Significance of Rare Metals

To illustrate the pivotal role played by rare metals, it is instructive to focus on neodymium and dysprosium, both of which are integral to the manufacturing of permanent magnets employed in wind turbines and electric vehicle motors. These magnets are pivotal to the efficiency and efficacy of these technologies, assuming a fundamental role in the realization of a successful transition towards more sustainable energy sources. According to a study conducted by the United States Geological Survey (USGS) in 2020, the global demand for neodymium is projected to surge by 75% by 2025, while the demand for dysprosium could witness a commensurate increase of 59% over the same period.



Lithium and cobalt, conversely, assume paramount significance as primary constituents of lithium-ion batteries, ubiquitous in electric




vehicles and energy storage systems. These elements also occupy an indispensable niche in the advancement of renewable energy sources, as they facilitate the storage of energy generated by intermittent sources such as solar and wind. Projections from the International Energy Agency (IEA) in 2020 indicate that global demand for lithium is poised to escalate tenfold by 2030, with demand for cobalt potentially more than doubling within the same timeframe.

## China's high concentration and dominance in this market

China, as the predominant global producer of rare metals, assumes a commanding position in the industry, accounting for an estimated 80-85% of the world's rare metal production. Furthermore, it exercises substantial control over a significant portion of the supply chain for these invaluable materials. China's primary rare earth deposits are situated within the precincts of Jiangxi province in the southern region of the nation, with the Bayan Obo mine, acclaimed as the largest rare earth mine globally, being a focal point of this resource-rich territory.

While China reigns supreme in rare metal production, other nations also contribute to this sector, albeit to a lesser degree. For instance, Australia features prominently as a key producer of these elements, particularly at the Mount Weld mine situated in the state of Western Australia, where neodymium and praseodymium represent the principal extracted elements.

In the African continent, rare earth deposits are discerned in Burundi and South Africa, specifically in the Gakara and Steenkampskraal mines, respectively. North America is not devoid of



significance in this landscape, with the Mountain Pass mine in California, USA, constituting a noteworthy source of rare metals, particularly cerium and lanthanum, albeit at substantially lower production levels in comparison to China. Canada, too, maintains reserves, with the Nechalacho mine, located in the Northwest Territories, contributing to global supply. In South America, Brazil plays a role with rare earth deposits present at the Araxá mine in the state of Minas Gerais, with niobium and tantalum being the primary targets of extraction.

As per data provided by the U.S. Geological Survey (USGS) in 2020, China achieved a production milestone, yielding approximately 140,000 metric tons of rare earth elements, as previously alluded, constituting around 80-85% of the worldwide output. Concurrently, Chinese exports of rare earths in the same year amounted to approximately 35,000 metric tons, underscoring the substantial portion of China's production earmarked for the global marketplace. Notably, Japan emerged as a paramount importer of Chinese rare earths in 2019, representing nearly 25% of the total Chinese exports of these materials. Other influential importers include the United States, which accounted for roughly 14% of Chinese rare earth exports, as well as European nations, including Germany and France, collectively importing around 10% of Chinese rare earth exports.

## A complex supply chain

A tangible manifestation of the intricate supply chain that facilitates the transit of rare metals from China to the global arena can be exemplified through the production and dissemination of rare earth magnets, specifically the neodymium-iron-boron (NdFeB)


magnets. These magnets are ubiquitous in both green technologies and consumer electronics, and the intricacy of their production process involves a multitude of stakeholders and intricate production stages.

The commencement of this supply chain is inaugurated by the extraction of ores in the Bayan Obo region of Inner Mongolia province, China. Subsequent to the mining phase, these ores undergo a rigorous processing regimen aimed at isolating and refining the diverse rare earth elements they encompass, including the pivotal element neodymium. These refining operations are dispersed across various regions within China. Among them, the Baotou processing complex, situated in Inner Mongolia province, stands as a colossal and pivotal hub for these activities.



Simultaneously, the Sichuan Mianyang facility, located in Sichuan province, assumes a prominent role in China's rare metal processing landscape, specializing in the meticulous processing and refinement of heavy rare earth elements, most notably dysprosium and terbium. These elements bear significant importance in the






creation of high-performance magnets that find application in clean energy technologies and electric vehicles.

In another geographically distinct region of China, the Ganzhou complex, nestled within Jiangxi province, is dedicated to the processing of rare earths extracted from ion-absorption deposits prevalent in the southern expanse of the nation. These deposits possess a wealth of heavy rare earths and are integral in the production of strategic materials, including but not limited to europium, gadolinium, and yttrium. Furthermore, the Xiamen Tungsten facility, situated in Fujian province, assumes a position of eminence in the processing and refinement of these strategic minerals. The Xiamen Tungsten Company, by extension, emerges as one of the most prominent producers of rare metals and other high-performance materials within China, boasting a substantial presence within the global market landscape.

## Preparing rare earths for export

Following the refinement of various mineral extractions, taking the case of NdFeB magnets as a prime example, the meticulously purified neodymium is amalgamated with iron, boron, and other requisite elements, culminating in the production of NdFeB alloys. These specialized alloys are manufactured within dedicated foundries equipped with the requisite expertise and equipment. Subsequently, these alloys are dispatched to magnet manufacturers who employ a gamut of processing methodologies, including sintering and injection molding, to fabricate rare earth magnets characterized by diverse shapes and dimensions.

Upon completion of the manufacturing process, the NdFeB magnets embark on a global journey, destined for component and



device manufacturers scattered across the globe. A considerable portion of these magnets traverses vast oceanic expanses, primarily departing from the bustling port of Shanghai and docking at the port of Los Angeles in the United States. There, they find utility in the assembly of electric vehicle motors. Alternatively, some magnets are shipped from the port of Guangzhou to the port of Rotterdam in the Netherlands, where they are instrumental in the construction of wind turbines, thus contributing to the burgeoning renewable energy sector.

Upon reaching their respective destinations, these rare earth magnets become integral constituents of final products, encompassing electric vehicles, electronic devices, and renewable energy systems. These end products are subsequently distributed and marketed either within local markets or exported to international destinations, thereby culminating the intricate journey of rare earth magnets within the global supply chain.


## **Impact on multiple areas of potential supply crises**

It is evident that a diminution in the supply of rare metals would exert profound repercussions across various dimensions of our economy, society, and technological advancement. These elements serve as foundational pillars underpinning a wide spectrum of industries and applications, as previously elucidated. Foremost among the sectors poised for substantial impact is the renewable energy domain, where a plethora of components within green technologies are reliant on rare metals for both their manufacture and optimal functionality.



In the event of a scarcity in the supply of these rare earths, the electronics and mobile device industry would also confront formidable challenges. Rare metals constitute indispensable elements in the production of vital electronic components, including high-power magnets, sensors, and displays. Such scarcity could engender product shortages, price escalations, and retardation of innovation in fields such as artificial intelligence, robotics, and information and communication technologies—areas where numerous companies and nations are presently making substantial investments to expedite technological advancements within their societies.

Immediate repercussions would also be observable within the defense sector and the arms industry, wherein rare earths are of paramount importance for the fabrication of advanced weaponry, communication systems, and navigation technologies. A decrease in the supply of these materials would imperil the capability of many nations to uphold and enhance their military and security assets. Against the backdrop of ongoing conflicts such as the war in Ukraine and the potential for military hostilities in various global regions, this




prospect assumes heightened concern for governments and security advisors.

A pertinent report emanating from the United States Congress, titled "*Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress*," underscores the critical role played by rare earths in military applications and underscores the implications of U.S. dependence on imported rare earth elements, particularly from China. Authored by Valerie Bailey Grasso, a specialist in procurement and contracting policy, the report underscores that rare earths are indispensable to the production of a wide array of military technologies encompassing guidance and control systems, communications infrastructure, sensing and monitoring mechanisms, aircraft propulsion systems, missiles, and armored ground vehicles. It further raises the concern that dependence on China's rare earth imports could potentially jeopardize U.S. national security, should China choose to restrict the supply of these elements in the event of a geopolitical conflict or discord.

Additional insight into this pivotal subject matter is furnished by an article titled "*The Role of Rare Earth Elements in National Defense*," disseminated by GlobalSecurity.org, a reputable platform for information and analysis pertaining to international security concerns. The article expounds upon the multifaceted deployment of rare earths in a gamut of military applications, encompassing the production of high-strength permanent magnets employed in aircraft and missile propulsion systems, in addition to their utilization within guidance and control systems.

Collectively, these sources underscore the strategic significance of rare earths within the military domain and emphasize the imperative of ensuring unfettered access to these critical resources to



preserve a nation's defense capabilities and safeguard national security.

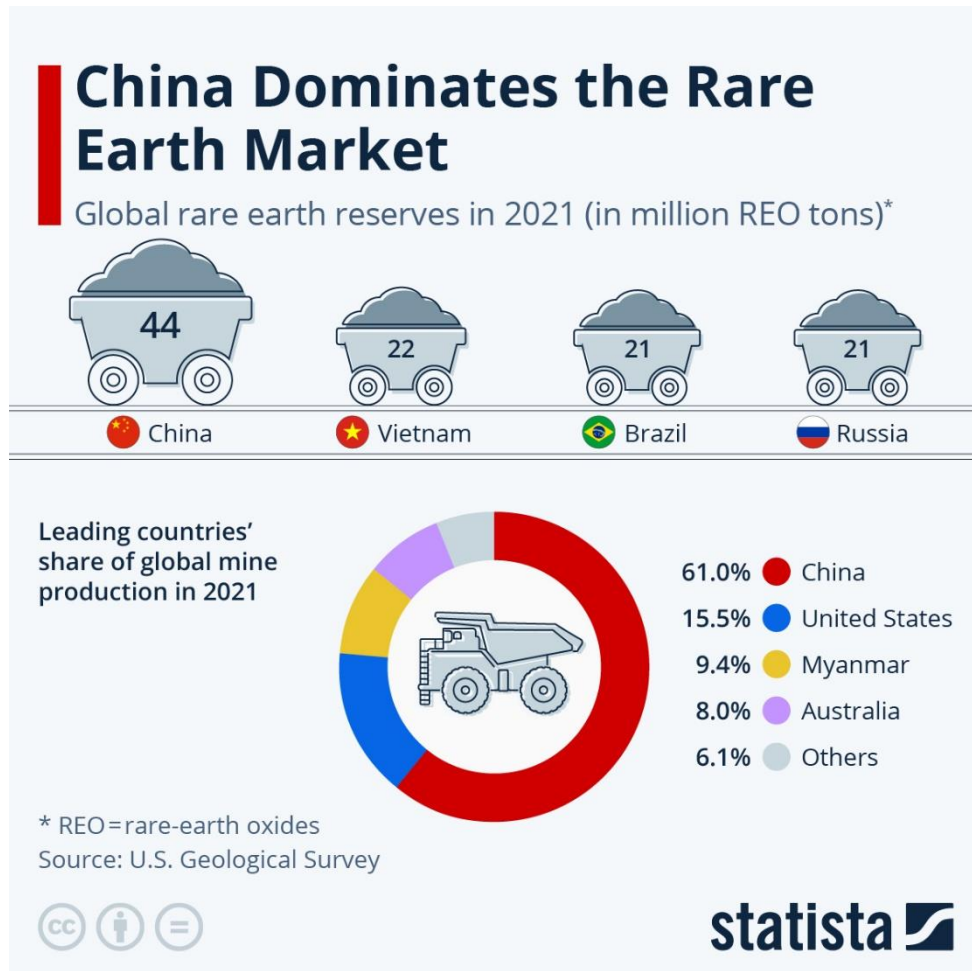
Lastly, the aerospace and automotive industries, which rely on rare metals for the production of lightweight yet robust alloys and electric propulsion systems, would also confront formidable challenges in the event of a supply reduction. Space exploration missions and enterprises engaged in space-related projects would grapple with a shortage of essential materials, thereby impeding progress in these costly and intricate space systems and vehicle development endeavors.

## **Triggers of a potential supply crisis. China and everything to do with its geopolitical decisions.**

The world's reliance on China as the principal supplier of rare earths endows the Asian powerhouse with a pivotal role in shaping the global supply dynamics of these critical elements. China's strategic imperatives in this regard are multi-faceted and may be analyzed through various lenses, each corresponding to its overarching objectives concerning security, growth, and development.

Primarily, China is actively engaged in expanding its influence and global footprint, a pursuit manifested through initiatives such as the Belt and Road Initiative (BRI). Envisioned by Chinese President Xi Jinping in 2013, the BRI represents a far-reaching infrastructure undertaking designed to interconnect China with Europe, Africa, and other regions via a comprehensive network of terrestrial and maritime trade routes. This initiative aspires to elevate China's stature in global trade while augmenting its access to pivotal resources and markets,

thereby enhancing its economic security and fostering sustained growth. Notably, China's rivalry with Western nations in this context has intensified in recent times.



Since its inception, the BRI has witnessed rapid expansion, garnering participation from more than 140 countries and international organizations. Data from the China Silk Belt and Road Initiative Development Center (BRI Development Center) underscores the extent of this initiative's reach, with approximately 200 cooperation agreements inked under its auspices. Furthermore, investments exceeding US\$4 trillion have been channeled into infrastructure and developmental projects across participating nations.



The BRI encompasses a diverse array of endeavors, encompassing infrastructure development encompassing roads, railways, and ports, the establishment of economic zones, and collaboration in energy and telecommunications sectors. It also embraces cultural and academic projects designed to facilitate knowledge exchange and foster mutual comprehension among participating countries. Nevertheless, the BRI has been the subject of scrutiny and apprehension on several fronts, including concerns related to transparency in decision-making, unsustainable debt burdens in select recipient nations, and the potential adverse environmental and social ramifications of associated projects. Notably, apprehensions persist regarding China's potential to employ the BRI as a tool for both geopolitical and economic influence, expanding its global sway while securing access to strategic resources, a topic of significant international discourse.

Concurrently, in safeguarding its economic interests, China has embarked on a path of trade diversification, endeavoring to reduce reliance on specific markets, particularly the United States, in response to the escalating imposition of sanctions by the latter. China's strategy includes participation in regional trade agreements like the Regional Comprehensive Economic Partnership (RCEP), which constitutes one of the world's most extensive free trade zones, encompassing numerous Asian and Pacific nations. While China often asserts dominance in such regional pacts, it is also pursuing bilateral agreements that span decades, directed at securing rare metal sources through investments in countries hosting deposits of interest, notably in various South American nations.

Illustrating this strategy is the 2019 accord between China Minmetals Rare Earth Co., a subsidiary of China Minmetals Corp, and the Government of Bolivia, establishing a joint venture aimed at

---


exploring and developing rare earth deposits within Bolivia. The Santa Cruz rare earth deposit, in particular, is the focal point of this collaboration, recognized as one of South America's largest repositories of rare earth elements. While precise reserve figures remain undisclosed, this accord is poised to galvanize Chinese investment in the Bolivian mining sector and reinforce collaboration in the domain of rare earths between the two nations.



Another pertinent instance is the Aricunga project in Chile, spearheaded by the Chinese entity Sichuan Fulin Transportation Group Co. Ltd. Situated in the Antofagasta region, this endeavor concentrates on rare earth exploration linked to salars, salt deposits within enclosed basins. Beyond these specific projects, China has been instrumental in brokering comprehensive trade and investment accords with South American countries, typified by the 2006 free trade agreement with Chile, which incorporates provisions concerning investment and mining sector collaboration.

These pacts are positioned to pave the way for future investments and undertakings related to rare earths and other mineral resources in the region, thus solidifying China's presence as it diligently seeks to secure access to these pivotal resources while





concurrently fortifying economic and political ties with South American nations.

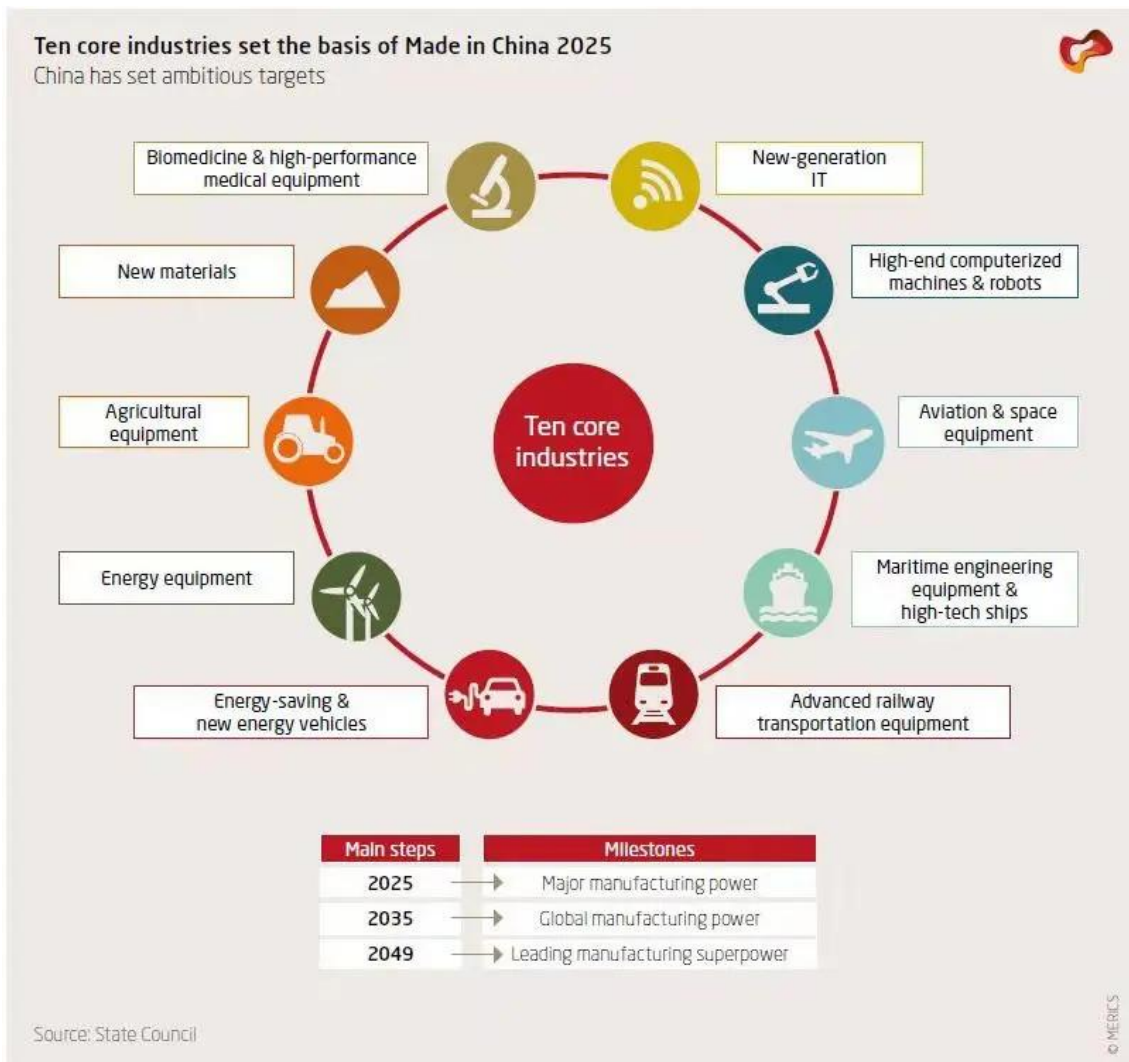
## Seeking Chinese leadership in multiple aspects of emerging technologies

The promotion of technological advancement constitutes a cornerstone of China's overarching geopolitical strategy. The nation has articulated its aspiration to ascend as a vanguard in the development and integration of emerging technologies, prominently encompassing artificial intelligence, renewable energy, and information technology. In pursuit of this ambitious vision, China is allocating substantial resources toward extensive research and development endeavors, while concurrently nurturing collaboration among its academic institutions, corporate entities, and governmental bodies, with the aim of fostering technological innovations and breakthroughs.


To this end, the Chinese government has meticulously executed a sequence of strategic blueprints in recent years, directed at catalyzing the progression of novel technologies and cultivating a climate of innovation within pivotal sectors of the economy. A pivotal document in this context is the "Made in China 2025" plan, unveiled in 2015, which articulates a comprehensive roadmap aimed at effecting China's transformation into a preeminent stronghold of advanced manufacturing and an avant-garde luminary in innovation within the span of a decade.

The "Made in China 2025" plan designates ten focal sectors that merit unwavering attention to accomplish the nation's objectives in innovation and technological advancement. These sectors encompass

a spectrum of domains, spanning information technologies, robotics and automation, aerospace, high-speed rail equipment, new energy vehicles, advanced materials, and medical devices, among others. Furthermore, the plan underscores the paramountcy of research and development initiatives in nascent technologies such as artificial intelligence, biotechnology, and clean energy technology.



In 2017, the Chinese government introduced the "New Generation Artificial Intelligence Development Plan," delineating the nation's artificial intelligence policy objectives extending through 2030. This plan articulates China's vision to claim preeminence in the realms of artificial intelligence research and development, along with the integration of artificial intelligence into the economic and societal



fabric. Crucially, the plan underscores the pivotal role of investments in research and development, human resource development, and international collaboration within the sphere of artificial intelligence.

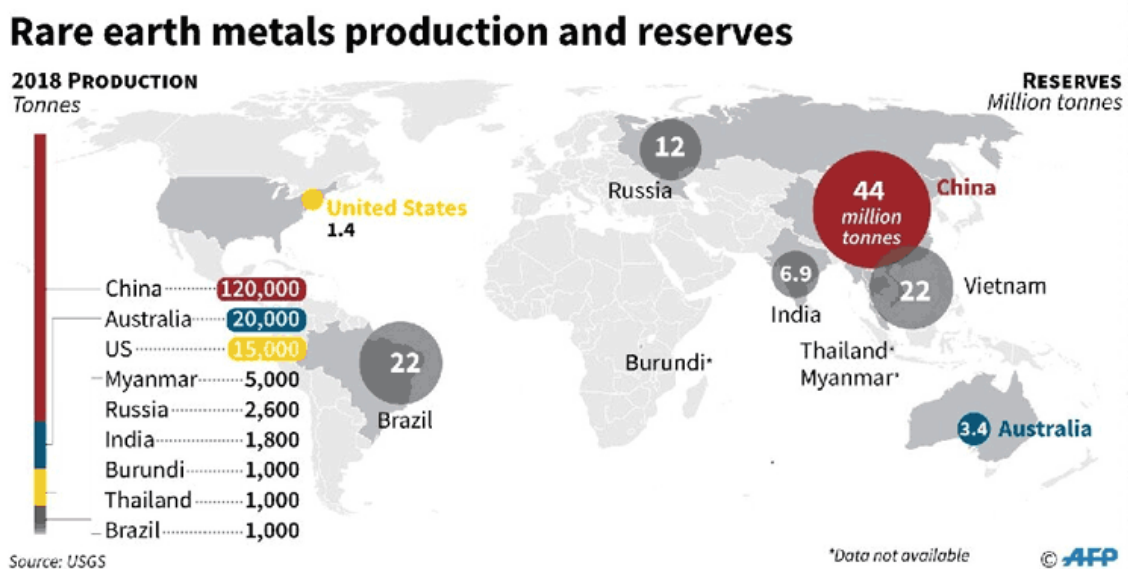
Beyond these specific plans, China has erected ambitious targets in the arena of clean energy and environment-centric technologies. Committing to the Paris Agreement on climate change, China has pledged to attain carbon neutrality by 2060 while augmenting the share of non-fossil energy within its energy matrix. In the pursuit of these objectives, China has channeled substantial resources into the development and deployment of renewable energy technologies, embracing solar, wind, and nuclear power, in addition to energy storage technologies and electric vehicles.

The dominant stature of China in the rare metals market equips it with considerable leverage to influence the global supply and demand dynamics of these critical materials, according to the consensus among rare earth analysts. An illustrative publication in this context is the report titled "China's Rare Earth Elements Industry: What Can the West Learn?" issued by the Institute for the Analysis of Global Security (IAGS), a center dedicated to energy security research and analysis. Authored by Cindy Hurst, the report probes into the escalating importance of rare earths in the global economic landscape and underscores the ramifications of supply concentration in China for other nations. It elucidates the vulnerability of many countries tethered to Chinese rare earths, accentuating potential threats to their supply security and elucidating conceivable geopolitical and economic repercussions, including China's potential employment of its commanding rare earth market position as a means of political or economic leverage.


A complementary contribution emanates from the report titled "Rare Earths: The Hidden Cost to Their Magic," issued by the Council

on Foreign Relations (CFR), a think tank focused on foreign policy and international affairs. Co-authored by Varun Sivaram and Teryn Norris, this report expounds upon the critical significance of rare earths within emerging technologies while highlighting the attendant risks to the national and economic security of other nations stemming from China's dominant reliance on these elements.

## Various ways to control the supply of rare metals



The escalating concerns center around the potential ramifications should China opt to wield its influence over the supply of rare earths as a strategic bargaining tool in response to sanctions or restrictions levied upon its economy—most notably in domains such as semiconductor manufacturing technology. Additionally, China may contemplate amplifying its domestic development initiatives on an expanded scale, harnessing all available resources within its borders. In this scenario, China's dominance within the rare earths market could be harnessed to trigger disruptions in the global supply chain of these critical elements.




Given the pivotal role that rare earths play across nearly every technological sector of society, utilizing control over their supply as a leverage tool in trade or political disputes represents a formidable card in the hand of Chinese leadership. In the event of escalating tensions between China and Western nations, the Chinese Communist Party could entertain the prospect of curtailing or restricting exports of rare metals to a consortium as substantial as the entire European Union, the United States, or Canada. Such a move would reverberate across industries reliant on these materials and ultimately reverberate throughout the global supply chain. Heightened trade disputes between China and the United States could potentially see China exploiting its commanding position within the rare metals market to exert pressure upon the United States and extract concessions in other domains of bilateral relations.

Within this framework, were China to embark on a path of pressuring the United States by dangling the threat of rare earth supply interruption, it might seek to secure advantages in various facets of trade in exchange for maintaining the flow of these critical materials. Some of these potential areas for negotiation encompass:

**Access to the U.S. Market:** China may aspire to secure improved access to the U.S. market for its products and services. This could encompass measures such as the reduction of trade barriers, tariffs, and quotas that are currently in place, some of which were enacted by prior U.S. administrations. This could carry particular significance in sectors where China has previously encountered trade restrictions, including information and communication technologies, steel and aluminum products, and agricultural goods.

**Technology Transfer:** China might exert pressure upon U.S. companies to share their advanced technologies and expertise across



strategic domains like artificial intelligence, semiconductors, robotics, and biotechnology. Notably, this approach stands in contrast to the current U.S. stance, which has opposed extensive technology sharing. Such pressure from China could manifest through collaboration agreements, technology licensing, or even through Chinese entities acquiring U.S. companies.

**Foreign Investment:** China could concurrently seek assurances that its investments within the United States will be treated equitably and fairly. This entails avoiding discriminatory restrictions or national security policies that impede or limit Chinese investments—a scenario currently in play. Such assurances could encompass the removal of regulatory barriers or the creation of favorable conditions to incentivize Chinese companies to invest within key sectors of the U.S. economy, thereby mitigating the trajectory of economic decoupling that has emerged over recent years.

**Trade Dispute Resolution:** An additional realm where intensified Chinese pressures upon the United States and Europe could surface pertains to employing the threat of rare earth supply restriction as a means to compel resolution of lingering trade disputes. These disputes may extend into domains such as intellectual property, industrial subsidies, and alleged unfair trade practices. If executed, this strategy could culminate in U.S. commitments to address China's trade grievances or bring about resolutions within pending cases within the World Trade Organization (WTO).

Nevertheless, it is imperative to underscore that the deployment of rare earth supply constraints as a bargaining instrument may trigger adverse consequences for both China and the United States. Such a course of action could potentially kindle an escalation of trade tensions, retaliatory measures, and a surge in mutual distrust between the two nations. In the long term, this could inflict damage upon their


economies and bilateral relations, thus necessitating a prudent approach to the use of rare earths as a geopolitical bargaining tool.

## Temporary pressures and limited restrictions



In a less drastic scenario, wherein a complete cessation of supply is avoided to prevent direct repercussions, China possesses the potential to curtail the volume of rare earths allocated to other nations through the application of export restrictions and quotas—strategies that it has previously employed. These actions have been justified on the grounds of environmental and sustainability concerns, akin to the situation in 2010 when China opted to diminish its export quotas for rare earths by a substantial 40%. This decision, in turn, engendered a significant upswing in the international market prices of these materials.

In accordance with data from the United States Geological Survey (USGS), China's rare earth exports in 2009 amounted to approximately 50,000 tons. However, following the imposition of



restrictions in 2010, exports dwindled to around 30,000 tons in 2011. This alteration in export policy precipitated a marked escalation in the prices of specific rare earth elements, exemplified by neodymium and dysprosium, which, in some instances, surged by a staggering 700%.


China rationalized these export constraints and quotas by invoking the imperative of safeguarding its natural resources and addressing environmental apprehensions linked to the extraction and refinement of these metals. Historically, China has harnessed its commanding position within the rare earths market as a lever to exert influence over the global supply and demand dynamics of these critical materials. Moreover, it has employed this influence to advance the adoption of alternative technologies developed within China's borders or to favor Chinese enterprises reliant upon rare metals within their production processes.

## Addressing a potential crisis in the supply of rare earth metals and rare earths

To mitigate the looming risk of a rare metal supply crisis and ensure a seamless transition to cleaner and renewable energy sources, several pivotal issues warrant consideration, including diversification of supply sources, advancement of research and development in alternative technologies, and the adoption of more sustainable and responsible extraction and production practices.

Diversifying supply sources assumes paramount importance in the endeavor to diminish reliance on China and ameliorate vulnerability to supply disruptions. This necessitates the exploration and development of novel rare metal deposits across various global regions, accompanied by a concerted effort to bolster international






cooperation in the realms of mineral resources trade and diplomacy. Concurrently, the promotion of a circular economy and the recycling of rare metals found within discarded electronic products constitute indispensable measures that can significantly augment the availability of these materials while alleviating the pressure on natural resource extraction.

A multitude of unexplored or underutilized rare earth deposits, situated outside China, offer promise in diversifying the global supply of these critical materials. For instance, the Mountain Pass project in California, USA, managed by MP Materials, stands out as an illustrative example. MP Materials has undertaken the task of reactivating this mine, once a primary global source of rare earths before its closure in 2002 due to economic and environmental concerns. According to data from the United States Geological Survey (USGS), the Mountain Pass mine is estimated to harbor reserves encompassing approximately 2.94 million tons of rare earths.

Another noteworthy prospect is the Kvanefjeld rare earths project in Greenland, home to one of the world's largest deposits of rare earths and uranium. Australian firm Greenland Minerals spearheads the development of this project, which is believed to encompass roughly 10.33 million tons of rare earth oxides and 593 million pounds of uranium. Progress in this endeavor hinges upon securing government permits and approvals, as well as the prevailing market conditions.

Australia's Nolans rare earth project, overseen by Arafura Resources, represents a third salient example. This venture boasts substantial potential, with an estimated ore reserve of approximately 56 million tons, featuring an oxide concentration of around 2.6% rare earths. The Nolans project could emerge as a significant source of rare earths, particularly neodymium and praseodymium, essential




components in the manufacture of permanent magnets used in electric vehicle motors and wind turbines.

It proves challenging to offer a precise estimate of the potential reduction in China's rare earth production dependence that could ensue if all the aforementioned projects, alongside others worldwide, materialize as intended. This outcome hinges upon multifarious factors encompassing production scale, deposit quality, and the processing and refining capacities of the respective countries involved. As exemplified by the Mountain Pass project, despite being one of the largest non-Chinese mines, a substantial portion of the material extracted from Mountain Pass is still dispatched to China for processing, which diminishes its efficacy in reducing reliance on China.

Simultaneously, contributing to the lessening of China's global dependence in this realm necessitates the amplification of production across all other rare earth deposits scattered across the planet. Lynas Corporation in Australia, which operates the Mount Weld mine and rare earth processing plant in Malaysia, has already embarked on this path. Lynas presently contributes approximately 10% of the world's rare earth supply and represents one of the few significant non-Chinese sources. The expansion of Lynas' operations, coupled with the establishment of a novel processing facility in the United States, is anticipated to further curtail reliance on China.

Several other projects already in progress include the Nolans project in Australia (under the purview of Arafura Resources), the Kvanefjeld project in Greenland (operated by Greenland Minerals), and the Bear Lodge project in Wyoming, USA (managed by Rare Element Resources). If these projects advance as planned and attain their envisaged production capacities, they hold the potential to substantially augment the diversification of the rare earth supply over the ensuing decade.




## Decrease dependence on rare earths by encouraging the development of alternatives

It is pivotal to recognize that while these projects hold promise in increasing rare earth production outside of China, diversifying the supply chain hinges on the development of processing and refining capacities for these materials in other countries. Currently, China retains its status as the primary processor of rare earths, underlining the critical importance of bolstering processing capabilities beyond Chinese borders to mitigate dependence on Chinese production.

In parallel, investment in research and development of alternative technologies assumes paramount significance in the quest to reduce reliance on rare metals across various sectors, including the production of renewable energies, automotive manufacturing, and other technology-intensive industries with substantial dependencies on these elements.

This endeavor should encompass several key facets, such as the conception of innovative permanent magnets utilizing more abundant and less critical materials. Additionally, the development of batteries and energy storage systems employing alternative chemical technologies, like sodium-ion batteries or solid-state batteries, should feature prominently. Furthermore, research in advanced materials and nanotechnology can pave the way for novel approaches aimed at enhancing the efficiency and sustainability of green technologies while minimizing reliance on rare metals.

A significant aspect of mitigating supply problems in the rare earth sector is intensifying efforts to increase the recycling of previously manufactured components containing these elements.



At present, multiple recycling processes exist for rare metals, although many of them remain in the early stages of development or find limited application on a large scale, chiefly due to technical, economic, and regulatory challenges. These processes share the common goal of salvaging and reusing rare earth elements present in electronic and technological products as they reach the end of their useful life. The overarching objectives are to curtail reliance on primary sources and reduce the environmental footprint associated with the extraction and production of these metals.

One prevalent recycling method entails the manual or mechanical disassembly of electronic products, followed by the segregation of components containing rare earths. Notable examples include neodymium-iron-boron magnets found in hard disks and electric motors, lanthanum and cerium phosphates in liquid crystal displays (LCDs), and yttrium oxide powders in fluorescent lamps. Following this initial separation, chemical or physical processes are employed to extract and purify the rare metals.

Chemical extraction serves as a widely employed technique for rare metal recovery from electronic components. This process typically involves dissolving materials in potent acids, such as nitric acid, sulfuric acid, or hydrochloric acid. Subsequently, specific chemical agents facilitate the selective precipitation of rare metals. While effective in recovering rare metals at relatively high concentrations, this method can generate substantial amounts of toxic liquid waste and greenhouse gases, raising environmental and health concerns.

An emerging approach in rare metal recycling is ionic liquid extraction, which leverages liquid ionic compounds in lieu of traditional acids to dissolve and extract rare metals from electronic components. Ionic liquids boast advantages like reduced


---

corrosiveness, lower toxicity, and enhanced selectivity in rare earth extraction, thereby curbing waste generation and enhancing process efficiency. However, this technology is still in its nascent stages of research and development and has not seen widespread industrial implementation.

Physical methods, including magnetic separation and flotation, constitute additional techniques for recycling rare metals. These methods capitalize on the magnetic or hydrophobic properties of rare earth-containing materials to effectuate separation from other components and waste. Such processes often tout advantages such as cleanliness and lower energy consumption compared to chemical methods but may also suffer from reduced efficiency and necessitate substantial investments in infrastructure and equipment.

**It is important that the ecological, energy and technological transition does not come to a halt**






The transition towards cleaner and renewable energies and the rapid advancement of various emerging technologies across multiple sectors of society face significant jeopardy in the event of a crisis in the supply of rare metals.

This shift towards greener and more sustainable energy sources and the utilization of environmentally friendly materials throughout various technological and industrial domains are of paramount importance to humanity. They must not be impeded by the scarcity of these currently indispensable components, for several compelling reasons, primarily associated with climate change, resource sustainability, and the enhancement of quality of life.

The sustainability of Earth's resources serves as the pivotal factor driving the imperative for adopting greener and more environmentally conscious technologies. As a consequence, society at large must continue its endeavors to minimize the adverse impact of our way of life on the global ecosystem. Fossil fuels, being finite and non-renewable resources, are destined to be depleted over time. This depletion can potentially lead to economic and geopolitical strife as nations vie for access to dwindling reserves. In contrast, renewable energies, as emphasized by numerous international agreements, offer the promise of a long-term, sustainable energy supply.

Given that the current energy transition heavily depends on the use of rare earths, recycling these metals and other critical materials essential in green technologies assumes paramount significance. Recycling efforts can effectively reduce the demand for extracting natural resources, mitigate the risk of supply disruptions, curtail environmental impacts, and diminish reliance on volatile sources of supply. By recycling more rare earths and exploring alternative elements in technological advancements across various societal domains, we distance ourselves from the potential adverse



consequences of a rare earth and metal supply crisis on the global market and overall societal progress.

Tackling this challenge necessitates a multifaceted approach, encompassing the diversification of supply sources, the encouragement of research and development into alternative technologies, and the promotion of sustainable and responsible practices in the extraction and production of these invaluable materials. Only through such comprehensive measures can we ensure a sustainable and resilient energy future for future generations.



**IDHUS**

**Institute for the Development  
of Human Societies**