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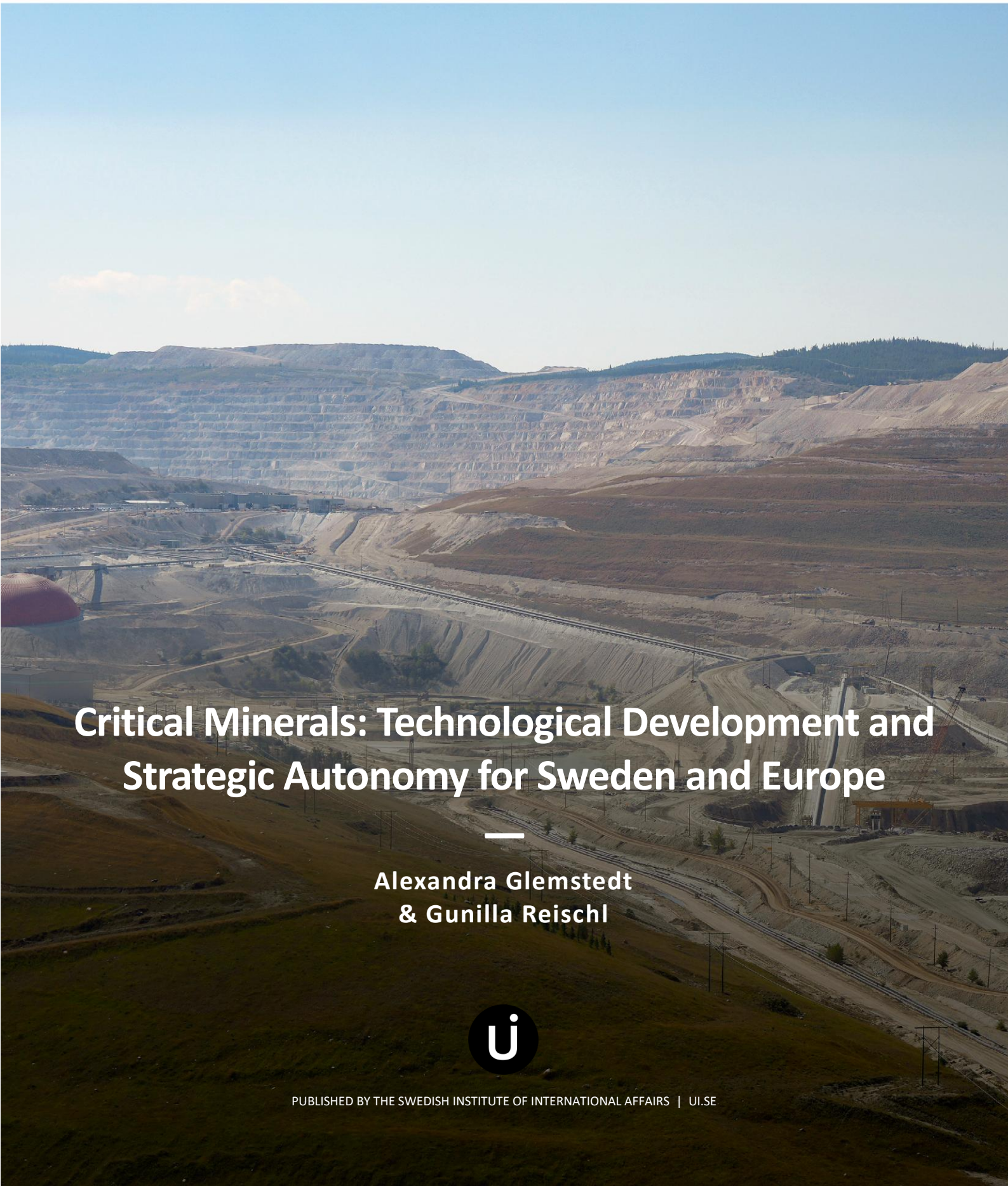

Critical Minerals: Technological Development and Strategic Autonomy for Sweden and Europe

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Summary

Critical raw materials (CRMs) continue to be strategically important and at the centre of geopolitical rivalries. They are increasingly treated as strategic assets at a time when technological innovation and the need for sustainability are intensifying. Technological development, CRM demand and governance structures, however, are highly dynamic, creating uncertainty for policymakers and industry alike. For Sweden and the European Union, strategic autonomy will be reliant on long-term resilience and strategic flexibility, as well as multilateral cooperation, to strengthen supply chains. Increased attention to these challenges highlights the need for adaptive responses in a rapidly changing geopolitical landscape. Against this backdrop, this report summarises the main insights from the panel, *Critical minerals: Technological development and strategic autonomy for Sweden and Europe*, which was held at the Swedish Institute of International Affairs (UI) on 17 March 2026. The panel discussion convened representatives from academia, industry, civil society and government to discuss four themes. The first theme situated CRMs within broader geopolitical and geo-economic tensions, showing how growing concentration and complexity in supply chains link access to lithium, cobalt, nickel and other strategic materials to national security, industrial competitiveness and international power relations. The second theme examined emerging CRM strategies and alliance structures, illustrating how states seek to establish secure and trusted supply chains amid resource nationalism, export controls and China's dominant role in refining and processing. The third theme focused on technological change, analysing how advances in battery development are creating new forms of criticality as the demand for electrification and digital technologies outpaces the expansion of mining and processing capacities. The final theme turned to questions of strategic autonomy for Sweden and the EU, using lithium as a case to illustrate broader tensions between strategic ambitions, environmental sustainability and legitimacy concerns. Together, the four themes highlight how geopolitical dynamics, policy choices, technological change and questions of autonomy are increasingly interlinked.

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Photo: Christine Olsson/TT

Introduction

Critical raw materials (CRMs) have become central to global politics as geopolitical rivalries, industrial competitiveness and technological change converge, and as concerns about human rights and sustainability intensify.[1] While fossil fuels continue to dominate public energy debates in times of geopolitical crisis, minerals such as lithium and cobalt have progressively become strategic resources that underpin the clean energy transition, digitalisation and modern defence systems. The levels of concentration in extraction, refining and manufacturing, combined with increasing demand and geopolitical fragmentation raise questions of supply security, strategic autonomy and resilience in Europe and beyond. Against this backdrop, the panel *Critical minerals: Technological development and strategic autonomy for Sweden and Europe* was held on 17 March 2026 as part of the Mistra Mineral Governance Programme.[2] The panel combined research themes on the strategic dimensions of CRMs with a broader discussion involving participants from academia, civil society, government and industry. The themes addressed CRMs from four different perspectives: (a) the geopolitical and geo-economic dynamics; (b) national strategies and alliances; (c) technological change in battery systems and the implications for material demand; and (d) the prospects for and limits on European strategic autonomy, with a focus on lithium. The discussion highlighted key tensions between market mechanisms and security concerns, between short-term targets and long-term resilience, and between ambitions for strategic autonomy and constraints related to cost, legitimacy and technological uncertainty.

This report brings together the key points presented during the panel and identifies the central insights that emerged from the discussion. The report summarises the themes and analyses the key points raised in the discussion.[3] It concludes by reflecting on the implications of these debates for Sweden, the EU and international cooperation in an increasingly uncertain world.

1. Critical minerals, geopolitics and geoeconomics

Niklas Rossbach, *Swedish Defence University and UI*

In the current geopolitical climate, oil still dominates and has become especially pressing since Israel and the USA began their war in Iran. However, critical minerals and metals are becoming increasingly important and come with a set of geopolitical and geo-economic consequences and

[1] The concept of "criticality" in raw materials is inherently shaped by political, economic and strategic considerations. While specific definitions vary across national and institutional contexts, most frameworks converge on two principal dimensions: the material's economic importance and the vulnerability of its supply. A raw material is deemed critical when it is indispensable to key industrial sectors, such as energy, defence or digital technologies, and when its supply is exposed to significant risks, from geopolitical instability to environmental constraints, market concentration or regulatory uncertainty. Importantly, criticality is not a static attribute but a dynamic assessment that evolves with technological change, policy priorities and shifts in patterns of global trade (Bäärnhielm Poussette and Reischl, 2025).

[2] The panel was organised by Mistra Mineral Governance partners, the Global Politics and Security Programme at UI, Lund University and the SEI (www.mistramineralgovernance.se).

[3] The conversation was held under the Chatham House Rule; therefore, no comment is attributed to any participant.

interdependencies. The first presentation examined CRMs through a geopolitical and geo-economic lens, focused on how ongoing power relations and security dynamics shape access to strategic materials.

Criticality of CRMs for geopolitical defence

The public debate and policy discussions often confuse CRMs and rare earth elements (REEs).[4] However, it is important to challenge the concept of rarity, as rare minerals are widely found but rarely in large or economically exploitable quantities. The designation of minerals as *critical* is therefore not a reflection of physical rarity (see notes 1 and 4).

The European Union's 2024 Critical Raw Materials Act (CRMA) was implemented to enhance strategic autonomy by strengthening the EU's capacity to extract, refine and recycle critical minerals domestically, rather than depend on imports from other continents. According to the speaker, the CRMA appeared as a "foreign object" in the existing EU policy framework. At the time of its creation, there was little support for what would be required to increase access to critical raw materials. The CRMA was developed in response to geopolitical developments and aimed to increase the EU's independence, but the act does not explicitly name China as the primary source of dependency. Instead, the issue of strategic resources is framed as one of access to refined metals, or a potential supply security problem. As part of the EU's broader security strategy, the CRMA has contributed to plans for new mining projects across Europe.

The increased European commitment to the development of CRM projects must be seen as a direct link to civil defence as part of the preparedness sector, and involves other sectors of industry, construction and trade. CRM project development and the EU's CRMA highlight the importance of solidarity as a political aspect of this aspect of resource security, in order to develop new mines. This is not just a result of national political dynamics, but also about resilience in the broader geopolitical context. An example of such solidarity between states and alliances is article 3 of the NATO Charter. In this context, defence, is essential to understanding the geopolitical dimensions of CRM strategies and extends well beyond military defence. Dr Rossbach noted: "We need to strengthen the security of supply. This does not only mean military defence, but is also about feeding our stomachs and the ability to export due to the need to earn money. This is especially true because we are in an insecure geopolitical security situation".

Four scenarios for the future geopolitics of CRMs

By thinking about whether the future geopolitical security situation will become more conflict ridden or more cooperative, it is possible to outline different scenarios for the geopolitics of CRMs. Depending on the future balance between the supply of and demand for CRMs and the level of cooperation or conflict between states, four

[4] While the term rare earth elements (sometimes rare earth metals, REMs) is sometimes used interchangeably with critical minerals, they are not the same. Rare earth elements are 17 elements (including erbium, dysprosium, praseodymium and neodymium) that constitute a subset of critical minerals. They are not rare in geological terms, but tend to be found in low concentrations and to be difficult to extract. Critical minerals as a broader category encompasses any mineral that is defined as critical by a given nation's framework, based on economic importance, supply risk and lack of substitutes. The EU's list of CRMs, which dates from 2024, contains 34 materials, both rare earths and other materials, such as nickel, cobalt, lithium, manganese, graphite and magnesium. Critical minerals are heterogenous resources that change depending on geopolitical dependence and strategic urgency.

potential geopolitical development scenarios can be identified.

The first scenario, referred to as *globalisation 2.0,* would emerge from a combination of increased international cooperation and increased supply of CRMs. Second, if CRMs are in greater demand and there is a shortage of supply but global world politics are characterised by cooperation, new dependencies and new alliances will emerge. Third, if the world becomes more conflict-ridden and fragmented while the supply of rare metals exceeds demand, this could lead to deglobalisation as more separate supply chains are created. Finally, in the worst-case scenario, more conflict and fragmentation while the demand for CRMs exceeds supply could lead to wars over resources fought by military means.

The security paradox and weaponisation

Recent shifts towards national self-sufficiency risk undermining past decades of globalisation, a tendency known as the *security paradox*. States seek a stable and secure supply of strategic resources but are increasingly unwilling to rely solely on market prices, particularly when production is concentrated in the hands of a single low-cost producer. At present, China is the main exporter of rare earth metals, largely because the logic of economic globalisation has allowed it to "corner the market". This has made Chinese production of rare earth metals cheaper than alternative production elsewhere. Countries may now be willing to pay above market prices to ensure access to rare earth metals from other producers. In the short run, however, there are few alternatives to China. States are acting because they seek security and do not want to risk being at the mercy of China, which has the capacity to restrict its rare earth exports to highly dependent western economies, such as EU member states and the USA. If China halts exports of rare earth metals, as it did to the USA in 2025, it can be labelled a *weaponisation* of its rare earth metals. In this sense, China uses export restrictions to put pressure on dependent countries that it has disagreements with on other matters, such as trade.

At the same time, when importing countries are willing to pay more for security of supply by supporting new and more expensive production outside China, they undermine the market logic that enabled globalisation in the first place. Nonetheless, this is considered preferable to the risk of being without essential strategic raw materials. Western countries therefore have little choice but to prioritise security of supply, even at a higher economic cost.

Finally, Swedish extraction should be understood as a means of increasing Sweden's strategic importance, both to allies and to other geopolitical powers. CRMs are therefore linked to defence, but also to the ability to use these resources to strengthen Sweden's position within the broader geopolitical security environment. CRM industries could therefore arguably be classed as part of the defence industry.

2. CRM security: National policy frameworks and alliances

Gunilla Reischl, *The Swedish Institute of International Affairs, UI*

States face increasing geopolitical competition over access to raw materials, with direct consequences for their strategic autonomy, industrial base and climate change-related ambitions. Understanding how CRMs are embedded in global politics is therefore essential for assessing the type of geopolitical era that is emerging. CRMs shape and influence international relations and have the potential to exert influence on

global politics in various ways. As a result, CRM alliances are created to
build stronger and more secure supply chains for rare minerals. CRM alliances can be understood as formal or informal arrangements between states, and sometimes non-state actors such as business and international organisations. Typically, they seek to enhance supply security, reduce strategic dependencies, share technological capacities and manage geopolitical risks associated with concentrated production and refining. This theme focused on questions of how states build alliances based on, or are affected by, CRMs, as well as the effects on global politics.

Security and the global politics of CRMs

Access to CRMs, the emergence of new partnerships and evolving trade flows are reshaping global politics. Given the strategic importance of these materials for defence, security and economic growth, CRMs have become central to states' national security considerations. As discussed in theme 1, states are increasingly reliant on the tools of economic statecraft, which can contribute to geopolitical rivalry and, in some cases, to the weaponisation of CRMs. At the same time, the growing role of international groupings, such as trade blocs or cooperative arrangements among producers and consumers, has the potential to shape national foreign and security policies. This, in turn, can affect global coordination on shared objectives, including sustainability.

An analysis of CRMs shows how states are increasingly required to develop differentiated strategies in response to changing geopolitical security dynamics. Examining how states are affected by CRM-related policies makes it possible to better understand how questions of security are defined, prioritised and operationalised. CRM policies intersect with different forms of security, such as national security, economic security and environmental security. Which types of security are emphasised plays an important role in how policies are created and determines whether CRM alliances are formed. For example, from an EU perspective, CRM policies seek to secure markets while linking the green transition to broader geopolitical considerations. In contrast, the USA places greater emphasis on national security and technological leadership in its CRM strategies and in the formation of CRM alliances and partnerships.

These differing formulations of security shape how security itself is understood, what conflict goals look like and how they are framed as security issues. This, in turn, legitimises how policy measures affect other areas, such as environmental issues, and affects the extent to which states deal with these challenges in policymaking.

CRM alliances: Driving forces

CRM alliances have emerged primarily as a response to growing strategic vulnerabilities in global supply chains and the concentration of production and refining capacities. Core objectives of these alliances are to protect states from geopolitical risks and to balance asymmetric power relations in CRM markets. Technological development and trade dependencies are central drivers of these strategies, as access to CRMs increasingly determines states' economic competitiveness, defence capabilities and ability to make progress on the clean energy transition.

One key motivation behind CRM alliances is the desire among import-dependent western states to reduce their dependence on China. This is closely connected to efforts to mobilise investment and technology across the entire value chain, from extraction and processing to recycling. CRM alliances also aim to create clearer and more predictable rules of the game by coordinating with states that are considered reliable and like-minded. In this sense, alliances are not only about

access to resources, but also about governance, trust and long-term stability.

Rooted in broader geopolitical dynamics, CRM alliances reflect a complex mix of interdependencies, in trade, access to resources and technological capabilities. Taken together, three practical drivers explain why CRM alliances have proliferated: reducing dependence on China, mobilising investment and technology along the value chain and establishing predictable frameworks with partners.

CRM alliance patterns and future developments

Despite their shared underlying drivers, CRM alliances are far from uniform but vary significantly in terms of structure, focus and design. A notable pattern is overlapping membership, as the same countries participate in multiple alliances. This reflects both the strategic importance of CRMs and the absence of a single coordinating framework. Different CRM alliances follow distinct logics. The Quad Critical Minerals Initiative is primarily security-driven and connected to Indo-Pacific geopolitics. The earlier Minerals Security Partnership (MSP) focused on mobilising investment and promoting environmental, social and governance (ESG) standards, while the Sustainable Critical Minerals Alliance emphasises sustainability and rights. All the commonalities discussed above can be identified across these formats. CRM alliances generally aim to reduce the risks associated with highly concentrated supply chains and to manage dependence on China. Among the important differences are that the USA tends to favour more hierarchical alliances, centred on a bloc of trusted partners, whereas the EU prefers broader, rules-based partnerships.

Looking ahead, the future of CRM alliances is likely to be shaped by continued efforts to cluster allies around CRM, but also by growing geopolitical uncertainty. Drivers such as the mobilisation of investment, technological competition, sustainability goals and security concerns will continue to coexist. As the western geopolitical environment becomes more uncertain and fragmented, and US behaviour is perceived as increasingly unpredictable, there will be a growing need for continued research on CRM alliances. Understanding how these alliances evolve is essential for assessing how states collaborate, or fail to collaborate, on critical minerals and how future CRM policies will shape global economic and security dynamics.

Audience discussion

In response to the presentation, a question was raised about how geopolitics has been affected by tariffs, especially the collaboration between Canada and the USA. Dr Rossbach replied that as the world becomes more multipolar, new multilateral blocs are emerging, and their interactions create friction in global economic and financial developments. Dr Reischl added that there is a need for trust in order to create these interstate relationships, and that tariffs, of course, affect trust.

3. Technological innovation

Björn Nykvist, *Stockholm Environmental Institute*

The technological development of batteries, which is central to enabling the clean energy transition, is a key driver of the growing demand for critical minerals. The future trajectory of and prospects for battery innovation are uncertain and highly dynamic, however, as transformative technological and economic impacts continue to unfold.

These uncertainties were the focus of the third theme.

Battery innovation and criticality

The modern batteries used in electric vehicles (EVs) rely on materials that are often framed as critical. This perspective connects to the earlier presentations, which highlighted that "criticality" should be questioned rather than taken for granted. Historically, a range of different materials has been used in the development of lithium-ion batteries. Technological choices therefore play a central role in determining which minerals come to be defined as critical.

Early battery-driven EVs, on the market around 2010, used lithium manganese oxide (LMO-)based batteries. When Tesla started selling EVs, NCA batteries, which combine nickel, cobalt and aluminium, became the most common in just four or five years. After an additional four to five years, additional nickel-rich chemistries using nickel manganese cobalt (NMC) became more popular, while LMO batteries largely disappeared. In the early 2020s, China began to commercialise lithium iron phosphate (LFP) batteries. China continues to dominate the innovation of LFP batteries, and the technology has continued to evolve in the four to five years since. LFP batteries now dominate the Chinese market, while NCA batteries remain more common in the USA.

Technological and material dependencies

The rapid growth in battery production is being driven by the strong increase in sales of battery electric vehicles. As new technologies scale-up rapidly, they create new forms of material dependency, as each battery chemistry relies on a distinct set of minerals. These shifting dependencies are often underestimated in the current literature on batteries and critical raw materials.

One example of this dynamic discussed was the declining average cobalt intensity of batteries. The amount of cobalt required per unit of energy storage has fallen from around 0.2 kg per kWh to 0.1 kg per kWh. While this suggests improved efficiency, lower intensity does not necessarily reduce overall demand. As battery production rapidly expands, total material consumption increases even if individual batteries use less of a given mineral. Dynamic price developments for cobalt and lithium are likely to have incentivised producers to phase out cobalt, but the social and environmental impacts of cobalt extraction and production are also severe, which has added to the pressure to find alternatives. Cobalt is less "critical" than before but remains in use, and its use continues to increase in absolute terms.

Dynamic development of technology

Using a counterfactual scenario comparison of 2019 and 2023, Dr Nykvist's research illustrates that the demand for cobalt would have been twice as high if historical trends had continued. A key factor behind this shift is the rise of LFP batteries, which have lower costs and lower socio-environmental impacts. LFP batteries have now been adopted on a large scale, contributing to a reduction in cobalt use. While this reflects a move towards lower material intensity, often described as "relative decoupling", there is still no "absolute decoupling". As a result of the changes in material composition, there is significant momentum in the development of battery technology.

Dynamic and heterogenous developments in battery technologies mean that future scenarios cannot cover the full range of uncertainty. This uncertainty is further amplified by ongoing technological developments.

Strategic flexibility?

Viewing battery development as flexible rather than fixed opens up significant scope for sustainability practices, including on the demand side where there is substantial

customer heterogeneity and flexibility. Battery size in vehicles, for example, varies significantly globally. At the same time, stricter mineral recycling requirements risk leading to the premature recycling of minerals. Overemphasising criticality, through requirements on recycling targets for individual elements, could have unintended consequences, such as early recycling instead of longer lifetimes. A narrow focus on individual minerals can therefore be counterproductive. A broader emphasis on battery technology and market-driven innovation might be more effective than fixating on specific minerals, as there is no predetermined pathway for mineral use and production. In this context, adaptability and reduced strategic dependence on other states are essential for building a resilient European battery value chain.

Audience discussion

Following the presentation, one participant asked why the rapid global rise of LFP batteries, which now account for around 64% of the world market, has not led to a reduction in cobalt use in batteries. Instead, all battery combinations have expanded at the same time, "like a fan". The participant further observed that increased use of CRM is happening in all markets, including areas such as stationary storage where LFP batteries dominate. As markets grow, interest is also increasing in other technologies that rely on these materials. The tightening geopolitical environment raises important questions for states: What resources do we have? What are we best at? Differences in access, resources and knowledge generate highly uneven conditions, especially in sectors where supply security is crucial.

In response, Dr Nykvist emphasised that battery development is far from complete. Rapid technological shifts could take place many more times, as production is expected to multiply several times before transition is complete, and will also depend on highly dynamic market demand. Rather than seeking to predict specific technological pathways, the key takeaway is the importance of remaining flexible.

4. Autonomy

André Månberger, *Lund University*

To what extent can Europe become self-sufficient in lithium in its pursuit of strategic autonomy? This question was the focus of the final theme of the panel discussion. As a result of shifting supply and demand dynamics, the most basic mechanisms of the market, together with the effects of global politics discussed above, the demand for CRMs such as lithium is increasing. This trend is particularly evident in the EU and contributed to implementation of the 2024 Critical Raw Materials Act (CRMA). The CRMA seeks to ensure a resilient and sustainable supply of critical and strategic minerals in Europe by focusing on increasing the extraction, processing and recycling of minerals within the EU. In addition, the European Commission has labelled several lithium production projects "strategic", a status that allows prioritisation measures such as shortened permitting times.

Securing European lithium

Lithium is classified as a critical raw material. The EU is currently dependent on imports to meet its needs. At the same time, demand is increasing drastically, driven primarily by the growing demand for batteries, especially for battery electric vehicles. Historically, lithium has not been extracted on a large scale. However, it is a relatively common element. This complicates conventional notions of 'criticality'. While lithium is mined in only a limited number of countries, China dominates lithium refining and battery manufacturing. Unlike dynamics of cobalt

demand discussed above, the case of lithium is yet to undergo a similar shift. Some technologies may require more lithium in the future, while others may require less. This makes the future of lithium demand highly uncertain.

Following implementation of the CRMA in 2024, the EU set self-sufficiency targets for lithium to be achieved by 2030. In addition, according to the EU Battery Regulation, batteries must contain 6% recycled lithium by 2031, rising to 12% by 2036.[5] While battery EVs account for the majority of the demand for lithium, the speaker highlighted the importance of understanding demand growth from other sectors, such as for stationary storage and traditional uses for lithium. Although these sectors are smaller in absolute terms, their combined share is still significant.

What is the future for lithium projects in Europe?

There is a growing discourse around the need for strategic autonomy to secure self-sufficiency rather than dependence on major state actors such as China. Alongside an existing mine in Portugal, a second lithium mine has recently begun production in Finland. Several other lithium mines could start production in Europe in the next decade, but this is uncertain due to challenges linked to access to capital, permitting processes and acceptance by local communities. In addition to projects located within Europe, European actors also participate in lithium extraction through ownership of mines on other continents, largely via foreign direct investment. However, most of these projects are owned by private sector mining companies, and their contribution to European strategic autonomy is therefore uncertain.

Assessment of supply, demand, trade and policy options

The speaker expanded on previous remarks regarding the inherent tension between prolonging battery lifetimes and achieving high recycling rates, which can create policy conflicts. A central question is whether the recycling targets set for 2031 by the EU Battery Regulation are realistically achievable. Batteries remain in use for many years and the availability of material for recycling is determined by their lifespan. This means that recycling volumes cannot increase faster than batteries reach end-of-life, regardless of policy ambition.

Approximately 2000 electric vehicles were sold in Europe in 2010. These vehicles are now approaching retirement. However, annual EV sales have since risen dramatically to 2–3 million vehicles. Consequently, the amount of lithium available for recycling from end-of-life EV batteries is far from sufficient. While recycling of lithium and other CRMs is desirable, it is not sufficient on its own to achieve self-sufficiency in the short term. Several demand-side options may therefore be required, such as reducing battery size or reducing levels of vehicle ownership, which could help to moderate the growth in demand for critical minerals.

Dr Månberger also highlighted the importance of identifying bottlenecks in the lithium supply chain, noting that “a chain is only as strong as its weakest link”. While secure access to raw materials is essential for producing technologies such as batteries, equal attention must be paid to downstream stages in the supply chain, such as processing and production, since these minerals must be processed and manufactured into usable components. As indicated in the CRMA, domestic processing is perceived as key to boosting strategic autonomy, as the self-

[5] Regulation (EU) 2023/1542 on Batteries and Waste Batteries | Circular Cities and Regions Initiative.

sufficiency targets are higher than those for extraction. Looking ahead, the EU will require a comprehensive and holistic strategy that addresses the trade-offs associated with expanded extraction and continuing foreign dependencies.

Discussion summary

The open discussion that followed the panel presentations brought together panel speakers and the audience with representatives from civil society, academia, government and industry. The discussion initially focused on the priorities for and uncertainties of strategic autonomy in CRMs in Europe. Participants and the panel speakers then discussed the challenges of and responses to geopolitical processes affecting CRM value chains, such as alliances and differing security logics.

EU strategic autonomy in CRMs: uncertainty, priorities and durability

The discussion highlighted the uncertainties shaping the future of CRMs in Europe, both geopolitically and in terms of evolving patterns of demand and technological change. As one participant observed, Europe faces a highly complex and fast-shifting situation in which long-term planning is made difficult by overlapping security, industrial and technological dynamics. In this context, participants focused on the tensions between the ambition for greater autonomy in CRMs and the practical challenges associated with achieving this. These include public acceptance of new mining projects, structural barriers such as access to capital and regulatory complexity, and continued dependence on external actors across global value chains. Taken together, the discussion underscored the gap between Europe's strategic aspirations and the practical constraints that continue to shape the development of CRMs, as well as the need for alliances.

As the EU works to strengthen its strategic autonomy, the outlook for future CRM refining capacity is uncertain. The EU's forthcoming Industrial Accelerator Act (expected in 2026) aims to increase the EU's strategic autonomy in key minerals. However, the proposed Act includes measures for cathode[6] materials but does not address anode[7] materials, which creates uncertainties for future battery value chains.[8]

Participants emphasised that while criticalities and import dependencies are not new, their nature has changed over time. Europe has been, and is likely to remain, dependent on imported raw minerals in the future. China's current dominance in value chains is a result of its innovation capacity and technological expertise, but this does not mean that alternative technological pathways, such as LFP batteries, could not be developed in Europe and the USA.

While self-sufficiency was broadly seen as desirable in an uncertain geopolitical environment, strategic priorities within the EU were perceived as unclear. The discussion highlighted the need to reflect on what should be prioritised, especially as global markets could become more fragmented with consequences for how battery components are sourced. By planning and preparing for multiple market configurations with different technological pathways,

[6] The positive electrode in a lithium-ion battery, made from lithium-based materials, where lithium-ions move during discharge.

[7] The negative electrode, usually made from graphite, where lithium-ions are stored during charging.

[8] Since both components are essential to the battery value chain, it is unclear why the anode is excluded, especially given Europe's strong dependence on imported graphite.

policymakers can prepare for an uncertain future.

Finally on this topic, concerns were raised about the longevity of European CRM projects once established. Participants cautioned against an excessive focus on short-term solutions and noted an underlying assumption that market dynamics cannot be influenced. Questions also persist about whether existing targets, such as those set in the CRMA, will be maintained, revised or extended beyond their current time horizon. Ensuring durability and consistency in policy frameworks was seen as essential for translating strategic ambition into lasting outcomes.

Partnerships, value chains and Europe's position in a transforming global economy

The discussion highlighted how partnerships and alliances might be important tools in states' CRM strategies, but also operate according to different logics and have different effects. CRM alliances cannot be assumed to generate uniform outcomes, as their design, objectives and underlying rationales vary. The empirical evidence for comparing their effects is currently limited. As new mineral policies and partnerships are developed, participants emphasised the importance of longer time horizons and closer observation to better understand how the security politics around CRMs evolve in practice.

These differing "security logics" also play out unevenly across actors and the stages of the value chain. While smaller mining companies view policies such as the CRMA as supportive, others argue that funding structures prevent projects from maturing. This illustrates how CRM policies and partnerships can have different impacts depending on project stage, actor type and position in the value chain, demonstrating the need to avoid one-size-fits-all logic.

The discussion situated these dynamics within a broader transformation of the global political economy. Participants noted that the EU emerged in an era of globalisation and that current debates about CRMs reflect uncertainty over whether this era is coming to an end or entering a new phase. From a longer-term perspective, the EU has historically adapted to structural shifts and could do so again. Alliances and collaborations were seen not only as tools for securing resources, but also as indicators of how global economic and political relations might be reconfigured.

At the same time, participants highlighted persistent tensions between market principles and self-sufficiency ambitions. European lithium projects, for example, often rank high in terms of production costs and struggle to advance without regulatory measures that encourage or mandate domestic sourcing. These challenges are compounded by the EU's institutional structure: should the EU institutions, the EU member states or private sector actors bear the risk? By contrast, China benefits from enormous economies of scale that enable it to get projects off the ground – but someone has to take that risk to get the ball rolling.

The discussion also underscored the importance of moving beyond the narrow focus on mining. Critical mineral value chains extend across extraction, processing, refining, manufacturing and technology development. Achieving greater strategic autonomy may therefore require public leadership, particularly where private sector actors are unwilling to invest. While Europe does not need to lead the whole value chain, participants stressed the strategic importance of downstream capabilities, technology ownership and building CRM alliances.

In closing reflections, the panel identified reasons for cautious optimism. Over time,

Europe is expected to build up a growing stock of CRMs embedded in its economy, particularly as many CRMs can be recycled. From a long-term perspective, this could result in a more resilient and less geopolitically vulnerable system than one centred on fossil fuels. Furthermore, the importance was emphasised of breaking down silos across policy domains. Increased attention on these challenges is essential to build momentum in a rapidly transforming landscape.

Concluding points

The future demand or need for critical raw materials remains uncertain. Their criticality is not driven by geological scarcity alone, but by political decisions, technological change and levels of concentration in extraction and processing.

Flexibility could increase the opportunities for better solutions and more sustainable practices. Rapid and unpredictable developments in battery technologies challenge mineral-specific policies and long-term demand projections. Preserving technological flexibility, encouraging innovation and avoiding locking-in specific materials are the strategies needed to manage future uncertainty.

Geopolitical competition has made CRMs not only market commodities, but also strategic assets. Growing geopolitical tensions, export controls and the weaponisation of trade have embedded CRMs in security and defence considerations.

Strategic autonomy for Sweden and the EU will remain conditional. Despite ambitious policies, such as the CRMA, Europe is likely to remain dependent on imports across key segments of CRM value chains. Strategic autonomy in a CRM context should therefore be understood as risk reduction rather than self-sufficiency.

Alliances and multilateral collaborations are needed. CRM alliances can play an important role in mitigating geopolitical risks, but their effects will vary based on design and context.

There is little evidence that current goals for recycling can be effective. While recycling will become important over time, recycled content cannot reduce demand in the short term.

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