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Trans-Atlantic Critical Mineral Supply Chain Cooperation: How to Secure Critical Minerals, Battery and Military Supply Chains in the European Theatre

by Fabian Villalobos

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ABSTRACT

The intensifying US-China competition has profound implications for critical mineral supply chains (CMSCs), affecting trade, export controls and market dynamics. US and European firms face difficulties competing with China's dominant market position, which has led to shutdowns and restricted access to essential materials. China's state-backed industrial policy, integration of the Communist Party into commercial operations and use of market power for geopolitical leverage have enabled it to control key mineral-technology value chains, complicating international cooperation and raising security concerns. The global push for decarbonisation has increased civilian demand for critical minerals, particularly in new energy technologies, outpacing defence sector needs and limiting its influence in securing resources. In response, both the US and EU have developed strategies to mitigate vulnerabilities in their supply chains, recognising the need for diversified control, crisis management mechanisms and enhanced cooperation. The war in Ukraine has further underscored the urgency of strengthening the defence industrial base, with case studies illustrating the material demands for military technologies such as FPV drones. Drawing on the experiences of South Korea and Japan, and fostering transatlantic cooperation through trade agreements and intelligence sharing, the US and Europe can build greater resilience against geopolitical disruptions and the concentrated, mercantilist nature of current CMSCs.

Critical raw materials | Supply chains | Transatlantic relations | Defence industry | Drones | Ukraine | South Korea | Japan

keywords

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by Fabian Villalobos*

The ongoing competition between the United States and the People's Republic of China (PRC) has had multifaceted repercussions across a variety of stakeholders. Within the realm of critical minerals supply chains (CMSCs), that competition has spilled into trade, technology export controls, information operations and predatory market behaviour. Domestically, US firms trying to compete in industries with strong Chinese market share have shuttered their operations. Access to critical raw material inputs have been restricted or banned. US allies and partners have been brought together to collaborate on supply chain issues only to find US divergence on trade and security has complicated the decision calculus. Meanwhile, China has continued to advance its control over supply chains and leverage its market power to geopolitical ends.

1. Background

International efforts to reduce carbon emissions are a major driver of the demand for new energy technologies and their raw material inputs, including critical minerals. According to a 2021 United Nations Climate Fact Sheet, the transport sector is responsible for 25 per cent or global CO_2 emissions.[1] According to the US Environmental Protection Agency, that number is 28 per cent for the United

[1] United Nations, *Sustainable Transport Conference Fact Sheet: Climate Change*, 14 October 2021, https://www.un.org/sites/un2.un.org/files/media_gstc/FACT_SHEET_Climate_Change.pdf.

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States.[2] Fossil fuels, and petroleum in particular, dominate as sources of energy. To reduce these emissions, global polices aim to reduce or eliminate the sales of internal combustion engines.[3] With such ambitious goals comes a demand signal for electric vehicles and the subsystems, components and raw materials required for their manufacture. Nations, especially those with established automotive sectors, are keen to capture or hold onto market share and preserve jobs and economic growth.

This large civilian demand signal dwarfs the demand for these same raw materials from the defence and aerospace sector. Important components for weapons systems and equipment produced by the defence industrial base include 'dual-use' technologies, which are usually developed in response to civilian demand by academia and commercial industry but also have military utility.[4] Lithium-ion batteries (LIBs) for energy storage are a prime example. LIBs have captured the greatest share of civilian demand for mobile energy storage, primarily because of their relatively high specific energy, which translates into longer life for mobile electronics and longer range for electric vehicles. LIBs, for the same reason, are needed to fill demand for mobile energy storage on the battlefield, whether for extending operational capabilities that depend on portable energy – and thus conserving JP-8 fuel and reducing the burden on operational energy missions and their logistical footprint – or introducing new capabilities like small unmanned aerial systems (sUAS). However, in dual-use technology markets such as the LIB market, the defence sector is often a small consumer within a larger market driven by demand from commercial applications. In contrast to technologies and capabilities with limited applicability outside warfare, such as munitions, the defence sector has little leverage to shape and influence suppliers to meet specific military requirements. This limits the policy options available to securing materiel and shapes the overall strategy with which to approach risk mitigation.

These challenges to the defence industry posed by vulnerable raw material supply chains are recognised by both the United States and the European Union in documents like the 2023 National Defense Industrial Strategy[5] and the 2024 European Defence Industrial Strategy,[6] respectively. Similarly, the North Atlantic Treaty Organization (NATO) published its first defence-critical raw materials list in 2024.[7]

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[2] US Environmental Protection Agency website: *Sources of Greenhouse Gas Emissions*, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

[3] For example, the earliest policy to reduce sales comes from Norway which aims for 100 per cent of new vehicles sales to be from hybrid and electric vehicles by 2025.

[4] Fabian Villalobos et al., *From Mines to Markets in the Middle East and Central Asia. Critical Mineral Suppliers and Dependencies in the U.S. Central Command Area of Responsibility*, Santa Monica, RAND, 2023, https://doi.org/10.7249/RRA2914-1.

[5] US Department of Defense, *National Defense Industrial Strategy*, 16 November 2023, https://www.businessdefense.gov/NDIS.html.

[6] European Commission, *A New European Defence Industrial Strategy: Achieving EU Readiness through a Responsive and Resilient European Defence Industry* (JOIN/2024/10), 5 March 2024, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52024JC0010.

[7] NATO, *NATO Releases List of 12 Defence-Critical Raw Materials*, 11 December 2024, https://www.nato.int/cps/en/natohq/news_231765.htm.

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Meanwhile, initiatives like China's Made in China 2025 detail the country's ambitions to move itself up the value chain in a variety of sectors, one of which is the New Energy Vehicles – which includes hybrid, electric and fuel cell vehicles. Speeches made by the Xi Jinping himself also highlights the importance of industries like batteries and electric vehicles.[8] Subsequently, Chinese industry, in the form of state-owned enterprises (SOEs) and non-state[9] firms, have enjoyed subsidies and preferential policies to help build a domestic electric vehicle industrial base. Through the use of incentives like access to these subsidies, foreign auto companies have set up partnerships with Chinese firms to transfer technology and manufacturing capabilities. The result has been an early start towards capturing market share of vehicle manufacturing as well as battery manufacturing. Battery manufacturing had an earlier start due to China's role as a manufacturer of mobile electronics components. Now, explicit and implicit subsidies within China have been reduced or removed. The result is domestic demand reduction, increased competition, oversupply and the need to export into other markets for Chinese firms to remain solvent, including the European market.[10]

But electric vehicles are not the only energy technology industry with techno-economic competition.[11] An earlier version of these dynamics played out in production of polysilicon solar photovoltaics, i.e., solar panels. Manufacturers and policy makers in Western countries are keen on not repeating the mistakes made in the solar industry which China now dominates. To incentivise domestic production capacity for electric vehicles and remain competitive with Chinese industry, the United States has enacted legislation like the Bipartisan Infrastructure Law and the Inflation Reduction Act. The European Union has enacted similar legislation in the form of the Green Deal Industrial Plan and Critical Raw Materials Act. Other countries like Japan and the Republic of Korea have their own legislation with more concerted efforts towards securing mineral-technology value chains.[12] Multilateral efforts like the Mineral Security Partnership (MSP) continue to offer a forum for diplomacy and "a collaboration [...] to catalyze public and private investment in responsible critical minerals supply chains globally".[13]

[8] A speech in France, president Xi Jinping delivers remarks alongside French president Emmanuel Macron highlighting the electric vehicles industry. See "Full Text of Xi's Signed Article in French Media", in *Xinhua*, 6 May 2024, http://en.qstheory.cn/2024-05/06/c_984254.htm.

[9] The selection of the term "non-state" as opposed to "private" firm is discussed in the next section.

[10] There is also a need to seek new consumers of these products in adjacent industries with a need for mobile energy storage (e.g., drones).

[11] For a definition of techno-economic competition, see Robert Atkinson, "How to Win Techno-Economic Competition with China", in *The National Interest*, 8 October 2024, https://nationalinterest.org/blog/techland/how-win-techno-economic-competition-china-213136.

[12] Mineral-technology value chain is a term used to describe not just the mining industry and its immediate supply chain ecosystem, but the value chain up to and including the final products minerals are need to produce. This encompasses intermediate chemicals and metals, technology-specific precursors, technology-specific sub-components and components, and articles sold by original equipment manufacturers like consumer products or military platforms, weapons and equipment.

[13] Samantha Carl-Yoder et al., "The Minerals Security Partnership", in *Proceedings of the 70th Annual Natural Resources and Energy Law Institute (2024)*, January 2025.

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Nor are these countries ignoring the demand for the raw materials needed for their manufacture and those needed for military weaponry and equipment. Largely, in response to the security concerns stemming from China – more specifically its activity in the Taiwan Strait, South China Sea and broader Indo-Pacific – but accelerated in response to the ongoing Russian war of aggression in Ukraine, a number of initiatives aimed at increasing the capacity of the defence industrial base have been started or are ongoing. In the United States, the US National Defense Industrial Strategy, the Partnership for Indo-Pacific Industrial Resilience, several White House executive orders relating to both minerals and the defence industrial base, the inclusion of critical minerals in trade policy considerations, and more reveals that CMSCs and mineral-technology value chains continue to be a priority concern and focus of efforts for the US government. A resilient priority means there is still opportunity for cooperation.

2. Underlying problems in critical minerals supply chains

The root of uncertainty in mineral markets is strewn across a variety of factors, but those resulting from China's market activity can be distilled into three categories: (1) China's industrial policy; (2) commercial integration with China's party apparatus; (3) China's economic statecraft. These three areas of market activity influence commodity prices and market power, the ability of foreign firms to operate nominally inside China, and access to Chinese supply by foreign firms. Combining these categories with other industry challenges yields market characteristics that can then inform policies to shape supply chain security.

2.1 PRC industrial policy

The People's Republic of China's non-market development strategy heavily leverages industrial policy to create technology and manufacturing capability and capacity in several interdependent value chains. These mineral-technology value chains are specified through the publication of Five Year Plans written by many state organs, often the Ministry of Industry and Information Technology. As illustrated in the 14th Five Year Plan for Raw Materials Industry Development,[14] the PRC issues guiding statements to direct the activity of state organs and industry including both SOEs and non-state firms.

The development goals reflect a desire for raw materials to "ensure and lead the high-quality development of the manufacturing industry"; in other words, to leverage critical minerals to onshore downstream nodes of technology value

[14] This plan was jointly developed by three state organs: Ministry of Industry and Information Technology, Ministry of Science and Technology and Ministry of Natural Resources. See, Chinese Ministry of Industry and Information Technology, *Notice on Issuing the 14th Five-Year Plan for the Development of Raw Materials Industry* (in Chinese), MIIT Joint Regulation No. 212 of 29 December 2021, https://wap.miit.gov.cn/zwgk/zcwj/wjfb/tz/art/2021/art_2960538d19e34c66a5eb8d01b74cbb20.html.

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chains. There is also a desire to increase the scale of "new materials industry" i.e., to increase supply of materials higher in the value chain. State organs react to directives such as these and issue explicit and implicit subsidies to increase the production capacity of currently operating firms or to encourage the opening of new firms. This can include cheap loans, cheap land and investments in supporting infrastructure for logistics, transportation and energy.

The resulting growth in quantity of firms and production capacity creates extreme competition inside of China to find customers. The competition decreases prices inside China's domestic market and forces some suppliers to seek customers in adjacent industries or to go abroad, pushing out supply into foreign markets. This lowers the cost for domestic Chinese original equipment manufacturers who consume the raw materials or intermediate metals and chemicals while simultaneously increasing prices outside of China thus creating a two-tiered commodity price structures. When coupled with policies that require foreign firms to transfer technology to local firms to gain access to China's domestic consumer market and export quotas that limit the amount of supply from outside of China, it disrupts foreign firms' ability to operate profitably and ultimately to compete. In the United States, the only cobalt refinery shut down its operations only months after starting production.[15] In Sweden, Northvolt, a battery cell manufacturer, is close to filing for bankruptcy.[16]

2.2 Commercial integration with the PRC Party apparatus

A concern from Chinese firms' legislative integration with the Chinese Communist Party (CCP), is that by extension, many other parts of the government and party, including the security apparatus and military services, are included in the decision-making calculus of the firm. This stems from many mechanisms, but an important one relates to SOEs. The first is the State-owned Assets Supervision and Administration Commission of the State Council (SASAC), which reports directly to the PRC State Council, overseas national level SOEs with extensive powers, like the ability assign leadership positions at will.[17] National SOEs cover a wide variety of sectors including mineral extraction, chemical processing, oil and gas, shipping and transportation, port infrastructure and more.

National SOEs are also integral to the PRC's Belt and Road Initiative in the form of ports and infrastructure construction and access to – and extraction of - minerals in Africa, Latin America, Central Asia and elsewhere. As an example, the 14th

[15] Cecilia Jamasmie, "Jervois Halts Idaho Project on Weak Cobalt Prices", in *Mining.com*, 29 March 2023, https://www.mining.com/?p=1113843.

[16] "Northvolt Close to Filing for Bankruptcy in Sweden, Newspaper DN Reports", in *Reuters*, 11 March 2025, https://www.reuters.com/markets/deals/northvolt-close-filing-bankruptcy-sweden-newspaper-dn-reports-2025-03-11.

[17] Li-Wen Lin, "A Network Anatomy of Chinese State-Owned Enterprises", in *World Trade Review*, Vol. 16, No. 4 (October 2017), p. 583-600, DOI 10.1017/S1474745617000210.

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Five Year Plan for Raw Materials Industry Development specifies a goal to "[m]ake leading enterprises bigger and stronger". In the case of rare earth elements, the directive was to "strengthen and expand rare earth enterprise groups, and encourage rare metal enterprises to accelerate integration".[18] Following the release of the plan, consolidation of the rare earth industry did in fact occur in December 2021.[19]

Another concern stems from the CCP presence inside non-state firms.[20] The use of the term "non-state" firm over "private" firm is deliberate to illustrate the implications of the PRC's legal framework. The PRC can request the presence of CCP officials within a company from as high as a seat on the board of directors to as simple as a desk in a corner.[21] Due to the participation of CCP officials in the non-public sector, a distinction must be made to signal that a firm with CCP presence may have a different set of motivations than purely profit-seeking entities in Western countries. However, it is entirely possible for a non-state firm to be both profit-seeking and adherent to broader CCP/PRC goals and act in accordance with one goal or the other depending on the situation. Of course, there is a spectrum of firms that are least likely to adhere to party goals (or least relevant) to those most likely to adhere to party goals. The firms more likely to be relevant to party goals might be those in industries identified in Five Year Plans.

2.3 PRC techno-economic statecraft

The PRC has used several tools of techno-economic statecraft[22] to coerce or otherwise influence the decision-making of other nations or companies. This includes limiting access to its domestic market and export restrictions on technology or raw materials.

Several pieces of legislation have allowed the PRC to limit access to China's domestic market. The first example is from China's 2017 National Intelligence Law,[23] which

[18] As translated.

[19] Fabian Villalobos et al., *Time for Resilient Critical Material Supply Chain Policies*, Santa Monica, RAND, 2022, https://doi.org/10.7249/RRA2102-1.

[20] Jeffrey Becker, "Fused Together: The Chinese Communist Party Moves Inside China's Private Sector", in *CNA InDepth Blog*, 6 September 2024, https://www.cna.org/our-media/indepth/2024/09/fused-together-the-chinese-communist-party-moves-inside-chinas-private-sector.

[21] This CCP presence may be a confluence of the following: "new official institutions to coordinate CCP affairs related to the private sector, 'sending down' a group of 'party-building instructors,' rewarding private business elites with appointments to party positions, and reorienting the work of local party organs to better serve the needs of the private sector". See Xiaojun Yan and Jie Huang, "Navigating Unknown Waters: The Chinese Communist Party's New Presence in the Private Sector", in *China Review*, Vol. 17, No. 2 (June 2017), p. 37-63.

[22] Fabian Villalobos and Morgan Bazilian, "Understanding America's Technological Tit for Tat with China", in *The Hill*, 25 June 2023, https://thehill.com/opinion/4057812.

[23] Center for Naval Analysis (CNA), *China's National Security Laws Implications beyond Borders*, December 2023, https://www.cna.org/quick-looks/2023/chinas-national-security-laws-implications-beyond-borders.

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included expanded authorities to compel the private sector to allow not only access to company records and share collected data, but also proprietary information about critical technologies. This manifested in the push from members of the US Congress to ban the popular social media app TikTok.[24]

A second example is the authority of the Cyberspace Administration of China to enact security reviews of products and services of foreign companies inside China's borders. This authority was invoked when the Cybersecurity Review Office announced investigations into Micron, the US microchip producer,[25] most likely in retaliation for US restrictions on semiconductor and microchips.[26] Without passing the review, Micron is restricted in its ability to sell its products or services in the country.

As mentioned before, the PRC requires foreign companies in some industries who want to operate effectively in China to form joint ventures with domestic firms. For example, in the auto industry, joint ventures were required in some form or another from 1979 until as recently as 2022.[27] These legislations and polices came with stipulations that include technology transfer. Forming joint ventures is also done to gain access to China's domestic tax incentives, which are limited to domestic firms, as was the case with the electric vehicles industry.[28] As mentioned earlier, with limited tax credits now available to incentivise domestic consumption, Chinese firms' search for revenue abroad is causing much tension in foreign EV markets.

The use of export restrictions has also been used as a method of coercion or retaliation by the PRC. A number of export restrictions on critical minerals de facto targeting the United States but which also have broad implications for other countries have been implemented. The restricted materials include ores, processed minerals, metals, intermediate chemicals, downstream products like magnets and manufacturing technology related to these materials. Table 1 records these recent announcements.

[24] Still a developing situation.

[25] China's Cybersecurity Review Office, *Announcement on the Initiation of Cybersecurity Review of Micron's Products Sold in China* (in Chinese), 31 March 2023, https://www.cac.gov.cn/2023-03/31/c_1681904291361295.htm.

[26] Fabian Villalobos and Morgan Bazilian, "Understanding America's Technological Tit for Tat with China", cit.

[27] Yueyuan Selina Xue, Wei Wei and Mark J. Greeven, "China's Automotive Odyssey: From Joint Ventures to Global EV Dominance", in *IMD Innovation Articles*, 26 January 2024, https://www.imd.org/?p=234043.

[28] Frank Bickenbach et al., "EU Concerns about Chinese Subsidies: What the Evidence Suggests", in *Intereconomics*, Vol. 59, No. 4 (July/August 2024), p. 214-221, https://doi.org/10.2478/ie-2024-0044.

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Table 1 | Recent timeline of Chinese export restriction de facto targeting the US

Date	Action (China)	Target country	Preceding action(s)	Date (preceding action)
1 Aug 2023	Export controls on gallium and germanium-related items[29]	None	*USA* – BIS initial rule restricting Chinese access to semiconductors[30] *EU* – Anti-subsidy investigation on Chinese EVs[31]	7 Oct 2022 30 Sep 2023
20 Oct 2023 (announced on this day but implemented in Dec 2023)	Export permits for some graphite products[32]	None	*Netherlands* – New export restrictions on advanced semiconductor equipment[33] *USA* – Restrictions on outbound investment in the semiconductor, quantum information and AI sectors in foreign "countries of concern"[34] *USA* – Expansion of restrictions on artificial intelligence (AI) chips and semiconductor manufacturing equipment; 13 Chinese firms added to the export control list[35]	30 June 2023 9 Aug 2023 17 Oct 2023 (announced on this day but went into effect 30 days after)
21 Dec 2023	Export ban on rare earth processing technology[36]	None	Likely the same as listed in the above row	N/A

[29] International Energy Agency (IEA), *Announcement on the Implementation of Export Control of Items Related to Gallium and Germanium*, last updated 25 April 2025, https://www.iea.org/policies/17893.

[30] Sujai Shivakumar, Charles Wessner and Thomas Howell, "Balancing the Ledger. Export Controls on U.S. Chip Technology to China", in *CSIS Reports*, February 2024, https://www.csis.org/node/109454.

[31] European Commission, *EU Imposes Duties on Unfairly Subsidised Electric Vehicles from China while Discussions on Price Undertakings Continue*, 29 October 2024, https://ec.europa.eu/commission/presscorner/detail/en/ip_24_5589.

[32] Siyi Liu and Dominique Patton, "China, World's Top Graphite Producer, Tightens Exports of Key Battery Material", in *Reuters*, 20 October 2023, https://www.reuters.com/world/china/china-require-export-permits-some-graphite-products-dec-1-2023-10-20.

[33] Arjun Kharpal, "Netherlands, Home to a Critical Chip Firm, Follows U.S. with Export Curbs on Semiconductor Tools", in *CNBC*, 30 June 2023, https://www.cnbc.com/2023/06/30/netherlands-follows-us-with-semiconductor-export-restrictions-.html.

[34] Sujai Shivakumar, Charles Wessner and Thomas Howell, "Balancing the Ledger", cit.

[35] Emily Benson and Thibault Denamiel, "China's New Graphite Restrictions", in *CSIS Commentaries*, 23 October 2023, https://www.csis.org/node/107858.

[36] Edward White, "China Bans Export of Rare Earth Processing Technologies", in *Financial Times*, 21 December 2023, https://www.ft.com/content/5b031db7-23dd-43d3-afe1-cef14817296f.

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Table 1 (continued)

Date	Action (China)	Target country	Preceding action(s)	Date (preceding action)
14 Aug 2024 (announced on this day but implemented in Sep 2024)	Export restrictions on 6 antimony-related products including antimony ore, antimony metals, antimony oxide and gold-antimony smelting and separation technologies; export ban on gold-antimony smelting and separation technology exports[37]	None	*USA* – New or increased tariffs on Chinese EVs, EV batteries, battery parts, semiconductors, solar cells, permanent magnets and certain steel and aluminium products[38]	14 May 2024 (day announced)
3 Dec 2024	Ban on shipments of gallium, germanium, antimony and so-called superhard materials to the United States[39]	USA (first time restrictions specially targeted the US)	*USA* – Second expansion of export restrictions on semiconductor equipment; 140 Chinese entities added to the export control list[40]	2 Dec 2024
4 Feb 2025	Export licenses required for tungsten, tellurium, bismuth, indium and molybdenum	USA	Likely the same as listed in the above row	N/A
4 Apr 2025	Export licenses required for samarium, gadolinium, terbium, dysprosium, lutetium, scandium and yttrium oxides, intermediate compounds and related products (magnets) and manufacturing technology	USA	*USA* – Increased and broad sweeping tariffs placed on imports from China	2 Apr 2025

Source: Author's compilation of various sources.

The motivation behind these export controls is split mostly between retaliation for US technology export restrictions and trade policy. In 2019, the PRC's National Development and Reform Commission suggested restrictions on rare earth products in response to US trade policy.[41] The most recent restrictions have similar

[37] Gracelin Baskaran and Meredith Schwartz, "China's Antimony Export Restrictions: The Impact on U.S. National Security", in *CSIS Critical Questions*, 20 August 2024, https://www.csis.org/node/112028.

[38] Brooks E. Allen et al., "US Announces New Tariffs on Chinese-Origin Goods, with an Exclusion Process", in *Skadden Insights*, 15 May 2024, https://www.skadden.com/insights/publications/2024/05/us-announces-new-tariffs.

[39] Gracelin Baskaran and Meredith Schwartz, "China Imposes Its Most Stringent Critical Minerals Export Restrictions Yet Amidst Escalating U.S.-China Tech War", in *CSIS Critical Questions*, 4 December 2024, https://www.csis.org/node/113585.

[40] "US unleashes Another Crackdown on China's Chip Industry", in *Al Jazeera*, 2 December 2024, https://aje.io/reprvk.

[41] Fabian Villalobos et al., *Time for Resilient Critical Material Supply Chain Policies*, cit.

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motivations. Meanwhile, export restriction on gallium, germanium, graphite and tungsten from 2023 to 2024 appear to be more motivated by US export restrictions on semiconductors and microchips and related technologies. In addition, China's Ministry of Industry and Information Technology suggested that US defence contractors were potential targets for export restrictions in 2020 due to their role in supplying military technology to Taiwan.[42] China restricted urea shipments to South Korea in 2021 amid internal shortages,[43] demonstrating that even when not executed with malign intent, Chinese dominance poses threats to supply chain stability. The origin of these supply disruption concerns stems from the 2010 Diaoyu/Senkaku Island dispute with Japan. This demonstrates that China's market power in mineral-technology value chains is a coercive weapon that can be implemented in many different contexts and may be used in retaliation for actions or activities in contexts not yet envisaged by the United States and its partners.

Along with their use as coercive measures, export restrictions and licensing requirements may also serve an additional purpose – to gather data[44] on importers, company internal operations, their customers, etc. – to find targets for future sanctions by adding them to China's Export Control List or Unreliable Entities Lists.[45]

Finally, these restrictions have had notable impacts on third party suppliers to the United States, who are reliant upon China for these production inputs and then export value added products to the United States.

3. Market characteristics contributing to industry challenges

The market actions of the PRC and Chinese firms, the projected future demand for minerals and the policy responses by developed and developing nations all contribute to challenging market conditions for industry participants. A qualitative industry analysis of the mining industry found that several industry challenges limited competitiveness and shaping market characteristics.[46] Several market characteristics emerge from the challenges in the industry:

[42] Ibid.

[43] See Kim Bo-eun, "Korea Urged to Diversify Material Imports", in *The Korea Times*, 11 November 2021, https://www.koreatimes.co.kr/business/companies/20211111/reporters-notebook-korea-urged-to-diversify-material-imports; Yukyung Yeo, "Urea Crisis Sparks South Korean Supply Chain Revamp", in *East Asia Forum*, 23 August 2024, https://eastasiaforum.org/?p=2339017.

[44] "Japan Complains that China's Export Control Law Is Too Broad and Unclear", in *WorldECR*, 22 June 2023, https://www.worldecr.com/?p=2026650.

[45] The Export Control List prohibits the export of Chinese dual-use items to these companies while the Unreliable Entity List "prohibit[s]...exporting or importing in China or from making new investments in the country". See Liza Lin, "China Adds 15 American Companies to Export-Control List", in *The Wall Street Journal*, 4 March 2025, https://www.wsj.com/livecoverage/trump-tariffs-canada-mexico-china-stock-market-today-03-04-2025.

[46] Tom LaTourrette et al., *The Potential Impact of Seabed Mining on Critical Mineral Supply Chains and Global Geopolitics*, Santa Monica, RAND, 2025, https://doi.org/10.7249/RRA3560-1.

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- *Concentrated industry and geography* – the large market share of Chinese firms at several nodes in mineral-technology value chains is well documented, as is the dominance of other countries like the Democratic Republic of the Congo (DRC) for cobalt extraction and Indonesia for nickel extraction. Owing to this industry clustering, value chains are also highly concentrated in the Indo-Pacific region. This makes disruption from natural disasters or human-factors in the region more impactful to both public and private sector consumers. Not only is there concentration in the primary mining industry, but Chinese firms are also present in ancillary mining product and service industries like mining vehicles, drills, bulk shipping of ores and exploration technologies like drone and satellite data collection. In other words, the problem is bigger than originally thought.

- *Mercantilist behaviour and price volatility* – the governments of both developed and developing countries have demonstrated an inclination toward protectionism and goals other than firm profitability with respect to mineral-technology value chains. This results in wide swings in prices over years, months and sometimes days or even hours. These behaviours, policies and industry activity lowers predictability and drives competitors out of the market. Economic statecraft in the form of sanctions and trade barriers also restrict access to materials. In the case of China, export restrictions may also be precursors to information gathering. So far US trade policy has exempted critical minerals from broader tariffs, but that may change.

- *High barriers to entry* – a variety of factors prevent new firms from entering the exploration, extraction, processing, refining and intermediate chemical production industries and manufacturing of components heavily reliant on these inputs. Oversupply of some minerals creates downward pressure on commodity prices. Regulatory complexity and local stakeholder pushback slows the timeline for project initiation. Limited numbers of processing and refining firms' places constraints on offtake agreements (where buyers agree to buy a certain amount of products at a specific price for a specific time period, which is typical in mining). Buyers have switching costs in terms of limited ability to accept ores and concentrates from new suppliers.[47] Investors prioritising profitability – both public and private – are often disincentivised at greater levels of uncertainty, making it difficult to finance green-field and brown-field projects and any related infrastructure projects.

- *High barriers to exit* – mines are highly specialised assets and closing a mine incurs a cost. Long term storage of tailings and other waste, employee severances and other expenses often incentivises a shuttering mine to continue operating long enough to cover the expenses of the shutdown. The pool of prospective buyers of a mine and mining equipment is also limited, meaning that a mine

[47] However, some offtake agreements are based on annual contracts, which provides opportunities for new entrants.

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may continue to operate – and continue affecting commodity prices – long after the mine has been identified as unprofitable simply because enough prospective buyers are not available. Business or government goals other than profitability also keep mines producing materials longer than would typically be expected.

- *Information opacity* – due to the use of implicit and explicit subsidies inside of China and other countries, it can be difficult to estimate the cost-structure of a mineral commodity price to look for areas of inefficiency and potential innovation. Contracts between suppliers and offtakers are sensitive business materials and not widely available to report prices. It is difficult to anticipate changes in trade policy or export controls and their impact on prices. Many trade codes are not specific enough to provide ample data collection or detailed data analysis to clarify risks and dependencies.

4. Other CMSC problems that complicate decision calculus

In addition to the political risks posed by outsized PRC influence in CMSCs and market characteristics, there are four other areas where CMSCs are exposed to risk and externalities that complicate decision-making:

- *Conflict near or caused by access to mineral resources*. For example, the ongoing Rwanda-DRC conflict has some confluence with the presence and mining of Congolese coltan (tantalum ore) by the Rwandan-backed M23 militia. A memorandum of understanding (MOU) between the European Union and Rwanda for Sustainable Raw Materials Values Chains that includes tantalum[48] further complicates the situation in that signing an MOU with a country explicitly exporting coltan illegally[49] could be seen as an endorsement of the criminal activity and conflict in the DRC. The situation is further complicated by Congolese outreach to the United States for a "minerals-security" agreement and DRC use of private military contractors.[50]

- *Human rights and labour*. The use of forced Uyghur labour by Chinese firms in the Tianjin region is well documented.[51] So too is the presence of artisanal and small-scale mining (ASM). The ASM sector is a major source of employment

[48] European Commission, *EU and Rwanda Sign a Memorandum of Understanding on Sustainable Raw Materials Value Chains*, 19 February 2024, https://ec.europa.eu/commission/presscorner/detail/en/ip_24_822.

[49] Oluwole Ojewale, "Mining and Illicit Trading of Coltan in the Democratic Republic of Congo", in *ENACT Research Papers*, No. 29 (March 2022), https://enactafrica.org/research/research-papers/mining-and-illicit-trading-of-coltan-in-the-democratic-republic-of-congo.

[50] "Blackwater Founder and Trump Ally Strikes Mineral Security Deal with Congo", in *Mining.com*, 17 April 2025, https://www.mining.com/trump-ally-prince-strikes-mineral-security-deal-with-congo.

[51] Laura Murphy et al., *Driving Force: Automotive Supply Chains and Forced Labour in the Uyghur Region*, Sheffield, Sheffield Hallam University Helena Kennedy Centre for International Justice, December 2022, https://shura.shu.ac.uk/34918.

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in several developing countries, engaging approximately 41 million people worldwide, many of whom are women. In some developing countries, ASM often surpasses large, industrial-scale mines in terms of workforce size. Nonetheless, the sector faces significant challenges and is frequently misrepresented, which deters meaningful engagement by downstream manufacturers and consumers.[52]

- *Cyber, information operations and social unrest*. The information domain has not been ignored by Chinese entities. The PRC-linked entity Dragonbridge was identified as targeting information campaigns at US firms trying to diversify the rare earth supply chain.[53] Similar rare earth firms in Australia were hacked by other PRC-linked entities.[54] Social or political discontent with the CMSC industry also presents challenges. For example, protestors in Germany clashed with police as they stormed a Tesla factory.[55] These developments are also vectors for disruption, albeit less well understood.

- *Near- and long-term environmental damage*. Lastly, the environmental effects of mining, processing and refining have put the sector in a bad light. Some long-term effects are still not known, such the potential impacts of seabed mining.[56]

5. Cobalt case study: Supplying a Ukrainian demand signal

The challenges described above can be found within the cobalt supply chain upon which lithium-ion batteries heavily rely. Battery systems now proliferate military weapons and equipment. One such weapon system includes small unmanned aerial vehicles (sUAVs). To illustrate the potential military demand for minerals from a contingency in the European theatre, a case study for the demand for cobalt from first person view (FPV) sUAVs is explored.

Currently, the main exporters of military drones are China and Turkey.[57] Chinese firms in particular control about 80 per cent of the commercial drone market.[58]

[52] Fabian Villalobos et al., *Technology-Driven Opportunities and Risks to Sustainable Development of Critical Minerals in Developing Countries*, Santa Monica, RAND, May 2025, http://www.rand.org/t/PEA4008-1.

[53] Fabian Villalobos, "Emerging U.S. Battery Supply Chain Should Be Wary of China's Information Ops", in *The Hill*, 15 November 2022, https://thehill.com/opinion/3736643.

[54] Paul-Alain Hunt, "Second Australian Rare Earths Producer Suffers Cyber Attack", in *Bloomberg*, 13 June 2024, https://www.bloomberg.com/news/articles/2024-06-13/second-australian-rare-earths-producer-suffers-cyber-attack.

[55] Morgan Meaker, "Climate Protestors Storm Tesla's Europe Gigafactory", in *Wired*, 10 May 2024, https://www.wired.com/story/climate-protestors-storm-teslas-europe-gigafactory.

[56] Tom LaTourrette et al., *The Potential Impact of Seabed Mining*, cit.

[57] Ulrike Franke, "Drones in Ukraine: Four Lessons for the West", in *ECFR Commentaries*, 10 January 2025, https://ecfr.eu/article/drones-in-ukraine-four-lessons-for-the-west.

[58] ChinaPower, *Is China at the Forefront of Drone Technology?*, last updated 25 August 2020, https://

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Given China's dominance of the battery supply chain, there is potential for Chinese firms to influence the supply of batteries for military sUAS. In fact, a RAND study on the autonomous systems industrial base found that military drones had a large dependence on Chinese-sourced batteries.[59] In 2024, China continued to leverage its market power to weaponise its control over supply chains to reduce Ukraine's access to components critical to the production of dual-use drones, including batteries.[60] One such affected company is Skydio, whose CEO posted a message to customers in which he complained that, due to Chinese sanctions, battery supply would be limited for months as alternative sources to China were unlikely to be available for some time yet.[61]

5.1 Demand from Ukrainian UAVs

A recent study by the Kyiv School of Economics estimated that Ukrainian industry has about a four million drones per year production capacity for 2024 with plans to reach production capacities exceeding 10,000 units per month.[62] According to the *Kyiv Independent*, a daily, Ukraine planned to procure 4.5 million drones in 2024.[63]

FPV drones make up a large portion of Ukraine's UAVs.[64] Assuming an FPV drone using a 7in rotor,[65] the typical battery size for that range would be approximately 2200mAh.[66] These batteries can use a cathode active material (CAM) like lithium iron phosphate cathode – which uses no cobalt – or another that does (e.g., LCO or NMC622).[67] The cathode active material loading is assumed to be 96 per cent to

chinapower.csis.org/china-drones-unmanned-technology.

[59] Bradley Wilson et al., *Characterizing the Uncrewed Systems Industrial Base*, Santa Monica, RAND, April 2023, https://doi.org/10.7249/RRA1474-1.

[60] Kollen Post, "Ukraine Builds Drone Parts at Home as China Weaponizes Supply Chain", in *Kyiv Independent*, 10 December 2024, https://kyivindependent.com/as-china-weaponizes-the-drone-supply-chain-ukraine-is-building-more-parts-at-home; Mark Bergen, Mackenzie Hawkins and Gian Volpicelli, "China Is Cutting Off Drone Supplies Critical to Ukraine War Effort", in *Bloomberg*, 9 December 2024, https://www.bloomberg.com/news/articles/2024-12-09/china-is-cutting-off-drone-supplies-critical-to-ukraine-war-effort.

[61] Adam Bry, *China's Sanctions on Skydio*, in Skydio website, 30 October 2024, https://www.skydio.com/blog/chinas-sanctions-on-skydio.

[62] Olena Bilousova et al., *Ukraine's Drones Industry: Investments and Product Innovations*, KSE Institute and Brave1, 4 October 2024, https://kse.ua/wp-content/uploads/2024/10/241004-Brave1-report-v.1.pdf.

[63] Tim Zadorozhnyy, "Ukraine to Buy 4.5 Million FPV Drones in 2025", in *Kyiv Independent*, 10 March 2025, https://kyivindependent.com/ukraine-to-buy-4-5-million-fpv-drones-in-2025.

[64] Tomas Milasauskas and Liudvikas Jaškūnas, "FPV Drones in Ukraine Are Changing Modern Warfare", in *UkraineAlert*, 20 June 2024, https://www.atlanticcouncil.org/?p=774697.

[65] United24 Media claims that, "FPV drones typically come in 7" or 12" base configurations. See Audrey MacAlpine, "Ukraine's Drone Evolution, from Mavic Scouts to Long-Range Strike Weapons", in *United24 Media*, 28 February 2025, https://united24media.com/war-in-ukraine/ukraines-drone-evolution-from-mavic-scouts-to-long-range-strike-weapons-6232.

[66] Chinahobbyline (CNHL), a leading Chinese supplier of drone batteries, recommends using a 2200mAh lithium polymer battery for 7in rotor drones. See CNHL website: *CNHL G+Plus 2200mAh 22.2V 6S 70C Lipo Battery with XT60 Plug*, https://chinahobbyline.com/products/cnhl-gplus-series-2200mah-22-2v-6s-70c-lipo-battery-with-xt60-plug.

[67] CNHL, "Detailed Explanation of 6s Lipo Battery Cathode Material", in *Chinahoobyline Blog*, 18

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account for additional materials in the cathode live activated carbon and binder. The specific capacity (mAh·g–1) of LCO and NMC622 is 145[68] and 185,[69] respectively. The mass of CAM present in one 2200 mAh battery using LCO and NMC622 cathodes to power a 7in rotor FPV is thus 14.6 grams and 11.4 grams, respectively. Assuming a total of 4.5 million drones per annum and one battery per drone,[70] the total demand for LCO and NMC622 would be approximately 65.5 metric tons and 51.4 metric tons per annum, respectively.

5.2 Mining and refining capacity needed

Based on stoichiometry of the two CAMs and cobalt sulphate,[71] a common CAM precursor material, Ukrainian demand for cobalt sulphate would be 65.5 metric tons and 10.3 metric tons per annum for LCO and NMC622, respectively. This would be equal to the cobalt sulphate demand from the European refining industry. Finland, Norway, Belgium and France have refineries that may be able to produce cobalt products.[72] Currently, Finland's Umicore Kokkola cobalt refinery's output of cobalt sulphate is about 3,500 metric tons per annum which should satisfy demand.[73] However, Finnish cobalt refineries rely heavily on imports, as domestic mining meets only a small fraction of their overall raw material requirements.[74]

Assuming a 0.35 per cent cobalt ore grade,[75] between 1,870 and 2,900 metric tons of ore would need to be mined in Europe. The European cobalt mining and refining industry is highly concentrated in Finland, where two mines – Kevitsa (Boliden) and Sotkamo (Terrafame) – produced a combined 1,084 metric tons of cobalt as a by-product in 2021.[76] According to Chatham House's Resource Trade.Earth, Europe imported about 2700 metric tons of cobalt ores and concentration in 2022 with

August 2022, https://chinahobbyline.com/blogs/news/detailed-explanation-of-6s-lipo-battery-cathode-material.

[68] Naoki Nitta et al., "Li-ion Battery Materials: Present and Future", in *Materials Today*, Vol. 18, No. 5 (June 2015), p. 252-264, https://doi.org/10.1016/j.mattod.2014.10.040.

[69] Sara Hamed et al., "Optimized NMC622 Electrodes with a High Content of the Active Material: A Comprehensive Study", in *Journal of Power Sources*, Vol. 608 (July 2024), Article 234549, https://doi.org/10.1016/j.jpowsour.2024.234549.

[70] This is a low estimate. Often spare batteries are offered with the drone to minimize drone down time.

[71] The cobalt ratio of cobalt sulphate to CAM is 1:1 and 1:0.2, for LCO and NMC622, respectively. Cobalt sulphate (CoSO4) molar mass = 152.05 grams per mole meaning that it requires about 152 grams and 30.4 grams to produce an equivalent quantity of LCO and NMC622, respectively.

[72] Rifat Jabbar et al., *Polymetallic Nodules and the Critical Minerals Supply Chain: A North American Approach*, Washington, Wilson Center, March 2024, https://www.wilsoncenter.org/node/118396.

[73] Wood Mackenzie, *Umicore Kokkola Cobalt Refinery*, 14 December 2023.

[74] Jukka Konnunaho et al., "A Mining Industry Overview of Cobalt in Finland: Exploration, Deposits and Utilization", in *Geoenergy*, Vol. 1, No. 1 (December 2023), Article geoenergy2023-016, https://doi.org/10.1144/geoenergy2023-016.

[75] The Metals Company reports that the average DRC cobalt ore body percentage is 0.35 per cent. See The Metals Company, *Summary Report Nickel and Cobalt Mining Impact on Terrestrial Carbon Sinks in Sulawesi, Indonesia and Katanga, DRC*, October 2023, https://metals.co/wp-content/uploads/2023/11/Benchmark_Carbon-Sinks_Summary_2023.pdf.

[76] Jukka Konnunaho et al., "A Mining Industry Overview of Cobalt in Finland", cit.

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Finland making up about 1,300 metric tons.[77]

Given the demand signal from Ukrainian FPV drones, Europe has limited ability to meet even the low estimated demand for raw cobalt ore. However, Europe likely has the capacity to refine the cobalt it needs to support the production cobalt sulphate needed for FPV drones at current levels needed by Ukraine.

6. Lessons from abroad: How Korea and Japan learned from disruptions

In meeting the requirements to fulfil future demand, whether during peacetime or during disruption, it is helpful to look to others who have made progress in securing their own supply chains and strengthening economic security. South Korea and Japan have both experienced supply chain disruptions. As such, these two countries have had serious motivation to develop strategies and a legal architecture to strengthen their ability to monitor risk and manage crises. Each has passed legislation and implemented polices that are informative for other countries seeking to better diversify CMSCs and plan for uncertainty.

6.1 South Korea

In the past three years, the Republic of Korea has passed three key pieces of legislation that have created and resourced a supply chain security capability.[78] They are:

1. Act on Special Measures to Strengthen Competitiveness and Stabilise Supply Chain of Materials, Components, and Equipment Industry (25 May 2023);
2. Framework Act on Supply Chain Stabilisation Support for Economic Security (8 December 2023);
3. Special Act on National Resource Security (9 January 2024).

These three laws aim to provide a legal foundation for 14 policy tools that (1) minimise the risk of supply chain disruptions in advance and (2) enable fast recovery when disruptions occur. The result is a Comprehensive Supply Chain Stabilisation Plan resourced by the Ministry of Economy and Finance, designation of roles and responsibilities of ministries and agencies for "policy directions" and "policy tasks" and the creation of the Supply Chain Stabilisation Committee as a cross-government control tower for economic security and supply chain management. These efforts represent a model worth further studying and potentially emulating.

[77] Chatham House resourcetrade.earth website: https://resourcetrade.earth.

[78] Yukyung Yeo, "Urea Crisis Sparks South Korean Supply Chain Revamp", cit.

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6.2 Japan

Japan has created a unique organisation with authorities and resources to help explore and develop new projects in CMSCs. Under Japan's Ministry of Economy, Trade and Industry (METI) is the Japan Organization for Metals and Energy Security (JOGMEC), an independent administrative corporation that executes the policy developed by METI. In 2023, JOGMEC signed an MOU with the European Commission's Directorate General for Internal Market, Industry, Entrepreneurship and Small and Medium Enterprises which highlighted how the two trading partners would work together on energy technology supply chains.[79]

As a policy execution organisation, JOGMEC has expertise on geology, supply chains and capital allocation and investment under one roof. It also does due diligence and feasibility studies in mining, processing or refining projects. So long as a Japanese company invests in a project, JOGMEC can offer liquidity or make loans or loan guarantees to reduce risk to the private company. This organisation was created in the wake of China's ban of rare earth elements to Japan in 2010 and was instrumental in creating Lynas Rare Earth in Australia. JOGMEC represents another model worth further study and potential emulation.

7. Policy objectives for securing supply chains

There are many policy instruments available to countries seeking the security of CMSCs. They vary in their availability and implementation by country, but by analysing market characteristics, it is possible to generalise a set of desirable objectives and capabilities needed to secure supply chains. Generally, they fall into seven categories:

1. *Strategic guidance and coordinating implementation* – providing government policy making and implementation organisations with priorities helps focus efforts. To do so may require a combination of new authorities or resources. Marshalling institutional capabilities with a whole-government-effort is likely to provide better results than a single agency or ministry bearing the brunt of the burden.
2. *Incentivise new supply and demand* – existing contracts among suppliers and buyers limits the ability for new industry entrants to develop new sources of minerals. Alternative mineral resources from waste streams, recycling or seabed minerals likewise face similar challenges. But reducing barriers to entry and stimulating demand with incentives can help attract capital and spur new traditional and alternative mineral supply.
3. *Diversify or localise ownership and control over existing sources* – diversifying

[79] European Commission DG for Internal Market, *Enhancing Cooperation with Japan on Critical Raw Materials Supply Chains through a New Administrative Arrangement*, 6 July 2023, https://single-market-economy.ec.europa.eu/node/2177_en.

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the ownership of firms in the mineral-technology value chain so that companies based in foreign entities of concern (FEOC) countries[80] are limited in their influence can reduce political risks. In this way, Inflation Reduction Act incentives not only diversify the location of manufacturing but concurrently helps 'de-risking' efforts. However, just because a firm does not have significant influence by a FEOC country does not mean all risk is eliminated, as illustrated by the pause in operations at Syrah Resources' graphite mine in Mozambique after social unrest broke out.[81]

4. *Coordinate and cooperate with partners and allies* – international cooperation can help overcome the uncertainty of these markets. Diplomatic, finance and trade efforts like the Mineral Security Partnership, the Defense Production Act Investment programme and trade can leverage US ally and partner capabilities and help build relationships with neutral countries where possible. Partnerships with countries like Australia, Canada, the European Union, Japan and South Korea have contributed greatly. These efforts can be expanded to include new partners with capital like Gulf state countries[82] or technical expertise like India.
5. *Risk assessment and crisis management* – though risk can be reduced or mitigated, it will never disappear completely and thus preparing for disruption is essential to ensure resilience. A thorough national risk assessment capability is needed to inform a crisis management plan. Actions to prepare for disruption include stockpiling end-use components, intermediate products and raw ores and concentrates; entering agreements to share resources during periods of disruption; and incentivising the private sector to stockpile. Crisis response could also include resources and processes to help specific firms targeted for sanctions or regulatory overreach as was the case with Micron in 2023.
6. *Leverage existing strengths* – where current market power exists in non-FEOC countries, it can be leveraged against coercive measures from protectionism. This may mean limiting access to domestic markets, investigating trade issues, restricting foreign access to technology of products and services, capturing foreign knowledge and expertise, or enforcing sanctions and other deterrent measures.
7. *Innovate past existing dependencies* – in the longer-term, research and development may be able to keep industries competitive or reduce vulnerabilities. Making existing mineral-technology value chains more efficient by developing new methods of extraction, processing, manufacturing and recycling processes can be effective in remaining competitive with Chinese market power. Meanwhile, research into potential substitute components and raw materials could help reduce overall dependency on the existing industry leaders and promote exploration of alternative sources or discover substitute materials.

[80] These countries as defined in the Inflation Reduction Act are: China, Russia, Iran and North Korea.

[81] See Cullen S. Hendrix, "New-Risking rather than De-Risking: The Challenges in US Efforts to Reduce Dependence on Chinese Critical Minerals", in *RealTime Economics Blog*, 13 December 2024, https://www.piie.com/node/17582.

[82] Fabian Villalobos et al., *From Mines to Markets in the Middle East and Central Asia*, cit.

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7.1 Identifying areas for cooperation between the United States and Europe

Although disagreements exist between US and European foreign policy priorities, it is important to highlight where efforts to secure supply chains could focus should opportunities for cooperation on CMSCs continue to arise. Broadly, these efforts could focus on the following:

- *Reduce barriers to desirable foreign investment, trade, specialised labour and knowledge/skills transfer* – though US trade policy remains unpredictable, there exist frameworks for sectoral trade agreements. The concept is not without precedent – the World Trade Organization Information Technology Agreement is an example.[83] The initial exclusion of critical minerals from tariffs demonstrates their importance to the United States.[84] And with the recent US announcement of Section 232 tariff investigation into critical minerals tariff policy,[85] there may be opportunity for protective sectoral trade agreement talks to share mutual concern and willingness to work on trade policy specifically for critical minerals. Inclusion of trade, investment rules and incentives could be conducted within the Mineral Security Partnership framework.

- *Reduce barriers to sharing data and intelligence* – advancing knowledge of disruption, vulnerabilities and concepts of risk is important for crisis management and risk mitigation. Cooperating on potential new trade codes represents one particular are with high pay off but which may take time to implement. Existing information sharing agreements and could incorporate supply chain risk into their frameworks, for example within NATO.

- *Create shared crisis management mechanisms and processes* – both South Korea and Japan have created national stockpiles. The European Defence Industry Programme includes language on the creation of a stockpile. France has a separate stockpile as well. However, the concept of joint stockpiling between countries has not been explored in depth, although many questions would need to be resolved for the concept to be implemented effectively (who contributes to the stockpile? How would stock be prioritised and released? How would it be funded?) Developing mechanisms, processes and procedures takes time and should be pursued early. Such crisis management mechanisms might also include support packages for Western firms targeted for coercion by the PRC. When Lithuania was subjected to Chinese sanctions, Western firms put

[83] WTO website: *Information Technology Agreement*, https://www.wto.org/english/tratop_e/inftec_e/inftec_e.htm.

[84] Alexander Cook et al., "Critical Minerals Sidestep US 'Liberation Day' Reciprocal Tariffs", in *Fastmarkets*, 4 April 2025, https://www.fastmarkets.com/?p=83400.

[85] White House, *Ensuring National Security and Economic Resilience through Section 232 Actions on Processed Critical Minerals and Derivative Products*, 15 April 2025, https://www.whitehouse.gov/presidential-actions/2025/04/ensuring-national-security-and-economic-resilience-through-section-232-actions-on-processed-critical-minerals-and-derivative-products.

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together an investment package to come to its aid.[86] Likewise, when Micron was investigated in 2023, G7 countries created investment opportunities inside of Japan.[87] These can serve as examples for processes and procedures to be institutionalised.

- *Pool and target resources in foreign production or infrastructure projects* – the Lobito Atlantic Railway project is an excellent example of how foreign development projects can counter the foreign direct investment by China through the Belt and Road Initiative or the "new" Global Development Initiative. However, infrastructure projects in the Indo-Pacific or even within the EU and North America could help benefit their respective mining industries and better integrate equities.

- *Provide expertise to improve mineral resource exploration, management and development in resource-rich countries* – developed economies hold tremendous technical expertise with respect to governance, technology, mineral exploration and more. Developing countries with access to minerals are in need of institutions to better govern and regulate the mining industry. Helping developing countries develop their institutions can also create more clearer and more certain business environments that would benefit multi-national mining corporations originating in the EU and the United States. It also serves to counter China's efforts to exploit grey areas of governance in foreign markets.

- *Increase access to foreign markets for domestic industry and protect domestic investments in foreign countries* – working together to open new markets for foreign direct investment or protecting existing investments can help reduce risks in existing and future supply chains. This could include diplomatic engagement through the MSP Forum or through alternative financing mechanisms.

Conclusion

The high priority of mineral-technology value chains provides an opportunity to continue and to enhance cooperation between the EU and the United States on CMSCs. While policy implementation remains uncertain in some contexts, that should not deter the two parties from continuing to seek areas of common understanding. Cooperation must address underlying issues in CMSCs and the resulting market characteristics in order to be effective. By establishing supply

[86] Bryan Frederick and Howard J. Shatz, *Countering Chinese Coercion Multilateral Responses to PRC Economic Pressure Campaigns*, Santa Monica, RAND, December 2022, https://doi.org/10.7249/PEA796-1.

[87] Annmarie Hordern, "Micron-Japan Deal Counters China 'Coercion,' Rahm Emanuel Says", in *Bloomberg*, 18 May 2023, https://www.bloomberg.com/news/articles/2023-05-19/micron-japan-deal-counters-china-coercion-rahm-emanuel-says.

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chain security capabilities based on rigorous analysis and learning lessons from East Asian countries who have delt with CMSC disruption in the past, Western countries can better enhance their supply chain resiliency, should they be faced with supplying materiel for a military conflict like Russia's war of conquest in Ukraine. The future is yet to be determined but within uncertainty lies opportunity.

Updated 25 June 2025

List of acronyms

ASM	Artisanal and small-scale mining
CAM	Cathode active material
CCP	Chinese Communist Party
CMSC	Critical minerals supply chain
DRC	Democratic Republic of the Congo
EU	European Union
EV	Electric vehicle
FEOC	Foreign entities of concern
FPV	First person view
JOGMEC	Japan Organization for Metals and Energy Security
LIB	Lithium-ion battery
METI	Ministry of Economy, Trade and Industry
MOU	Memorandum of understanding
MSP	Mineral Security Partnership
NATO	North Atlantic Treaty Organization
PRC	People's Republic of China
SASAC	State-owned Assets Supervision and Administration Commission
SOU	State-owned enterprise
sUAS	Small unmanned aerial system
sUAV	Small unmanned aerial vehicle
US	United States

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