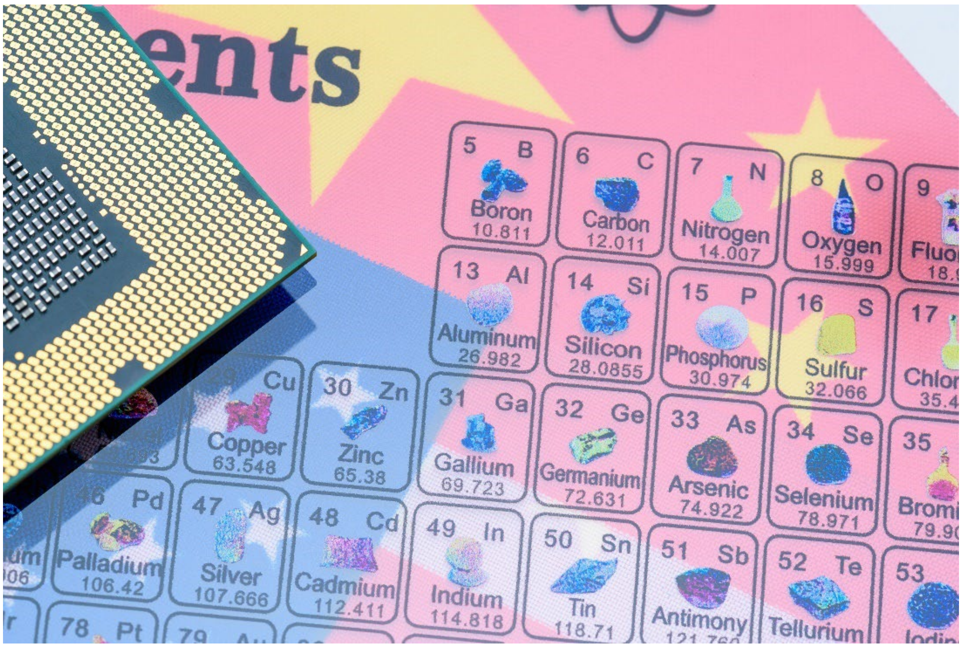
STUDY

European Parliament

US critical minerals policy and its implications for the EU's strategic autonomy

Staff working document on the US critical raw materials strategy



Policy Department for Economy and Growth
Policy Department for Transformation, Innovation and Health
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Abstract

This study analyses the United States' critical minerals strategy, mapping its institutional framework, policy instruments and value-chain priorities, such as tax incentives, funding mechanisms, strategic stockpiling and demand-anchoring mechanisms. It provides a comparative analysis with the EU's approach, highlighting differences in scale, coordination and market intervention. Finally, it explains how its findings relate to the specific policy areas of the European Parliament's IMCO and ITRE Committees.

The document was jointly prepared by the European Parliament's Policy Department for Economy and Growth and its Policy Department for Transformation, Innovation and Health.

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LIST OF ABBREVIATIONS

AI	Artificial intelligence
ARPA-E	Advanced Research Projects Agency – Energy
CBO	Congressional Budget Office
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CfD	Contract for Difference
CMA	Critical Minerals Agreement
CRM	Critical Raw Materials
CRMA	Critical Raw Materials Act
CRS	Congressional Research Service
DCRM	Defence-critical raw material
DFC	US International Development Finance Corporation
DG GROW	European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
DOC	US Department of Commerce
DOD	US Department of Defense
DOE	US Department of Energy
DOI	US Department of the Interior
DPA	Defense Production Act
EBRD	European Bank for Reconstruction and Development
ECA	European Court of Auditors
ECON	European Parliament's Committee on Economic and Monetary Affairs
EIB	European Investment Bank
EO	Executive Order
EOL-RIR	End-of-life recycling input rate
EOL-RR	End-of-life recycling rate
ESG	Environmental, social and governance
EOP	Executive Office of the President of the United States
ESPR	Ecodesign for Sustainable Products Regulation
EV	Electric vehicle
EXIM	Export-Import Bank of the United States
FEOC	Foreign entity of concern
FSR	Foreign Subsidies Regulation

FORGE	Forum on Resource Geostrategic Engagement
GATT	General Agreement on Tariffs and Trade
GSEU	Geological Service for Europe
GWh	Gigawatt-hour
IEA	International Energy Agency
IFRI	Institut français des relations internationales
IIJA	Infrastructure Investment and Jobs Act
IMCO	European Parliament's Committee on the Internal Market and Consumer Protection
IMERA	Internal Market Emergency and Resilience Act
INTA	Committee on International Trade
IRA	Inflation Reduction Act
IRS	Internal Revenue Service
ITRE	European Parliament's Committee on Industry, Research and Energy
JOGMEC	Japan Organization for Metals and Energy Security
LoI	Letter of Intent
MSP	Minerals Security Partnership
NDS	National Defense Stockpile
NEDC	National Energy Dominance Council
NMC	Nickel manganese cobalt
OBBBA	One Big Beautiful Bill Act
PPA	Power purchase agreement
REEs	Rare earth elements
REMSA	Rare Earth Magnet Security Act
RMI	Raw Materials Initiative
RMM	Raw Materials Mechanism
SCM Agreement	Agreement on Subsidies and Countervailing Measures
SRMs	Strategic Raw Materials
USGS	US Geological Survey
USTR	Office of the United States Trade Representative
WEEE	Waste from Electrical and Electronic Equipment
WTO	World Trade Organization

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EXECUTIVE SUMMARY

Critical raw materials have become central to economic competitiveness, technological leadership and geopolitical security. As these materials exhibit systemic constraints (such as concentrated supply, long lead times and limited substitutability) that heighten vulnerability to disruptions, they are not governed solely by market dynamics. Growing geopolitical tensions, export restrictions and the dominance of key actors, notably China, further reinforce supply risks, particularly in the processing stages.

In response, policymakers on both sides of the Atlantic are adopting increasingly interventionist approaches. Against this backdrop, this study examines the institutional architecture surrounding the US critical minerals strategy, its policy instruments and value-chain priorities. It then maps the evolution of the strategy from 2017 to 2026. Finally, it compares it with the EU framework in order to assess implications for the EU's economic autonomy and formulate policy options for ITRE and IMCO on market access, industrial policy and strategic resilience.

Value-chain framework

Before addressing policy concerns, the study builds a **four-part analytical value-chain framework** (upstream, midstream, downstream and recycling). This segmented approach makes it possible to identify precisely where supply vulnerabilities exist, what interventions are required, and which policy instruments are structurally appropriate.

The main finding of this analysis is that the strategic risk lies in **the midstream gap**, not in a lack of upstream capacity. For example, while the United States and the EU possess some mining potential, China controls 90 % of the refining of rare earth elements (REEs) and 74 % of that of lithium and cobalt. This processing bottleneck allows dominant nations to threaten downstream manufacturing across strategic sectors such as defence, semiconductors, space and electromobility. Diversification strategies therefore need to pair upstream extraction with investments in domestic midstream refining capacity.

US critical minerals policy, its governance and historical evolution

Over the last decade, critical raw materials (CRMs) – generally called "critical minerals" in the United States – have become a core pillar of US industrial, energy and security policy, driven by import dependence, concentrated supply chains and geopolitical rivalry. This study describes the resulting approach as a patchwork of executive orders, statutes, industrial incentives and international partnerships that now spans the whole value chain, without, however, constituting a single, unified plan.

US governance can be described as a hybrid model that blends executive coordination (White House, NEDC), technical intelligence (DOI/USGS), industrial development (DOE), defence security (DOD), fiscal incentives (Treasury/IRS, IRA), financing (EXIM, DFC) and diplomatic outreach (State, USTR), as well as congressional oversight.

US critical minerals policy has evolved in successive phases:

- **Strategic recognition (2017-2020)**: EO 13817 created the first federal strategy. Congress subsequently advanced the American Mineral Security Act[1], the substantive provisions of which were ultimately enacted through Section 7002 of the Energy Act of 2020[2];
- **Integration of supply-chain resilience into industrial policy (2021-2022)**: EO 14017 placed minerals in a whole-of-government supply chain review. The legal framework expanded with the Infrastructure Investment and Jobs Act, the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act and the Inflation Reduction Act, introducing funding, tax incentives and local content rules;
- **Consolidation of the policy framework (2023-2024)**: as the basic framework had been established by then, the policy initiatives shifted to permitting reforms through the Critical Mineral Independence Act (2023). The coordination between public actors was also streamlined, and executive instruments were used to unblock midstream bottlenecks. During this period, cooperation with partner countries also expanded, with the launch of the Minerals Security Partnership with allied countries on supply diversification and strategic projects;
- **Second Trump administration (2025-26)**: since January 2025, US critical minerals policy has turned into a markedly interventionist programme. In particular, EO 14213 established the National Energy Dominance Council, a WhiteHouse-level body that coordinates the Department of Energy, the Department of the Interior, the Department of Commerce and the Defense Production Act offices, giving the administration a single point of execution. Successive measures have led to a more systematic use of the Defense Production Act to fund domestic processing projects, signalling a shift from long-term framework-building to rapid, executive-driven implementation. Congress has paralleled the executive push with a suite of legislative initiatives that target the same vulnerable stages of the value chain. Congressional hearings in 2026 have also raised questions about transparency and oversight of these public-private deals, underscoring tensions over the balance between executive authority and the scale of public support needed to secure a resilient critical-minerals supply chain.

Comparison of EU and US CRM policy

This operational and historical mapping of the US critical minerals strategy allows **a comparison with the EU's own CRM policy**.

- On the **funding** dimension, the consolidation of figures for both jurisdictions highlights that the United States provides much more public funding than the EU. US federal agencies mobilise about EUR 46 billion while, by contrast, the EU provides only EUR 5-6 billion in CRM funding. The two regions also use different financial tools: the United States offers more flexible, large-scale support with a high degree of risk-sharing, whereas the EU relies mostly on grants and loans;

[1] The bill did not receive a floor vote as stand-alone legislation.

[2] See Energy Act of 2020, Division Z of the *Consolidated Appropriations Act, 2021*, Public Law 116-260, signed 27 December 2020, s. 7002 (Critical Minerals Security). Section 7002 codified the statutory definition of 'critical mineral' and directed the Secretary of the Interior, acting through the director of the US Geological Survey (USGS), to develop and maintain a Critical Minerals List, to be updated at least every three years.

- The (existing and announced) **stockpiling** models also reflect different levels of centralisation, with the United States now using a dual system composed of the long-standing National Defense Stockpile and the EXIM-backed Project Vault. The EU is still operationalising its stockpiling strategy, relying on the upcoming CRM Centre and coordinated governance among the 27 Member States. Both approaches stand in contrast to Japan's JOGMEC, which is often seen as a foundational operational stockpiling template, combining market intelligence, direct funding along the whole supply chain, and physical reserves within a single state agency;

- **Price-stabilisation mechanisms**: In the volatile price environment of CRM, price support instruments are used by public authorities to help developers secure bank loans.

  The United States relies on trade-linked price floors and adjustable tariffs, which, in isolation, may be hard to sustain – unless they are set up collectively with allies through frameworks like FORGE. The EU still lacks a dedicated instrument to guarantee long-term revenues for mine and processing plant developers. Used widely in the renewable energy sector, contracts for difference (CfDs) could offer a middle way to bridge this gap.

Implications for the European Parliament and the IMCO and ITRE Committees

The domain of critical raw materials has been a focus of the European Parliament for several years, and the competent committees may help shape the solutions to address the impacts of the US and Chinese strategies. For example, the July 2025 resolution on export restrictions on critical raw materials[3] called for the rapid implementation of the CRMA, condemning China's coercive behaviour, and warned it could jeopardise EU security. It called for the activation of domestic mining, the creation of minimum strategic stocks of rare earth elements (REEs), and the swift conclusion of sustainability - and human-rights-compliant bilateral deals on raw materials.

The **IMCO** Committee can support the CRM policy through its remit for the internal market, competition, standards and the Digital Single Market. The committee's purview covers legislative actions, especially where market concentration and state-backed investment distort the mid-stream processing stage. The study lists policy options such as:

- using the Foreign Subsidies Regulation to screen Chinese-backed mid-stream projects and US-origin subsidies (IRA, CHIPS) that could create hidden dependencies or distort EU competition;

- addressing asymmetric Member-State financing schemes that risk fragmenting the single market, and consider EU-level financing (future Sovereignty Fund) to harmonise support;

- leveraging demand-side pressure by embedding CRM supply chain resilience as a condition on demonstrating resilient and secure critical raw materials (CRM) in the CHIPS and Science Act and public procurement rules; and

- examining whether EU firms reliant on US IRA credits operate on distorted terms when re-entering the EU market.

[3] European Parliament, European Parliament resolution of 10 July 2025 on Tackling China's critical raw materials export restrictions (2025/2800(RSP)), 2025.

For the **ITRE** Committee, the study highlights policy axes that can be explored, in particular to close the financing gap and de-risk CRM projects, such as:

- introducing two-way CfDs, "buyer-of-last-resort" schemes, and other tools to ensure revenue certainty and to improve projects' bankability;
- mitigating higher costs of resilient supply chains through environmental, social and governance (ESG)/defence procurement criteria and strategic stockpiling – for example, EU funding and regulatory benefits might be linked to diversified, low carbon CRM sourcing, and "resilience" scores could be considered in the Net-Zero Industry Act and Industrial Accelerator Act; and
- addressing high energy costs by facilitating long-term, fixed-price power purchase agreements (PPAs) through credit guarantees, and promoting flexible, load-shifting refining processes in order to reduce electricity costs.

1. INTRODUCTION

1.1. Strategic context

Critical raw materials (CRMs) have become pivotal in economic, technological and geopolitical debates. The acceleration of the green and digital transitions, the growing material intensity of advanced technologies and the re-emergence of industrial policy have collectively transformed raw materials from conventional industrial inputs into enablers of competitiveness, resilience and security[4]. Particularly in the United States, this shift reflects wider security and geopolitical considerations beyond industrial competitiveness. CRMs are linked to technological leadership, supply-chain security and geopolitical competition. They are considered essential inputs for semiconductors, clean-energy technologies, defence systems and advanced manufacturing. As a result, they have moved beyond being a narrow resource-policy issue and have become part of a broader economic and security policy agenda.

At the same time, the EU faces a strategic crossroads. While pursuing ambitious decarbonisation and industrial objectives, it remains highly dependent on external suppliers for many critical materials and much processing capacity. The EU therefore faces the challenge of balancing open-market principles with measures aimed at strengthening supply-chain resilience, diversifying sourcing and supporting strategic industries.

1.1.1. Not a simple commodity

Conventionally, raw materials markets have been primarily analysed through the prism of their allocative function. Prices are indicative of scarcity, serve to coordinate investment decisions, and facilitate the efficient distribution of resources along global value chains. The Hotelling framework[5] and subsequent resource-economics literature have emphasised the role of scarcity rents and intertemporal price dynamics in guiding efficient use of resource. These price signals, in principle, have the capacity to support industrial development, encourage technological substitution and promote long-term supply responses. However, the structural characteristics of many CRM markets (long project lead times, limited short-term supply responsiveness, high capital intensity, and strong geographical concentration of extraction and processing) frequently limit the effectiveness of price signals alone. Such characteristics contribute to supply volatility, investment cycles and persistent vulnerabilities that are not fully addressed by market signals alone[6].

1.1.2. A volatile geopolitical landscape

Recent geopolitical developments have served to reinforce these structural constraints. The gradual fragmentation of global trade, the expansion of export restrictions and the emergence of resource nationalism (see Box 1) have heightened supply-side uncertainty[7].

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4 Braunstein J., Chuchko M., Resource curse in the age of critical minerals: Geopolitical forces and market maturity, 2025.

5 Hotelling, H., The Economics of Exhaustible Resources. *Journal of Political Economy*, 1931.

6 Heydari, M., Jennings, E., Thomas, H., Cabrera Serrenho, A., Cullen, J., Resilience of Critical Minerals Supply Chain, 2025.

7 Brooks, S., and Voeten, E., Green Industrial Policy and the Geopolitics of Investment in Critical Minerals and Batteries, 2025.

Box 1: The critical raw materials "cold war" with China: escalation in trade measures (2022–2026)

China currently controls not only a dominant share of REEs (around **60 % of global REE mining and 90 % of REE refining**), but it also holds strong positions across a wide range of CRMs, including graphite, lithium, nickel, cobalt and zinc. This dominant position is a result of decades of industrial policy, low labour costs and less stringent environmental standards. In recent years, Beijing has started using this dominance as a foreign policy tool, specifically targeting the United States and the EU. This has led to an escalation of trade measures[8]:

- October 2022: the US Department of Commerce introduced restrictions on the export of advanced semiconductors and chip-making equipment to China;
- July 2023: China imposed export licences on gallium and germanium, minerals that are essential for high-frequency semiconductors and fibre optics. Global prices for gallium rose by 50 % within weeks;
- October 2023: the US updated and expanded its chip rules, restricting more types of AI hardware; China implemented export licensing for high-purity graphite materials and products, key elements for EV battery anodes;
- December 2023: China banned the export of rare earth processing technology;
- December 2024: the United States expanded export controls of advanced hardware and software, added 140 entities to the list of companies banned from receiving US technology, and expanded its legal jurisdiction over foreign-made goods; China escalated by completely banning the export of gallium, germanium, antimony and superhard materials to the United States;
- February 2025: The United States announced an additional 10 % baseline tariff on all Chinese imports. This was followed on 2 April 2025 by another additional, country-specific, 34 % duty on a wide range of Chinese goods, including electronics and components that rely on REEs;
- April 2025: China retaliated again by restricting the export of seven medium and heavy REEs essential to permanent magnets;
- October 2025: A second wave of controls by China added five more REEs and, for the first time, introduced extraterritorial reach. This restriction requires foreign companies to seek Chinese approval if they export magnets containing as little as 0.1 % of Chinese-origin REEs or are made using Chinese processing technology;
- November 2025: following a US-China trade agreement, Beijing suspended the second wave of restrictions until November 2026, while the United States agreed to delay higher tariffs, extend certain tariff exemptions, and pause some new trade restrictions for one year.

We are currently in a tactical pause in this "cold war" over critical materials. The EU, lacking domestic capacity in both semiconductors and CRM extraction, reacted in 2024 by adopting the Critical Raw Materials Act[9] (CRMA) and by imposing duties on unfairly subsidised EVs from China.

Sources: European Parliamentary Research Service (EPRS), China's rare-earth export restrictions, November 2025; International Energy Agency, Global Critical Minerals Outlook 2025 - Regional snapshots, 2025; Caixin Global, Export restriction timeline, July 2025; SFA Oxford, China Imposes Export Controls on Key REE, April 2025; Center for Strategic and International Studies, China Imposes Its Most Stringent Critical Minerals Export Restrictions Yet Amidst Escalating U.S.-China Tech War, December 2024; European Commission, EU imposes duties on unfairly subsidised electric vehicles from China while discussions on price undertakings continue, October 2024; Center for Strategic and International Studies, China's Antimony Export Restrictions: The Impact on U.S. National Security, August 2024; Center for Strategic and International Studies, China's New Graphite Restrictions, October 2023.

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[8] After the 2010 incident involving a Chinese ship within disputed waters of the **Senkaku/Diaoyu Islands**, China imposed an unofficial restriction on rare-earth shipments to Japan, on top of pre-existing export quotas. This intensified fears about supply concentration, and prices of key REEs such as dysprosium and neodymium surged sharply in 2010-2011, revealing the acute vulnerability of the supply chain dominated by China. This 2010 episode is widely understood as an early, highly visible case of supply-chain leverage becoming strategically salient in a modern economy. See Prachi, P., Senkaku/Diaoyu Islands Dispute (2010–2012), National University of Singapore: Lee Kuan Yew School of Public Policy, 2026.

[9] Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020 (OJ L, 2024/1252, 3.5.2024, ELI: http://data.europa.eu/eli/reg/2024/1252/oj).

Concurrently, the consolidation of refining and processing capacity in some jurisdictions (notably for REEs, battery materials and specialised metals) has redirected focus from upstream extraction to midstream industrial bottlenecks. Processing capacity, technological expertise and access to downstream manufacturing ecosystems have thus become pivotal factors in determining economic power in raw materials value chains[10].

1.1.3. Policymakers are doubling down on critical materials

In parallel with these geopolitical events, the resurgence of industrial policy in the world's major economies has reshaped the governance of critical materials. Public interventions are increasingly designed not only to rectify market failures but also to influence value-chain positioning[11, 12], technological leadership and strategic resilience. The growing demand for specialised minerals, attributable to rising demand for defence systems, AI infrastructure, renewable energy technologies and semiconductor manufacturing, has the effect of intensifying competition for secure access to these minerals, which cannot be readily replaced by alternatives.

In this evolving landscape, transatlantic partners share broad objectives related to supply security and industrial competitiveness yet differ in policy design and underlying conceptual approaches. The United States has historically approached the issue of critical minerals from the perspective of national security and economic prosperity. This approach has emphasised demand-pull incentives, the support of domestic production and the strategic management of stockpiles. The EU, while similarly concerned with resilience, has generally pursued a hybrid approach combining market integration, diversification of external supply, regulatory coordination and sustainability objectives within the framework of strategic autonomy and the constraints of the EU Treaties.

These differences are indicative of a more extensive conceptual shift in the interpretation of the market function of critical raw materials. **Rather than functioning exclusively as commodities governed by price-based allocation**, **critical materials are increasingly demonstrating characteristics of strategic markets**, **where security considerations**, **industrial policy objectives and geopolitical risk management interact with traditional market mechanisms**. The resulting hybrid governance model raises significant questions regarding investment incentives, international cooperation, regulatory divergence and the future organisation of global value chains.

This conceptual transition from commodity to strategic markets carries significant policy-design implications. It is suggested that ensuring supply security and industrial competitiveness may require a combination of market integration, diversification strategies, strategic partnerships, investment support and, in some cases, stockpiling or price-stabilisation mechanisms. Understanding these evolving market characteristics is essential to assessing the approaches adopted by the United States and the EU with regard to CRMs and the broader organisation of global supply chains.

Against this background, **this study aims to map and analyse the United States' evolving raw materials strategy and to assess the interaction of that strategy with the EU's policy framework**.

It examines institutional structures, policy instruments and value-chain priorities, with a view to providing a comparative perspective on how these two actors address the balance between market efficiency, industrial competitiveness and strategic resilience regarding CRMs.

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10 Zhiyenbayev, M., Securing the New Resource Frontier: Critical Minerals in an Era of Great-Power Rivalry, Geneva Centre for Security Policy, September 2025.

11 Ozkan, O. and Akadiri, S.S., How Does Geopolitical Risk Affect Energy Transition Minerals?, *Energy Research Letters*, April 2026.

12 Bastianin, A., Li, X., Shamsudin, L., Forecasting the Volatility of Energy Transition Metals, 2025.

1.2. Objectives and methodological approach

1.2.1. Objectives

The aim of this study is to provide a systematic and policy-relevant mapping of the United States' critical minerals strategy between 2017 and 2026, and to assess its implications for transatlantic industrial competitiveness and supply-chain resilience.

The analysis is guided by five interrelated objectives, namely to:

1. systematically map the US critical minerals strategy;
2. identify institutional architecture and policy instruments;
3. assess upstream–midstream–downstream priorities;
4. compare the United States' strategy with the EU's critical raw material framework; and
5. assess how both actors organise market access, industrial policy and security in CRMs.

1.2.2. Methodology

The study employs a qualitative and comparative policy-mapping methodology combining institutional analysis, value-chain assessment and cross-jurisdictional comparison.

The first analytical layer is a chronological mapping of US strategy development between 2017 and 2026. This encompasses federal strategies, executive orders, legislative initiatives and agency programmes addressing mineral security, supply-chain resilience and industrial competitiveness. The mapping is not merely descriptive. It takes a phasing logic, designed to identify when and why the dominant policy rationale shifted, from supply vulnerability assessment, through industrial resilience integration, to the more interventionist market-shaping posture visible since 2025.

The second layer is a value-chain analytical framework that distinguishes between the upstream extraction, midstream processing and downstream manufacturing segments. This approach facilitates the identification of structural bottlenecks, policy priorities and areas for policy intervention across diverse stages of mineral supply chains. A fuller description of this framework – including its application to the defence, space, semiconductor, transport and clean-energy sectors – is provided in Section 2 of this study.

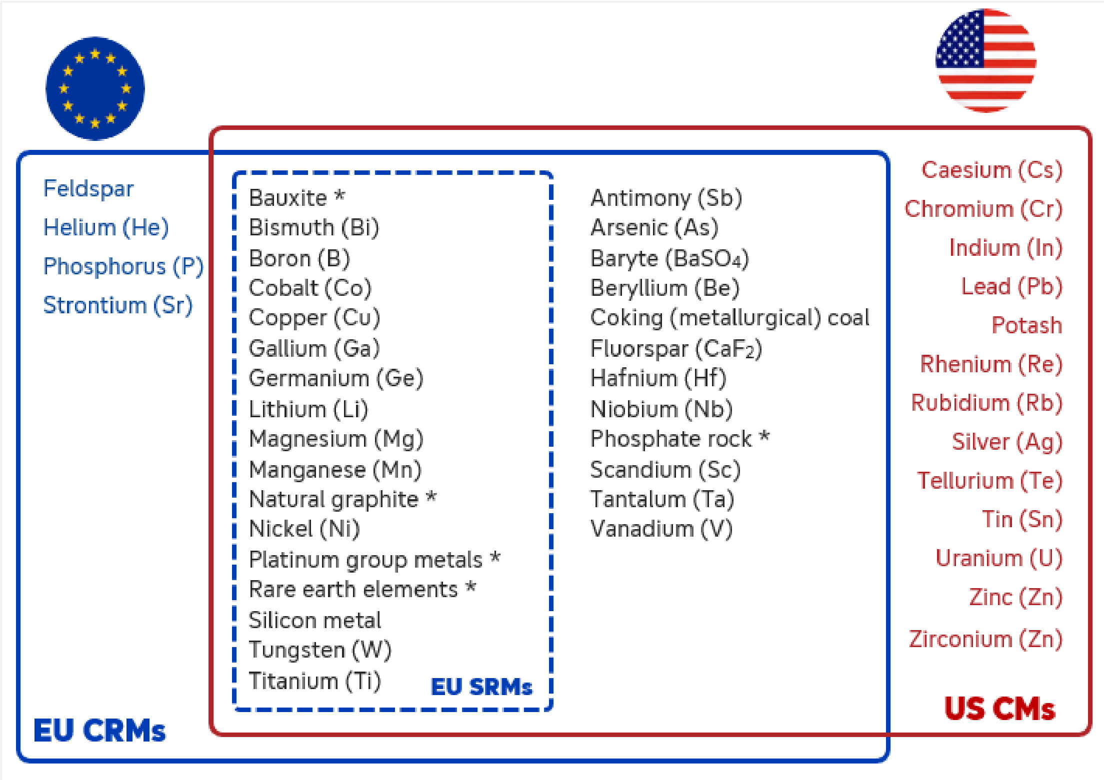
The third layer is a comparative governance perspective, examining how the United States and the EU balance market allocation, industrial policy and national security considerations. The study places particular emphasis on the differences in policy instruments, investment incentives, regulatory approaches and external supply strategies.

Across all three layers, the study applies a market-function analytical lens, assessing how structural characteristics of critical minerals markets – including supply concentration, investment risk and geopolitical exposure – shape policy intervention and contribute to the emergence of hybrid governance models combining market mechanisms with strategic and security objectives.

1.3. Key differences between the EU and the US terminology and scope

Critical/strategic raw material terminology differs slightly across jurisdictions but shares a common logic: these materials have both **economic importance** and a **vulnerable supply chain**.

Figure 1: Critical (raw) minerals/materials in the EU (2024) and US (2025) lists



* The nomenclature or classification differs between the two lists, as discussed in greater detail in the text.
Source: The authors, based on Annex II CRMA.

Even though the US critical minerals' (CMs) list initially seems much larger, **the scope of the two lists does not differ significantly**, as Figure 2 shows. The apparent divergences can be explained by the fact that:

- REEs (15 elements) and platinum group metals (5 elements) are not grouped together in the US list;
- the US list covers a wider range of sectors, including agronomy and traditional manufacturing, and;
- the US model focuses more on domestic mineral supply, whereas the EU model looks into the economic importance of each material and flags as critical materials that are assessed as important in future industries.

The nomenclature of the two lists also differs because the methodologies focus on different stages in the supply chain. The EU's nomenclature focuses on the initial stages of the raw material's entering the supply chain, whereas the US approach focuses on the industrial material that is used in specific industrial sectors. For example:

- platinum group metals tend to occur together in the same mineral deposits and are grouped in the EU's list, while the USGS distinguishes them, owing to their different industrial and defence uses;

- bauxite, natural graphite and phosphate rock (EU list) are raw ores/minerals yielding aluminium, graphite and phosphate (US list), which are found in the later stages of the supply chain;
- the REEs in the EU list are split into two categories – light and heavy – due to the differences in the supply/demand issues between the groups. The USGS list does not include promethium, since it is generally obtained through synthetic methods and not mined like other REEs.

Table 1: Critical/strategic raw material terminology in the United States and in the EU

Item	United States	EU
Legal basis	Energy Act of 2020 *	Critical Raw Materials Act (2024)
Official definition	Critical minerals (**CMs**) **	Critical raw materials (**CRMs**) Strategic raw materials (**SRMs**)
Definition level	Federal	European Union
Number of items	60	34 CRMs 17 SRMs
Operationalisation	List of CMs maintained by the US Geological Survey (USGS).	List of CRMs and SRMs embedded in the CRMA, defined by the European Commission.
Update	3 years (last updated: 2025)	3 years (last updated: 2024)
Definition of criticality	**CMs** are non-fuel mineral commodities that*: (i) are essential to the economic or national security of the United States; (ii) are vulnerable to supply chain disruption; (iii) serve an essential function in the manufacturing of a product, the absence of which would have substantial consequences for the economy or national security.	**CRMs** are raw materials that are: (i) of high economic importance for the EU; (ii) subject to a high risk of supply disruption. **SRMs** are a defined subset of CRMs that have high strategic importance due to their use in technologies essential for the green and digital transitions, and for defence and space.

Source: Congressional Research Service, "Critical Minerals Resources: National Policy and Critical Minerals List", 2026 and European Commission, DG GROW, "Critical raw materials".

* There are two separate and overlapping[13] classifications for essential materials in the United States. The Department of Energy (DOE) maintained a list of critical materials crucial for energy purposes, while the USGS kept a list of critical minerals crucial for economic and national security, and the DLA. maintains a list of materials critical for defence purposes. The Critical Mineral Consistency Act of 2025 bill attempts to harmonise the DOE and USGS lists into one unified framework. At the time of writing the bill has passed the House with bipartisan support and is now awaiting a Senate vote to move forward.

** The Energy Act of 2020 defines a "**critical mineral**" as any mineral, element, substance or material designated as critical by the Secretary of the Interior, acting through the director of the USGS. The Energy Act of 2020 defines a "**critical material**" as any non-fuel mineral, element, substance or material that the Secretary of Energy determines: (a) has a high risk of supply chain disruption; (b) serves an essential function in one or more energy technologies, including technologies that produce, transmit, store and conserve energy; or, (c) a critical mineral, as defined by the Secretary of the Interior.

[13] CSIS, 2025, Three U.S. Government Lists: Which Minerals Are the Most Critical?.

2. VALUE-CHAIN ANALYTICAL FRAMEWORK FOR CRITICAL RAW MATERIALS

KEY FINDINGS

A value-chain framework is essential in identifying where dependencies on foreign actors occur and for designing policy across its principal segments – upstream, midstream, downstream and recycling.

- **Upstream** processes are constrained by long lead times between discovery and production, stringent environmental regulations and finite geological potential;
- **Midstream** processes are identified as a key bottleneck across value-chain frameworks and a primary source of geopolitical leverage and supply risk, due to the extreme concentration of such processes in China;
- **Downstream** processes are the point where economic value materialises. They reveal the dependencies of key sectors, such as defence, space, semiconductors, transport and clean energy, on a continuous supply of technologies containing processed critical raw materials and products, often coming exclusively from China;
- **Recycling** has become an important part of the value-chain framework due to ongoing progress in recycling and separating methods. However, because of limited capacity, it is seen as an additional actor in supplying midstream and downstream, rather than offsetting supply dependence at scale.

Another dimension of critical minerals value chains is complexity and the fast pace of technological progress. Both factors contribute to a need for **constant and frequent re-evaluation of the supply chains for each critical raw material**.

Despite significant investment in both upstream and downstream capacity, the United States is structurally exposed due to limited domestic midstream processing infrastructure. Even a country with a strong domestic mining industry cannot achieve supply-chain sovereignty if it remains dependent on Chinese refining, separation and magnet manufacturing.

The global competition for critical minerals has elevated supply-chain analysis from a technical exercise to a strategic imperative. Governments, multilateral institutions and private investors increasingly recognise that the ability to secure, process and manufacture mineral-derived products is a question of industrial sovereignty, technological competitiveness and geopolitical positioning. A value-chain analytical framework makes this complexity tractable: by differentiating between upstream extraction, midstream processing, downstream manufacturing and recycling, it becomes possible to identify precisely where a given dependency is located, what type of intervention is required to address it and which policy instruments are structurally suited to that specific stage[14,15].

Analysing the United States' critical raw materials strategy in a structured and policy-relevant manner requires a framework that goes beyond a narrow focus on resource availability. A mineral's criticality is not a fixed property, but rather a dynamic designation that shifts as technology evolves, demand structures change, new deposits are discovered or old ones depleted and geopolitical conditions alter the availability of supply.

[14] See CRS, Critical Mineral Resources: National Policy and Critical Minerals List, Report R47982, January 2026.

[15] See IEA, Global Critical Minerals Outlook 2024, May 2024.

Lithium, for example, was not considered a critical mineral by most governments before the mid-2010s; today it sits at the centre of both the US and EU critical minerals lists, driven by the exponential growth of lithium-ion battery demand for electric vehicles and stationary storage.

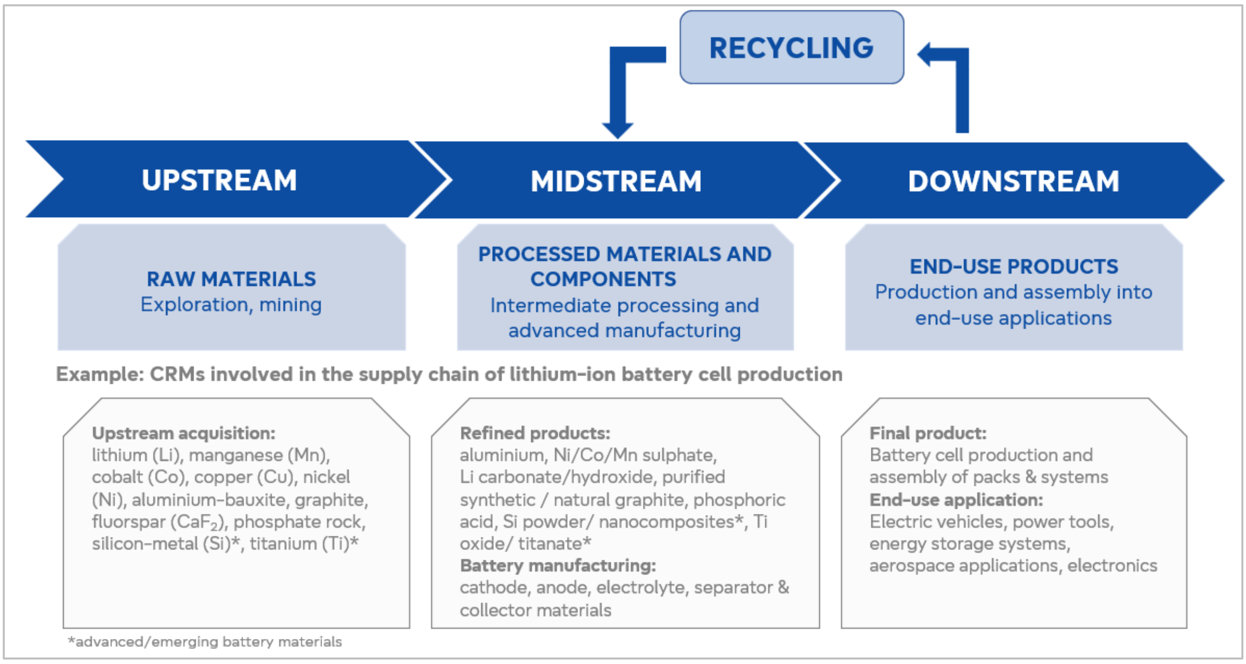
The value-chain approach captures this dynamism by assessing strategic importance at each production stage rather than treating the mineral as a uniform commodity[16].

Rather than treating supply as an undifferentiated aggregate, the framework locates dependence at the specific stage where it actually occurs:

- **upstream**, where domestic extraction may be absent or underdeveloped;
- **midstream**, where processing capacity is geographically concentrated in a small number of foreign jurisdictions; or
- **downstream**, where manufacturing ecosystems rely on imported processed inputs whose disruption can immobilise entire industrial sectors.

The distinction matters for policy design: a country may possess significant geological reserves (upstream endowment) yet remain wholly dependent on a foreign supplier for refined inputs (midstream vulnerability). The US illustrates this precisely – it holds the world's largest known lithium deposit at Thacker Pass, Nevada, yet in 2024 remained more than 50 % import-reliant for lithium compounds because domestic refining capacity had not yet been developed at scale (see Box 2).

Figure 2: Critical raw material value-chain framework and example in battery cell manufacturing



Source: The authors.

[16] See USGS, Mineral Commodity Summaries 2025, January 2025. Australia accounted for approximately 47 % of global lithium mine production in 2024.

The typical framework also integrates recycling, reuse, repurposing and circularity as a cross-cutting fourth dimension that operates across the whole value chain[17,18]. The four stages are illustrated with concrete examples in the sub-sections below.

2.1. Upstream extraction

The upstream segment covers the earliest stages of the value chain, including geological surveying, exploration, mine development and the extraction and initial beneficiation of raw ores. It is primarily associated with **resource endowment and territorial control**, where factors such as permitting timelines, environmental regulation, community acceptance and investment conditions are decisive. Upstream projects typically involve long lead times – an average of 16 years from discovery to production according to the IEA[19] – **high capital intensity** and significant environmental and political risks.

Box 2: Upstream – the Molycorp Mountain Pass and Thacker Pass cases

Two US projects illustrate the upstream stage and its structural constraints.

Mountain Pass, California - the only operating rare earth mine in the US – was reopened by the company Molycorp in 2012 (it had been closed in 2002), and received significant investment to modernise and expand it, in order to try and capitalise on high rare earth prices. However, China subsequently ramped up its rare earth production in response, and global prices fell by roughly 90 %, making Mountain Pass unprofitable. Despite controlling one of the most significant rare earth deposits in North America, Molycorp went bankrupt in 2015[20]. Mountain Pass was bought by the company MP Materials. At its peak, Mountain Pass produced approximately 15 % of global rare earth ore output. Yet until 2023, the mixed carbonate was shipped to China for separation, because no commercial separation facility existed in the United States: a clear illustration of how **upstream presence alone does not resolve midstream dependency**[21].

The Thacker Pass project in Nevada, backed by a USD 2.26 billion DOE loan guarantee to Lithium Americas, is the United States' most advanced domestic lithium project. Thacker Pass hosts one of the largest known lithium deposits in the world. However, construction timelines illustrate the upstream bottleneck: the project was first announced in 2018, faced multi-year permitting and legal challenges, and is not expected to reach full production before 2027. The high concentration of actors sharpens the competitive challenge. Australia’s Greenbushes mine in Western Australia, the world's largest hard-rock lithium deposit, operated by Talison Lithium (an Albemarle/Tianqi joint venture), accounted for approximately 30 % of world lithium mine output in 2024.

Source: The authors, based on the sources in the footnotes.

From a policy perspective, this stage implies an assessment of efforts to expand domestic mining, streamline permitting, enhance geological knowledge and **reduce import dependence**.

[17] See US DOE, Loan Programs Office, Lithium Americas Closes $2.26 Billion US DOE ATVM Loan, October 2024.

[18] See CRS, Critical Mineral Resources: National Policy and Critical Minerals List, Report R47982, January 2026.

[19] See IEA, Promoting exploration, production and innovation, 2022.

[20] After its bankruptcy, the company reorganised as Neo Performance Materials (Neo), a Canadian enterprise with facilities in North America, Europe, and Asia, including a REEs separations plant in Jiangyin, China. In April 2025, Neo sold the majority of its equity stakes in its REEs separation plants to Shenghe Resources, a Chinese partly state-owned REEs mining and processing company.

[21] See MP Materials, MP Materials Announces Transformational Public-Private Partnership with the Department of Defense to Accelerate U.S. Rare Earth Magnet Independence, 2025. Mountain Pass is the only operating rare earth mine in the United States.

At the same time, it highlights the structural limits of extraction-focused strategies, which are often constrained by environmental review requirements, infrastructure gaps and cost competitiveness relative to incumbents with lower regulatory overheads[22].

Bottlenecks to support upstream extractions are diverse, but the lack of skills is a fundamental limitation. For example, in the US, a stark **workforce shortage** is reported. More than half of the current domestic mining workforce (approximately 221 000 workers) will retire and need to be replaced by 2029[23], while in 2020, only 327 degrees were awarded in these fields nationwide. The closure of the US Bureau of Mines in 1996[24], which decentralised responsibilities, also reportedly caused the US to lose its position as a global leader in both production and cutting-edge mining technology.

In parallel, **social acceptance** and **environmental regulations** present distinct but interlinked hurdles to mining revival in the EU. Policymakers and local communities approach the question of domestic mineral extraction from different starting points. Whereas the former emphasises supply security and reduced import dependence, the latter raise concerns about ecological impacts and the distribution of costs and benefits. Opposition to new mining projects frequently reflects an unease about decisions taken at EU or national level whose consequences fall locally. Addressing this divergence calls for governance approaches that bring affected communities into project design at an early stage, alongside clear and consistent communication about trade-offs, as neither dismissing local concerns as obstructionism nor treating strategic supply objectives as negotiable can resolve the tension. Authors[25,26], some of whom have since coined the term "green extractivism"[27], and observers point to a constructive approach aligning both sets of legitimate interests through genuinely participatory processes.

2.2. Midstream processing

The midstream segment encompasses the industrial transformation of raw materials into manufacturing-ready inputs and includes processes such as refining, chemical separation, smelting and the production of intermediate products such as battery-grade lithium hydroxide, rare earth oxides or cobalt sulfate. This stage is typically the most strategically significant, as market power tends to concentrate in processing rather than in extraction, enabling control over pricing, access and technical standards. The **geographic concentration of midstream capacity is more extreme** than at the upstream stage: a country may lack significant geological endowment yet exercise decisive control over global supply chains by dominating a midstream process such as refinement. Key bottlenecks arise from capacity concentration, technological barriers to entry, high energy intensity (particularly for electrochemical processes) and the difficulty of attracting commercial financing to projects without long-term offtake certainty.

22 See CRS, Critical Mineral Resources: National Policy and Critical Minerals List, Report R47982, January 2026; and USGS, Mineral Commodity Summaries 2025 . Average permitting timelines for new US mines are estimated at 7-–10 years.

23 Congressional Testimony by Gracelin Baskaran , CSIS, Digging Deeper: Building Our Critical Minerals Workforce, 2024.

24 E&E News by Politico, Q&A: She was forced to close the Bureau of Mines. Could it return?, 2024.

25 Correia, V., Rosendo, L., and Falck, E., Understanding the narratives in the public debate about mining in Europe, 2024.

26 Ayeh, D., and Rutjes, H., Europe as a reemerging mining frontier? Contested lithium futures in the German Ore Mountains, 2025.

27 Green extractivism refers to the practice of extracting large amounts of natural resources (such as lithium, cobalt, nickel and copper) under the banner of fighting climate change and transitioning to a green economy. While traditional extractivism was driven by the demand for fossil fuels (such as coal, oil and gas), green extractivism is driven by the demand for clean energy technologies, such as EV batteries, solar panels, and wind turbines, and highlights the possible contradiction of using the same high-impact mining practices of the old fossil-fuel economy to build a new, clean energy future. In European contexts, green extractivism often overlaps with what researchers call grey extractivism, when modern companies return to old, abandoned industrial mine sites to extract materials for new technology. See Dunlap, A., Verweijen, J. & Tornel, C., The political ecologies of "green" extractivism(s): An introduction, 2024.

This stage is critical for distinguishing whether a given supply vulnerability stems from geology or from industrial structure – a distinction with profound implications for the type of policy intervention required[28].

Box 3: Midstream – China's processing dominance and the Lynas/MP Materials exceptions

China's midstream dominance across multiple critical minerals value chains provides the clearest illustration of this stage. China controls approximately 90 % of global REE separation and refining capacity, approximately 74 % of lithium carbonate refining and approximately 74 % of cobalt refining — despite holding proportionally far smaller shares of global mining output.

When Beijing imposed export controls on gallium and germanium in July 2023, immediate price spikes followed (gallium prices rose approximately 50 % within weeks), demonstrating how midstream control translates directly into geopolitical leverage[29].

Two exceptions illustrate policy efforts to diversify midstream capacity outside China.

- Lynas Rare Earths (Australia) operates the Mt Weld mine and the Lynas Advanced Materials Plant processing facility in Malaysia, representing the largest non-Chinese REEs separation operation and a direct model for what allied midstream capacity can look like[30];
- In the US, MP Materials, operates rare earth separation and refining at Mountain Pass, California, and completed its Independence metal-and-magnet manufacturing facility in Fort Worth, Texas, which began commercial NdPr metal production in January 2025[31].

In the battery sector, battery-grade lithium hydroxide production, the precursor for NMC cathode chemistry used in EV batteries, remains concentrated in China and South Korea. Albemarle, SQM, and POSCO Chemical represent the principal non-Chinese producers attempting to build Western midstream capacity, but their combined share of global production remains well below 30 %[32].

Source: The authors, based on the sources in the footnotes.

2.3. Downstream manufacturing

The downstream segment covers the use of processed raw materials in manufacturing components and final products. These include batteries for EVs, rare earth permanent magnets for wind turbines and defence systems, gallium-based semiconductors for radar and 5G communications, and a wide range of advanced materials for aerospace, medical devices and digital infrastructure. It is at this stage that value-added, innovation, and strategic competitiveness materialise: raw materials gain economic and security significance only through their integration into key technologies. The downstream stage links raw materials policy to broader industrial strategy, revealing whether a government's objective is merely to secure access to inputs or to build domestic industrial capacity to capture the economic value

[28] See European Commission, Critical Raw Materials Act Impact Assessment, 2023. China controls approximately 90 % of REE separation and processing capacity, approximately 74 % of lithium carbonate refining and approximately 74 % of cobalt refining.

[29] See USGS, Mineral Commodity Summaries 2025, 2025. China accounts for more than 80 % of global primary gallium and germanium production. China imposed export controls on gallium and germanium in July 2023.

[30] See Lynas Rare Earths, Annual Report 2024, 2024. Lynas operates the Mt Weld mine in Australia and the Lynas Advanced Materials Plant processing facility in Malaysia, representing the largest non-Chinese REEs processing operation.

[31] See MP Materials, Corporate disclosures 2023-2024: MP Materials completed the commissioning of its rare earth separation facility at Fort Worth, Texas in 2023, under a DOD partnership.

[32] See IEA, Global EV Outlook 2024, 2024. Battery-grade lithium hydroxide production capacity is concentrated primarily in China and South Korea, with Albemarle, SQM, and POSCO Chemical among the significant non-Chinese producers.

those inputs generate. It also indicates the most direct channel through which raw material vulnerabilities translate into concrete industrial or defence risks[33].

Box 4: Downstream – EV batteries, rare earth magnets and semiconductors

Three downstream examples illustrate the range of strategic dependencies that raw materials policy must address.

In the **EV battery sector**, CATL (China) held approximately 37 % of the global market share in 2023, followed by BYD, LG Energy Solution, Panasonic and SK On. The Inflation Reduction Act's Section 30D ("clean vehicle credit") (see paragraph 3.2.3) was explicitly designed to reshape this downstream dependency by conditioning tax incentives on sourcing battery minerals from the United States or free trade agreement partners – a direct use of downstream demand policy to drive upstream and midstream diversification[34, 35];

In the **rare earth permanent magnet sector**, China produces approximately 90 % of global neodymium-iron-boron (NdFeB) magnets, which are indispensable for the electric motors of EVs, direct-drive wind turbines and precision defence systems. Beijing's April 2025 export controls on seven heavy REEs directly targeted this downstream dependency;

In the **semiconductor sector**, gallium, refined almost entirely in China, is the substrate for gallium nitride components used in the US Navy's air and missile defence radar. China's 2024 export restrictions on gallium were the first direct use of a semiconductor-critical minerals as a coercive trade tool against Western defence procurement[36].

Source: The authors, based on the sources in the footnotes.

2.4. Recycling and circularity as a cross-cutting dimension

Circularity operates as a **cross-cutting fourth dimension of the value-chain** framework, intersecting with all three principal stages. Recycling can partially substitute for upstream extraction by returning critical minerals from end-of-life products back into the supply chain; it can reduce midstream processing requirements by supplying materials in a form closer to the finished product; and it can support downstream manufacturers by offering a more geographically diversified and price-stable secondary supply source.

When commenting on CRM circularity, there are at least two distinct metrics[37], each measuring something different:

- End-of-life recycling rate (**EOL-RR**) is the percentage of a material in waste flows that is actually recycled[38]. It is measured from the output side, i.e. how much comes out of the recycling system relative to how much was thrown away. A material with a high EOL-RR is being recycled efficiently once it reaches the recycler.

[33] See Modern War Institute, Minerals, Magnets, and Military Capability: China's Rare Earth Weaponization Should Be a Wake-Up Call, West Point, July 2025. China produces approximately 90 % of global NdFeB rare earth permanent magnets.

[34] See SNE Research (2024), *Global EV Battery Market, January–December 2023*. CATL held approximately 37 % of global EV battery market share in 2023, followed by BYD (15.8 %), LG Energy Solution (13.6 %), Panasonic (6.4 %), and SK On (5.4 %).

[35] See US Congress, Inflation Reduction Act of 2022, Section 30D (Clean Vehicle Credit): vehicles qualify for the full USD 7 500 credit only if a specified percentage of battery minerals originates from the US or FTA partners, with thresholds increasing annually.

[36] See USGS, Mineral Commodity Summaries 2025, 2025. Gallium is used in gallium arsenide and gallium nitride (GaN) semiconductors for RF electronics, radar, and 5G communications. The US AN/SPY-6 air and missile defence radar relies on GaN components.

[37] Talens Peiro, L., Nuss, P., Mathieux, F. and Blengini, G., JRC Technical Reports, Towards Recycling Indicators based on EU flows and Raw Materials System Analysis data, 2018.

[38] See Raw Materials Information System, Recycling's contribution to meeting materials demand, 2018.

But it says nothing about how much of the material is still in products in use, or how much of the economy's total demand it actually covers;

- End-of-life recycling input rate (**EOL-RIR**) is the input of secondary material from old scrap to the total input of materials (primary and secondary). It is regarded as a robust measure of recycling's contribution to meeting materials demand. Because of increases in material use over time and long in-use lifetimes for some products, many EOL-RIR values are lower than the corresponding EOL-RRs. In other words, a material can be recycled well when it gets collected, yet still supply only a small fraction of total demand simply because so much of it is locked up in products still in use.

The EOL-RIR for most critical minerals remains structurally low: lithium recycling supplied less than 1 % of global demand in 2023, cobalt approximately 16 %, and nickel approximately 4 %[39].

This low EOL-RIR reflects in part a **timing effect**: lithium-ion battery deployment scaled massively from roughly 2010 onwards. Most of those batteries have a calendar life of 10–15 years, therefore meaningful volumes have yet to reach end-of-life. The recycling input rate remains low simply because the feedstock does not yet exist at scale. A second structural factor is that the historical uses of these materials (lithium in ceramics and greases, cobalt in pigments and catalysts) were dissipative by nature and left no recoverable stock. Technical barriers in collection infrastructure and high-purity recovery from complex chemistries are real but, at present, secondary constraints: they would matter more if the feedstock volumes were significant.

Box 5: Recycling – Redwood Materials, Li-Cycle and the CRMA recycling target

In the US, Redwood Materials is constructing a battery materials campus in Nevada targeting 100 GWh of annual recycling capacity, with the recovery of lithium, cobalt, nickel and copper from end-of-life batteries and manufacturing scrap[40]. The IRA's Section 45X ("Advanced Manufacturing Production Credit") provides a financial incentive for domestic production of battery components, including those derived from recycled materials, directly connecting circular economy objectives to the downstream manufacturing incentive architecture.

Li-Cycle Holdings operated a spoke-and-hub model targeting recovery of more than 95 % of battery materials, including lithium, cobalt, nickel, manganese and copper, from lithium-ion batteries, with spoke facilities accepting battery waste and hub facilities producing battery-grade outputs. However, while listed since 2021 on the New York Stock Exchange, it faced some financial difficulties in 2025 and its assets were acquired by Glencore[41]. This demonstrates the commercial viability problem in battery recycling midstream.

In the EU, the Critical Raw Materials Act 2024[42] sets a binding target that at least **25 %** of EU annual SRM consumption should derive from recycled sources by 2030. This attempts to imbed circularity as a quantified policy objective rather than an aspirational principle[43].

Source: The authors, based on Redwood Materials campus in Nevada and Li-Cycle Holdings.

39 See IEA, Global Critical Minerals Outlook 2024, 2024.

40 See Redwood Materials, Corporate disclosures 2024: Redwood Materials is constructing a battery materials campus in Nevada with an annual capacity of 100 GWh, targeting recovery of lithium, cobalt, nickel, and copper from end-of-life batteries and manufacturing scrap.

41 See Glencore, Li-Cycle, Li-Cycle has been acquired by Glencore Plc., 2025.

42 See Li-Cycle Holdings, Corporate disclosures 2023-2024: Li-Cycle operates a spoke-and-hub recycling model targeting recovery of 95%+ of battery materials including lithium, cobalt, nickel, manganese, and copper from lithium-ion batteries.

43 Article 5 of the CRMA sets a target that at least 25 % of EU annual consumption of strategic raw materials should come from recycled sources by 2030.

2.5. Dynamic criticality: why supply-chain analysis must be continuous

A mineral's criticality is not a fixed property – it is a dynamic designation that shifts as technology evolves, demand structures change, new deposits are discovered or depleted and geopolitical conditions alter the availability of supply. A mineral that was considered non-critical a decade ago may become strategically indispensable as it finds essential application in an emerging technology; conversely, a mineral once deemed critical may see its strategic importance diminish if substitution advances occur or if new processing routes reduce dependence on a concentrated supply base. A mineral's criticality may therefore change over time as technology advances and other factors lead to changing supply and demand[44].

Three mechanisms drive changes in criticality over time:

- First, **technological change** affects both the demand side and the substitutability of a mineral: the emergence of EV batteries transformed lithium, cobalt, graphite and nickel from industrial commodities into materials of acute strategic concern within a single decade, while the development of lithium-iron-phosphate cathode chemistry began to reduce cobalt dependence. Change in the criticality of a mineral due to evolving technology highlights a reason to repeatedly analyse supply-chain risks over short time periods (such as one-year or five-year periods)[45];
- Second, **supply-side disruptions** — including the imposition of export controls by dominant producing nations, the opening or closure of major mines, or shifts in the geopolitical relationships that underpin trade — can alter a mineral's supply-risk profile rapidly and without warning;
- Third, policy-driven **demand shifts**, such as national clean-energy mandates or domestic content requirements attached to industrial subsidies, can generate sudden changes in demand profiles that no static assessment would have anticipated.

We observe that both the US and the EU recognise the need for a continuous assessment of criticality and have embedded this requirement in their respective CRM policies:

- The USGS's statutory obligation under the Energy Act of 2020 to update the critical minerals list at least **every three years**, and the DOE's commitment to revise its critical materials assessment on a comparable cycle, reflect precisely this recognition that criticality is a moving target requiring continuous analytical attention[46];
- On the EU side, the CRM list has been revised at three-year intervals over the past decade (the most recent revisions were in 2011, 2014, 2017, 2020 and 2023). The SRM list was first issued in 2024. The 2024 Critical Raw Materials Act formalised the periodic review of both lists, stating in its Articles 3 and 4 that they would be reviewed and, if necessary, updated by 24 May 2027, and **every three years** thereafter.

[44] See CRS, Critical Minerals Resources: National Policy and Critical Minerals List, Report R47982, January 2026.

[45] See DOE, Critical Materials Assessment, July 2023.

[46] See USGS, Final 2025 List of Critical Minerals, 90 Federal Register 50494, 7 November 2025; DOE, Critical Materials Assessment, July 2023.

2.6. Sectoral applications: defence, space, semiconductors, transport and clean energy

The value-chain analytical framework is most relevant when applied at the sectoral level. Different end-use industries place structurally distinct demands on critical raw materials at different stages of the supply chain, and the consequences of disruption differ profoundly in their economic scale, strategic urgency and reversibility[47].

2.6.1. Defence and national security

The defence sector's dependence on critical raw materials is qualitatively distinct from that of any other sector: substitution is largely infeasible within operationally relevant timescales and supply disruption does not merely raise costs but directly degrades military readiness:

- Approximately 78 % of US weapons programmes contain components dependent on rare earth permanent magnets. The NdFeB magnet enables electric motors in aircraft actuators, missile guidance, electronic warfare platforms, naval radar microwave tubes and propulsion drives in nuclear submarines[48]. The DOD's mine-to-magnet strategy, backed by approximately USD 540 million in investment since 2020, aims to establish a fully domestic rare earth supply chain by 2027. China's April 2025 export controls on seven heavy rare earth elements caused a 74 % year-on-year drop in magnet shipments within weeks[49];
- Cobalt is essential to jet engine superalloys operating at temperatures above 1 400 °C;
- Germanium is indispensable for infrared optics in guided munitions including the Javelin and TOW systems; China's December 2024 ban on germanium exports to the US removed a critical input to both night-vision and space-based optical systems simultaneously.

2.6.2. Space industries

The space industry presents a CRM supply chain challenge that differs from other sectors in two structurally important respects. First, performance specifications for space-grade materials are markedly more demanding than for terrestrial applications: materials must withstand thermal cycling between -150 °C and +150 °C, extreme radiation and atomic oxygen erosion in low Earth orbit. Second, once a satellite is deployed, the mineral dependencies embedded in its components cannot be remediated: a supply disruption affects only the ability to manufacture replacements or next-generation systems.

Key dependencies include gallium arsenide and germanium for multi-junction solar cells, gallium nitride for high-power radiofrequency electronics, germanium for infrared optics (including the James Webb Space Telescope's mid-infrared instrument), niobium C-103 alloys for rocket nozzle assemblies, and xenon/krypton as ion thruster propellants.

[47] See IEA, Global Critical Minerals Outlook 2025, 2025.

[48] See US Government Accountability Office GAO, Critical Materials: Action Needed to Implement Requirements That Reduce Supply Chain Risks, .GAO-24-107176, September 2024.

[49] See SFA Oxford, Critical Minerals for Space and Technology, 2025.

China's December 2024 germanium export ban simultaneously constrained satellite solar cell production, infrared optical component fabrication and space-grade compound semiconductor manufacturing[50].

2.6.3. Semiconductors and advanced electronics

Semiconductors hold a unique position in the CRM value chain: they are simultaneously a downstream product manufactured from processed critical minerals, and a critical input to every other sector in this study. The number of minerals essential to chip manufacturing has expanded from approximately 12 in the 1980s to more than 60 by 2025[51]. China controls approximately 98 % of global gallium production and 60 % of germanium production. In August 2023, China's export licensing requirements caused gallium shipments to fall from nearly 6 900 kg per month to zero within weeks, removing approximately 90 % of global supply from international markets. The USGS' 2024 probabilistic methodology estimates a potential USD 3.4 billion net decrease in US GDP from a simultaneous gallium-and-germanium export ban (germanium alone: USD 0.4 billion)[52]. Although enacted before China's 2023 export controls, the CHIPS and Science Act[53] constitutes the cornerstone of the U.S. strategy to strengthen domestic semiconductor manufacturing, providing USD 52.7 billion for manufacturing, research and development, and workforce development.

2.6.4. Transport and electromobility

The electrification of transport is the single largest driver of the growing demand for critical battery and magnet minerals. A standard 75 kWh NMC[54] battery pack requires approximately 8–10 kg of lithium, 35 kg of nickel, 20 kg of manganese, 13 kg of cobalt and 65 kg of graphite; EV motors additionally require 1-2 kg of rare earth permanent magnets. IEA projections in a Paris Agreement-aligned scenario indicate that lithium demand could grow by a factor of 40 between 2020 and 2040; graphite, cobalt and nickel could grow by a factor of 20-25; and rare earth elements could see a sevenfold increase[55].

The IRA's Section 30D EV ("clean vehicle credit") and Section 45X ("Advanced Manufacturing Production Credit") are the primary US demand-side and supply-side instruments. The structural challenge is that domestic gigafactory investment without secure midstream supply creates dependency at a different point in the chain: a domestic cell manufacturer dependent on Chinese cathode material remains structurally vulnerable even if nominally "domestic"[56].

2.6.5. Clean-energy and power systems

Wind, solar, hydrogen and grid infrastructure are mineral intensive[57]. Reaching the Paris Agreement goals would require clean-energy technologies to account for over 40 % of total demand for copper and rare earth elements, 60–70 % for nickel and cobalt, and almost 90 % for lithium, by 2040.

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[50] See USGS, Methodology and technical input for the 2025 US list of critical minerals, August 2025.

[51] See UNCTAD, Critical minerals, critical decisions: Industrial policy for the energy transition, UNCTAD/GDS/2025/5, 2026.

[52] Ibid.

[53] US Congress, H.R.4346 - CHIPS and Science Act, 117th Congress, 2022.

[54] NMC stands for 'nickel manganese cobalt', materials that are commonly used in lithium-ion batteries as the cathode.

[55] See IEA, The Role of Critical Minerals in Clean Energy Transitions, 2021.

[56] See UNCTAD, Critical minerals, critical decisions: Industrial policy for the energy transition, UNCTAD/GDS/2025/5, 2026.

[57] See IEA, The Role of Critical Minerals in Clean Energy Transitions, 2021.

A 2025 peer-reviewed study projects an increase, by a factor of 6.4, in the annual demand for 21 critical minerals in order to achieve the 2030 renewable energy targets. The supply-demand imbalances are most acute for graphite, cobalt, lithium, tellurium and rare earth elements.

China accounts for approximately 91 % of global rare earth separation and refining, approximately 80 % of global polysilicon production and nearly half of global copper refining.

The IEA Global Critical Minerals Outlook 2025 notes that the average market share of the top three refining nations rose to 86 % in 2024, with almost all supply growth coming from the single top supplier[58].

2.7. Structural conclusions: the midstream gap as the master vulnerability

The sectoral analysis produces a consistent structural finding that warrants explicit statement: for every sector examined, the dominant CRM supply chain vulnerability is not at the upstream stage, where geological reserves are generally distributed across multiple countries, but at the midstream stage, where processing, refining, separation and intermediate manufacturing are concentrated in a small number of jurisdictions, principally China. Supply chain diversification strategies that focus exclusively on upstream resource development will not resolve the structural vulnerability unless coupled with equivalent investment in midstream processing capacity. The analytical framework developed in this section therefore provides the diagnostic vocabulary for all substantive policy analysis in the sections that follow: **the distinction between upstream, midstream and downstream is not merely descriptive but is the structural precondition for identifying where intervention will generate systemic leverage**[59].

[58] See Chen et al., Critical mineral bottlenecks constrain sub-technology choices in low-carbon energy deployment, 2025; IEA, Global Critical Minerals Outlook 2025, 2025.

[59] See IEA, With new export controls on critical minerals, supply concentration risks become reality, IEA Commentaries, October 2025.

3. US RAW MATERIAL STRATEGY

KEY FINDINGS

The United States'approach to critical raw materials has developed through a multilayered institutional architecture combining executive direction, technical classification, legislative support and multi-agency implementation.

Within this system, **executive instruments play a key role**. Executive orders (EOs) prioritise critical minerals and coordinate action across government, whereas the **legislative branch provides the legal and financial backbone**. The US Congress sets the framework and funding, linking critical minerals to industrial, energy and security objectives.

- However, **implementation still depends on a fragmented structure**, in which the DOE leads industrial development, the DOD manages security exposure, the Department of the Treasury provides fiscal incentives and the State Department and USTR handle external engagement. The White House sets priorities and has a coordinating role. The creation of the NEDC in 2025 acknowledged that this coordination had to date been insufficient.

The dominant policy rationale has changed over time, increasingly pointing to a more directive model.

- Between 2017 and 2024, the policy framework was built, with a consolidated role for the USGS and the Energy Act of 2020. Supply chain integration was targeted via the IIJA, CHIPS Act and IRA, and a focus on permitting reforms and diversification via partner countries;
- New instruments have been added during the second Trump administration: equity investments, strategic reserves, demand coordination through Project Vault and a reference pricing framework through FORGE. Bilateral agreements and multilateral partnerships now form an external architecture designed to extend domestic supply-chain objectives beyond US borders.

Over the past decade, critical raw materials have moved to the centre of US industrial, energy and security policy. Growing concerns over import dependence, highly concentrated supply chains and geopolitical competition have forced successive US administrations together with Congress to develop new policy instruments in this area.

3.1. Understanding the US governance architecture of critical raw materials

The United States'approach cannot be considered a single coherent strategy. It has developed gradually through executive actions, legislation, industrial incentives and, more recently, international partnerships, several of which remain at an early stage of implementation. The policy has nonetheless moved beyond its original remit. Securing access to raw materials remains an important objective, but concerns about processing capacity, industrial resilience, and the wider restructuring of supply chains have become equally central. Understanding the US governance architecture for critical raw materials

The US policy architecture for CRM is organised across several institutions, each having different functions and mandates, reflecting both the constitutional division of powers in the United States and the fact that CRM policy is now closely linked to broader industrial, energy and security objectives.

3.1.1. Strategic direction and coordination

The Executive Office of the President (**EOP**) has a coordinating role within the US system. It sets strategic priorities and assigns responsibilities across departments and federal agencies. Given the considerable autonomy of these institutions, the EOP's role is primarily to support and coordinate implementation across different parts of the administration. The President exercises this authority mainly through EOs, which have increasingly been used to shape critical minerals policy. In practice, EOs have been used to accelerate permitting procedures and strengthen coordination across agencies. They have also played an important role in placing supply security more firmly within the industrial and national security logic.

Executive Order 14017 of 2021 brought together previously fragmented initiatives under a White House-led supply-chain review and linked critical minerals more explicitly to industrial resilience and supply-chain security (key executive orders are analysed further in Section 3.3). Much of this approach built on existing practices, but EO 14017 provided a clearer strategic framework. Coordination across agencies nevertheless remained uneven.

Executive authority is also reinforced by instruments such as the Defense Production Act (DPA), which allows the federal government to prioritise contracts, allocate materials and support production in strategically important sectors. The DPA was not originally designed for CRM policy, but it has been increasingly used to address policy needs that more targeted legislation has not yet addressed[60].

More recently, the creation of the National Energy Dominance Council (**NEDC**) in 2025 acknowledged that coordination had to date been insufficient. As a permanent inter-agency body within the EOP with a specific mandate over energy and critical minerals, it has moved the current administration closer to a centralised implementation model.

3.1.2. Definition and mineral intelligence

The Department of Interior (**DOI**), mainly through the **USGS**, performs a more technical function within the federal system. Under the Energy Act of 2020, the USGS maintains and periodically revises the federal list of critical minerals – designation on this list triggers policy responses across agencies, from DOD procurement priorities to IRA sourcing thresholds.

The USGS may not exercise direct regulatory or financing functions, but the agency's analytical work in producing the federal list provides the evidentiary basis for policy decision. Geological mapping, supply-risk assessments, import dependence data and market analysis produced by the agency are widely used across the administration. The practical significance of the USGS's function therefore depends on how other institutions respond to its outputs. It still plays an important role, however, in determining which materials are treated as critical and in assessing potential supply risks and strategic vulnerabilities[61].

3.1.3. Industrial development and technology

The Department of Energy (**DOE**), by contrast, acts as the main industrial, technological and supply-chain development actor. Its role has expanded through critical materials assessments, research initiatives and programmes supporting processing, recycling and clean-energy manufacturing.

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60 See US Congress, Defence Production Act of 1950, as amended (50 U.S.C. 4501 et seq.) and CRS, Defence Production Act of 1950: History, Authorities and Considerations for Congress, 2023.

61 CRS, Critical Mineral Resources: The US Geological Survey (USGS) Role in Research and Analysis report R48005, February 2025, and CRS, Critical Mineral Resources: National Policy and Critical Minerals List, report R47982, January 2026.

It also provides substantial funding to strengthen domestic production[62] and plays a technical role in project evaluation. In practice, the DOE now sits at the core of efforts to align raw materials policy with industrial strategy, particularly in areas such as batteries, semiconductors and clean-energy technologies.

Discussions on critical minerals policy often underestimate the role of technical and engineering capacity. The US also experienced a long-term decline in domestic mining activity and mining engineering education. The number of accredited mining and mineral engineering programmes in the US dropped from 25 in 1982 to 14 by 2020[63]. Prominent programmes at institutions such as the University of California, Berkeley and Columbia University were closed entirely. Industry and academics have pointed to falling numbers of mining engineering programmes and graduates over recent decades, together with concerns over ageing technical workforces and shortages of specialised expertise[64]. Nevertheless, the US maintained a broader pool of technical expertise and academic research linked to geological sciences and mineral processing though agencies such as the USGS and DOE specialised engineering schools and defence-related industrial ecosystems. Legislative initiatives discussed later in this section, notably the Energy Act of 2020 and the CHIPS and Science Act, further reinforced the research and technical dimension of US policy and helped preserve scientific and engineering capabilities relevant to industrial and technological competitiveness.

3.1.4. Defence and security

The Department of Defense[65] (**DOD**) plays a central role in integrating national security considerations into critical raw materials policy. Through the National Defense Stockpile (**NDS**) and related defence-industrial instruments, it treats certain mineral dependencies not simply as market vulnerabilities, but as potential risks to military readiness and the resilience of the defence-industrial base.

More recently, the DOD has expanded support for domestic rare earth separation, processing and magnet production projects through the DPA authorities and related industrial programmes, including major investments in projects such as MP Materials[66]. This growing involvement is linked to broader concerns in the United States over dependence on external manufacturing capabilities, particularly in sectors linked to advanced military and defence technologies.

3.1.5. Fiscal incentives, financing and investments

The Department of the Treasury, together with the Internal Revenue Service (**IRS**), has assumed an increasingly important role through fiscal design, compliance and implementation of tax-based industrial incentives. By setting sourcing thresholds, processing requirements, foreign entity restrictions and eligibility rules for clean-technology tax credits under the Inflation Reduction Act (**IRA**), it influences both investment decisions and the organisation of supply chains. In this way, the Treasury acts as a gatekeeper between strategic objectives and commercially meaningful incentives[67].

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62 See DOE, Energy Department Announces $355 Million to Expand Domestic Production of Critical Minerals and Materials, National Energy Technology Laboratory, notice of 17 November 2025.

63 See Society for Mining, Metallurgy & Exploration, Maintaining the Viability of U.S. Mining Education, 2022.

64 Thomas Hale, Center for Strategic and International Studies (CSIS), The United States Needs More than Mining Engineers to Solve Its Critical Minerals Challenges, , 8 May 2023

65 In September 2025, Executive Order 14347 (titled "Restoring the United States Department of War") authorised the use of 'U.S. Department of War' as a secondary name for the Department of Defense. The "Department of Defense" remains the statutory name.

66 See Brownstein Hyatt Farber Schreck, US Expands Critical Minerals Financing and Bilateral Partnerships under Trump, 10 November 2025.

67 Deberdt R., IFRI, The United States' Strategy for Securing Critical Minerals Supplies Can It Meet the Needs of the IRA?, 2024.

The Export-Import Bank of the United States (**EXIM**), notably through its Supply Chain Resilience Initiative and the US International Development Finance Corporation (**DFC**) support mining, processing and broader supply-chain projects through loans, investment partnerships and risk insurance.

Their roles have expanded in line with efforts to secure access to critical minerals and strengthen supply-chain resilience.

3.1.6. External engagement

The external dimension of the strategy involves two principal actors with rather complementary mandates. The US Department of State leads the diplomatic and partnership-building dimension. Through minerals diplomacy and coordination with partner countries, it has sought to diversify supply chains beyond highly concentrated sources and to strengthen cooperation with like-minded partners. This role became more visible through the Minerals Security Partnership (**MSP**) and later through initiatives such as the Forum on Resource Geostrategic Engagement (**FORGE**), which goes beyond the MSP's earlier focus on project coordination, placing more emphasis on policy alignment, pricing and trade-related tools (see Section 3.4).

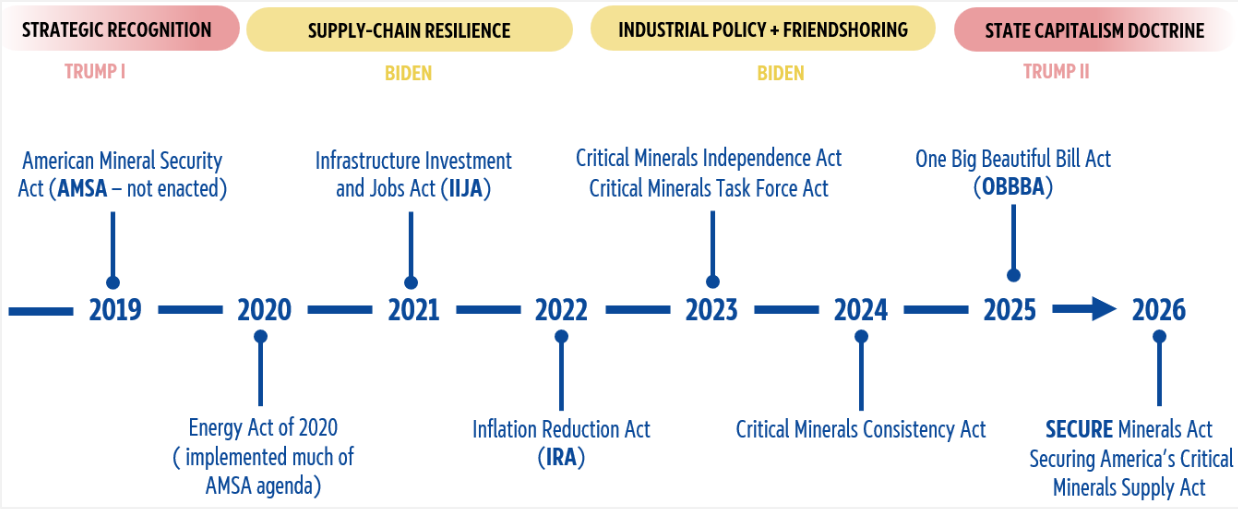
The Office of the United States Trade Representative (**USTR**), although institutionally located within the EOP, operates with a significant degree of functional autonomy in the trade domain. Its relevance for critical minerals policy has grown, particularly through its role in negotiating targeted critical minerals agreements (CMAs), such as the agreement concluded with Japan in March 2023[68]. Trade policy is now used more directly as an instrument of supply-chain resilience and in support of strategic objectives, rather than operating as a separate policy domain (see Section 3.4). The USTR increasingly links external economic relations with strategic resource policy.

3.1.7. Legislative authority and oversight

Congress provides the legal framework, funding and oversight for US critical minerals policy. It links critical minerals policy to broader objectives such as industrial competitiveness, energy security and defence, mainly through legislation and appropriations. Since 2017, both chambers (the Senate and the House of Representatives) have played an important role in shaping the direction of this policy, sometimes alongside the executive branch and at times in tension with it.

[68] Office of the United States Trade Representative (USTR), United States and Japan Sign Critical Minerals Agreement, Press Release, 28 March 2023.

Figure 3: Major US legislative initiatives on critical minerals, 2019–2026



Source: The authors, based on US congressional support sources.

Note: The American Mineral Security Act, S.1317 was proposed in 2019 but did not pass into law. Its substantive provisions were subsequently incorporated into the *Energy Act of 2020.* A successor bill, the *Restoring American Mineral Security Act of 2025* (S.2839, 119th Congress), introduced on 17 September 2025, remains pending before the Senate Committee on Finance.

The **Senate** has influenced critical minerals policy primarily through legislation, committee hearings, oversight of executive agencies and the confirmation of senior officials in this field. The Senate Committee on Energy and Natural Resources plays a leading role in this area, as it has direct jurisdiction over mining policy and the management of domestic mineral resources.

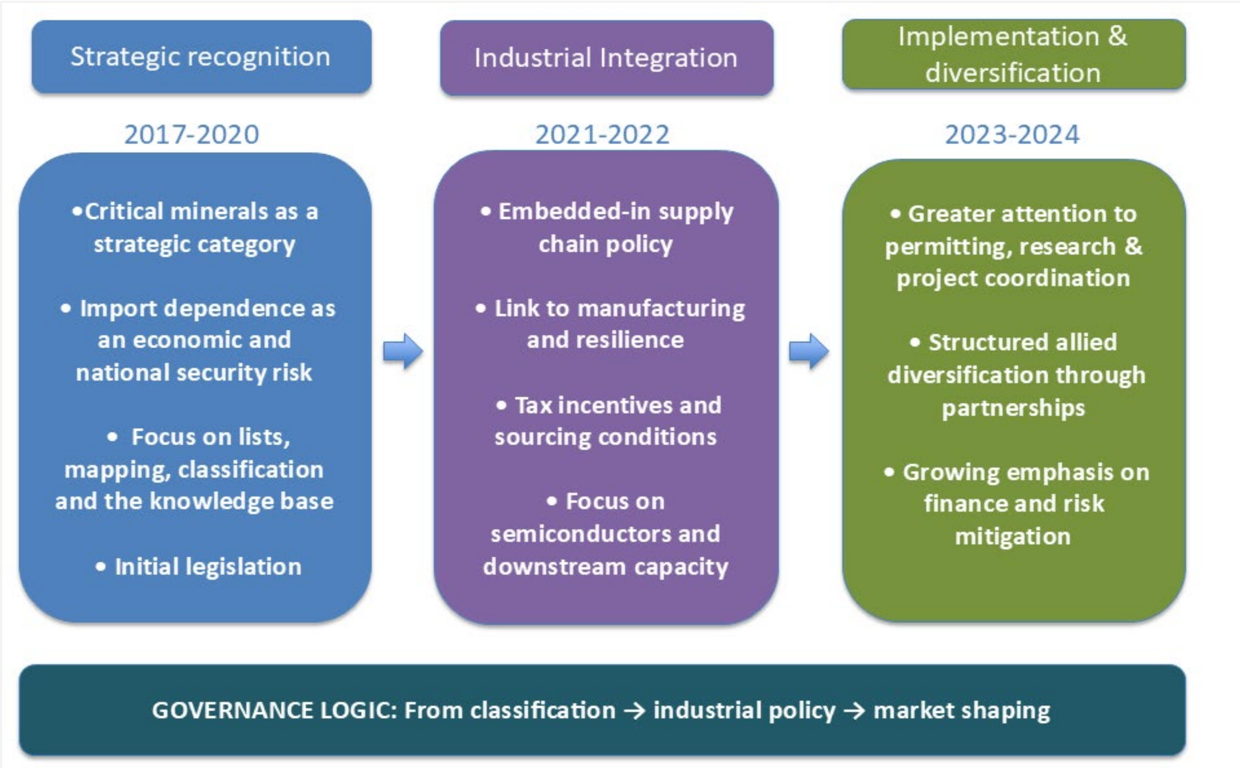
In the **House of Representatives**, the Natural Resources Committee and the Energy and Commerce Committee are the main bodies dealing with critical minerals. The bipartisan House Critical Materials Caucus, created in 2021, has also contributed to keeping critical minerals high on the congressional agenda in both domestic and foreign policy discussions.

3.2. Building the US critical minerals policy (2017–2024)

Between 2017 and 2024, the US critical minerals policy evolved from a relatively narrow concern regarding supply vulnerability and import dependence into a broader strategy linking critical minerals to industrial resilience, defence preparedness and geopolitical competition. This evolution did not initially result in a single, fully coherent strategy[69]. Rather, it developed incrementally through executive action, and consecutive successive legislation initiatives. By the end of 2024, however, the United States had moved further away from a purely market-driven approach.

[69] Peterson Institute for International Economics, The draft US critical minerals list: Clearer priorities, persistent challenges, September 2025.

Figure 4: The changing logic of US critical minerals policy, 2017-2024



Source: The authors.

3.2.1. Phase 1: strategic recognition and framework-building (2017–2020)

EO 13817, adopted in 2017, established the federal critical minerals strategy and created the basic framework and definition that later policies relied upon.

It consolidated the role of the USGS as the technical authority responsible for the critical minerals list and put more emphasis on identifying vulnerabilities, defining categories and improving the knowledge base rather than on directly shaping markets or industrial outcomes.

This strategic framing further expanded with EO 13953 (2020), which presented dependence on minerals from foreign adversaries as a national security risk and encouraged the use of emergency and trade-related tools.

In parallel, Congress began to build the first legislative layer of this strategy. The American Mineral Security Act (AMSA) of 2019[70] played an important agenda-setting role, while the Energy Act of 2020[71] established a broader statutory framework for critical materials research, geological mapping, processing, recycling and substitution. These measures signalled that supply risks could not be addressed through extraction alone. Legislative action at this stage remained enabling rather than interventionist in nature. Its purpose was to lay the institutional foundations of a federal response and not to shape markets or industry directly.

70 US Congress, American Mineral Security Act of 2019, S.1317, 116th Congress. It did not pass into law but it was incorporated into Section 7002 of the *Energy Act of 2020*

71 US Congress, Energy Act of 2020, Public Law 116-260.

3.2.2. Phase 2: integration into supply-chain resilience and industrial policy (2021–2022)

A substantial shift occurred from 2021 onward, when critical minerals policy became integrated into a wider supply-chain resilience agenda. EO 14017 institutionalised a whole-of-government review of critical supply chains, including critical minerals. Compared with earlier measures focused primarily on identifying vulnerabilities and establishing the policy framework, EO 14017 linked critical minerals explicitly to domestic manufacturing and broader debates on strategic autonomy.

The Infrastructure Investment and Jobs Act (**IIJA**) of 2021 expanded federal support for domestic battery supply chains, including funding for mineral processing, recycling and manufacturing. It also strengthened geological mapping efforts, including through the Earth Mapping Resources Initiative (Earth MRI) intended to improve understanding of domestic mineral resources.

The CHIPS and Science Act of 2022, linked critical minerals closely to technological competitiveness, particularly through its emphasis on semiconductor production and support for advanced materials research.

Nevertheless, the most consequential step in this stage was the Inflation Reduction Act (**IRA**) of 2022. Although primarily presented as a climate and energy measure, it introduced strong supply-chain incentives, including local content requirements for electric vehicle tax credits. These new provisions directly influenced corporate investment and sourcing decisions by creating incentives for domestic production and sourcing from partner countries.

3.2.3. Phase 3: implementation, coordination and system constraints (2023–2024)

By 2023-2024, the basic framework of US mineral policy had largely been established and attention turned to implementation challenges. Legislative and executive initiatives during this period focused primarily on regulatory bottlenecks and practical obstacles to the development of domestic supply chains.

Permitting emerged as one of the most visible obstacles. Mining and processing projects often faced lengthy review procedures involving multiple federal and state agencies.

Proposals such as the Critical Mineral Independence Act of 2023[72] sought to simplify permitting procedures and improve coordination across different levels of government. The legislation also reflected growing concern over the concentration of refining and processing capacity abroad.

Several proposals also attempted to address coordination gaps across federal agencies. The Intergovernmental Critical Minerals Task Force of 2023[73] focused on administrative barriers affecting critical minerals projects. The Critical Mineral Consistency Act[74] targeted inconsistencies of federal definitions of criticality, particularly between the US Geological Survey (USGS and the DOE). Moreover, executive instruments were used more actively during this period. Provisions under DPA were increasingly used more often to support selected projects linked to critical minerals processing and battery materials, giving a new impetus to midstream and downstream capabilities.

[72] US Congress, Critical Mineral Independence Act of 2023, H.R. 8440, 118th Congress.

[73] US Congress, Intergovernmental Critical Minerals Task Force Act, H.R. 4551, 118th Congress.

[74] US Congress, Critical Mineral Consistency Act, H.R. 8446, 18th Congress; the act was reintroduced as Critical Mineral Consistency Act, H.R. 755, 119th Congress.

Table 2: Legislative initiatives 2017-2024

Year	Legislative act	Core contribution
2019	American Mineral Security Act[75]	Agenda-setting; requirement for a regularly updated critical minerals list; mandate for inter-agency coordination
2020	Energy Act	Statutory framework for research, geological mapping, processing, recycling; strengthened DOE role
2021	Infrastructure Investment and Jobs Act	Battery supply-chain funding; Earth MRI expansion; mineral processing and recycling support;
2022	CHIPS and Science Act	Research support for semiconductor-critical materials; strengthening of the National Science Foundation;
2022	Inflation Reduction Act	Sourcing requirements; 45X production credit; FEOC restrictions; Treasury as eligibility gatekeeper;
2023	Critical Minerals Independence Act	Permitting streamlining; federal-state coordination; domestic processing expansion
2023	Intergovernmental Critical Minerals Task Force	Coordination mechanism for overlapping jurisdictions
2024	Critical Minerals Consistency Act	Alignment of USGS and DOE criticality definitions

Source: The authors. Note: for detailed provisions see Annex II.

Cooperation with partner countries also expanded during the same period. The Minerals Security Partnership (MSP) served as the main platform for cooperation with allied countries on supply diversification and strategic projects. The launch of the MSP Finance Network in 2024[76] reflected broader concerns over financing constraints affecting strategic-mineral projects and the need to mobilise investment across critical minerals value chains.

3.3. US critical minerals policy under the second Trump administration (2025–2026)

The second Trump administration clearly marks a more interventionist phase in the US critical minerals policy. Contrary to earlier initiatives described before, the emphasis has now shifted toward midstream investments and geopolitical competition over global supply chains. Growing concerns over the concentration of mineral processing capacity, particularly in China, as well as export restrictions and other trade measures has pushed supply-chain resilience in the forefront of US public debates. International supply chains, from now on, are treated as strategically critical systems to be organised through alliances, bilateral and multilateral agreements and stockpiling mechanisms.

[75] Did not pass as standalone legislation, its substantive provisions were subsequently incorporated into *Energy Act of 2020.*

[76] See Joint Statement on the Establishment of the Minerals Security Partnership Finance Network on 23 September 2024.

3.3.1. Executive coordination and centralisation

Since 2025, stronger executive coordination and centralisation have become more prominent. The new administration has relied extensively on EOs and newly created inter-agency coordination mechanisms to accelerate implementation and prioritise strategically important mineral projects.

The creation of the National Energy Dominance Council (NEDC) should be viewed within this context. Located within the EOP, the NEDC was designed to improve coordination across departments and establish a more centralised implementation model.

The increased use of EOs during 2025 (see Table 3) illustrates the more interventionist character of the new administration and its greater reliance on executive authority in developing industrial policy. At the same time, federal operational capacity has been reinforced to boost industrial development across the critical minerals value chain.

Measures adopted during this period placed particular emphasis on refining, separation and magnet production, underscoring the extent to which the United States still depends on Chinese processing capabilities. The administration also expanded its use of the DPA[77]. Although the instrument had already been used under previous administrations, it is now being applied in a more systematic manner to accelerate domestic processing projects and support investments linked to critical minerals.

[77] EO 14241, Immediate Measures To Increase American Mineral Production, 20 March 2025.

Table 3: Executive centralisation and acceleration instruments (2025–2026)

Year	Type	Measure	Main content	Strategic significance
2025	Executive order	EO 14154 – Unleashing American Energy	Directed departments and agencies to strengthen mineral supply chains, consider updates to the critical minerals list, accelerate geological mapping and identify barriers to domestic mining and processing.	Signals the shift from framework-building to faster implementation, resource mobilisation and supply-chain support.
2025	Executive order–Presidential Action	EO 14156 – Declaring a National Energy Emergency[78]	Directed agencies to use emergency authorities to facilitate identification, leasing, production, transport and refining of domestic energy resources, including critical minerals.	Recast critical minerals as part of a broader emergency-energy and production-security agenda.
2025	Executive order	EO 14213 – Establishing the National Energy Dominance Council	Created a high-level White House coordination body to accelerate inter-agency execution on energy policy, including critical minerals.	Institutionalised a more centralised and delivery-oriented coordination model.
2025	Executive order	EO 14241 – Immediate Measures to Increase American Mineral Production	Directed agencies to accelerate permitting and prioritise domestic mineral extraction projects.	Moved federal action toward direct production support, accelerated permitting and more active state-backed supply-chain development.
2025	Executive order	EO 14261 – Reinvigorating America's Beautiful Clean Coal Industry and amending EO 14241	Extended the scope of EO 14241 by directing the designation of coal as a mineral for the relevant purposes.	Broadened the resource-security logic and expanded the administration's strategic-mineral framing.
2026	Presidential Action	Presidential Proclamation (Section 232) – Adjusting imports of Processed Critical Minerals and their Derivative Products into the United States	Treated processed critical minerals imports as a national security issue under Section 232 and launched a framework for negotiated import adjustment.	Elevated processed critical minerals from a supply-chain concern to an object of active trade-security intervention. Processed critical minerals fully integrated into the Section 232 trade-security framework.

Source: The authors.

3.3.2. Congressional reinforcement since 2025

Congressional involvement has also strengthened since 2025. Legislative proposals introduced in this period place greater emphasis on supply security, industrial resilience and increased public support for strategically important sectors. In this context, congressional initiatives progressively target the stages of the value chain where the US remains structurally dependent on external actors, particularly in processing, refining and downstream manufacturing.

[78] The National Energy Emergency (EO 14156) was extended in January 2026.

A more operational approach to supply-chain development seems to emerge, with a particular focus on the full "mine to magnet" value chain.

The DOD assumed a more active role, by committing more than USD 400 million to rare earth separation, processing and magnet production projects, including support for MP Materials (see Box 3). This trend went even further in 2026 with a USD 1.6 billion investment framework linked to USA Rare Earth and related domestic magnet production initiatives[79].

Several proposals illustrate this evolution. The Rare Earth Magnet Manufacturing Production Tax Credit Act[80] seeks to strengthen domestic rare earth magnet production through targeted fiscal incentives. By contrast, the One Big Beautiful Bill Act (OBBBA)[81] reshapes the federal approach to critical raw materials through defence-related funding, changes to tax incentives and stricter restrictions on foreign entities. Securing America's Critical Minerals Supply Act of 2026[82] strengthened the role of the DOE in monitoring critical minerals supply chains and developing strategies to reduce vulnerabilities linked to foreign dependence or unexpected supply disruptions. Similarly, the Secure Minerals Act[83] established a strategic reserve mechanism for critical minerals aimed at strengthening domestic or allied supply chains.

Table 3: US congressional legislative action on critical minerals since 2025

Legislative act	Main content	Strategic direction
Rare Earth Magnet Manufacturing Production Tax Credit Act	Creates a production tax credit for rare earth magnets manufactured in the US.	Reinforces focus on midstream and downstream industrial capacity.
One Big Beautiful Bill Act (OBBBA)	Introduces a phase-out schedule for parts of the tax-credit framework relevant to critical minerals processing and advanced manufacturing.	Fiscal tightening within the broader implementation-and-supply-security phase.
Securing America's Critical Minerals Supply Act	Requires DOE to assess critical minerals and rare earth supply chains and develop strategies to address vulnerabilities and overreliance on adversarial nations.	Stronger supply-chain governance and security-oriented industrial planning.
SECURE Minerals Act	Further legislative push to reinforce strategic security and domestic control over critical minerals supply chains.	Strengthens the focus on strategic security and domestic control.

Source: The authors. Note: for detailed provisions see Annex II.

Developments in 2026 have also highlighted growing congressional assertiveness on transparency and oversight. Members of both chambers requested further explanations and documentation concerning the administration's private-sector investments in critical minerals projects, including the USA Rare Earth deal[84].

79 See USA Rare Earth Announces Letter of Intent with the U.S. Government, 26 January 2026.
80 US Congress, Rare Earth Magnet Security Act of 2025, H.R. 1496, 119th Congress.
81 US Congress, Public Law 119-21, One Big Beautiful Bill Act, H.R. 1, Public Law 119-21, 4 July 2025.
82 See Chairman of the House Committee on Energy and Commerce statement, 11 February 2026.
83 US Congress, SECURE Minerals Act of 2026, H.R. 7126, 119th Congress.
84 See US bets billions of dollars on unproven groups in rare earths deals, Financial Times, 30 March 2026.

These exchanges reflected unresolved tensions over transparency, environmental standards, the appropriate scale of public intervention and the growing role of the executive branch in directing investment decisions.

3.4. External dimension and diplomatic-security initiatives

A third distinctive feature of the post-2025 phase is the strengthening of the external dimension of US critical minerals policy. This external dimension should be understood as an extension of the broader shift identified in the previous sections towards more operational forms of supply-chain security. Earlier phases were more focused on domestic framework-building, industrial support and diversification. By contrast, the current phase places greater emphasis on the external organisation of supply security.

International supply chains are increasingly viewed as strategic systems that can be shaped through diplomacy, standards, financing instruments, reserve mechanisms and more targeted bilateral coordination. This gives **the State Department a more important role in the overall architecture**. As already noted in previous sections, it now serves as the main channel through which supply-chain policy is projected outward and aligned with broader economic-security objectives[85].

This external turn was also developed in parallel with a broader **plurilateral** shift. The G7 Critical Minerals Action Plan adopted in June 2025 is relevant in this respect, although it should not be perceived as a US instrument in itself. Its importance lies in the fact that it reflected a wider convergence among advanced economies around standards-based markets, capital mobilisation, partnerships and innovation.

It also highlights the need to anticipate shortages, coordinate responses to market disruption and support investment across critical minerals value chains. In that sense, it forms part of the broader context in which a more intervention-oriented understanding of external supply security has become easier to articulate.

3.4.1. From MSP to FORGE

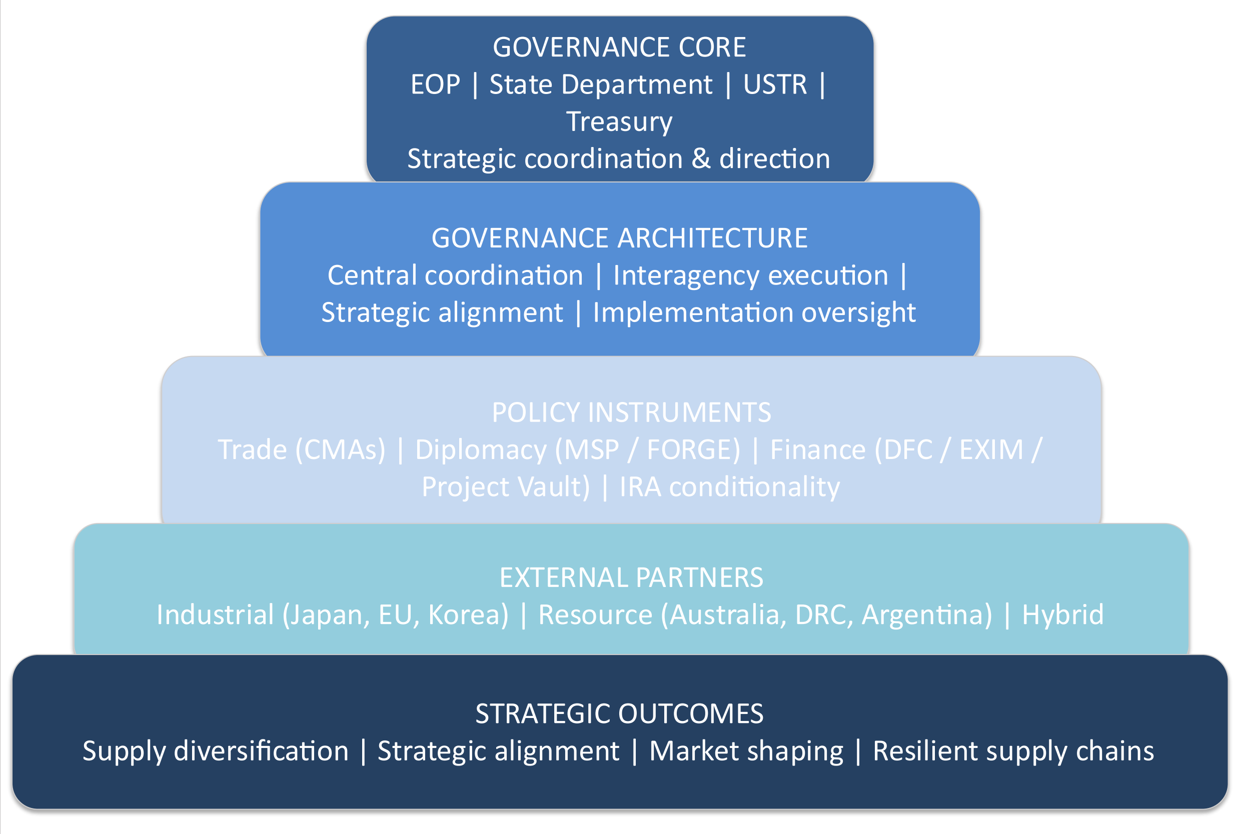
Within this broader shift, the move from the Minerals Security Partnership (**MSP**) to the Forum on Resource Geostrategic Engagement (**FORGE**) is particularly important. The MSP had already marked a significant step in the earlier phase of international diversification. As noted above, it emerged as the main platform for allied diversification and project coordination, while the MSP Finance Network showed that project development was increasingly being understood in financial as well as diplomatic terms. In that sense, the MSP belonged to the 2023-2024 phase in which the international dimension became more structured, but still focused mainly on coordination, standards and project support.

FORGE, by contrast, takes a **more interventionist approach**. It brings market, trade, investment and price-risk tools more directly into the policy framework. More broadly, it suggests a shift away from diversification as an objective in itself towards a more operational approach to supply security, where cooperation with trusted partners is increasingly structured through coordinated policy action[86].

[85] See White House, Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-based Growth, 2021; US Department of State, Minerals Security Partnership (MSP), 2021-2025; IEA, The Role of Critical Minerals in Clean Energy Transitions, 2021.

[86] Atlantic Council, US critical minerals policy goes collaborative with FORGE, 12 February 2026; US Department of State, official materials on FORGE;

Figure 5: US critical minerals external governance system



Source: The authors.

3.4.2. Project Vault, financing and the new strategic reserve logic

Project Vault is one of the clearest expressions of the operational approach. Announced on 2 February 2026, it was presented as a public-private partnership designed to strengthen access to critical minerals needed by advanced manufacturing and other civilian industries. It is not, however, a conventional stockpile. Rather, it combines elements of reserve policy with demand-side coordination, functioning as a **strategic buffer** intended to protect manufacturers against shocks, while also supporting more predictable access to supply. In this sense, Project Vault shows that reserves are now being used more directly to support supply security. This matters because it suggests that the US administration is relying not only on faster permitting, fiscal incentives and diplomatic outreach, but also on mechanisms intended to make resilient supply chains more commercially viable[87].

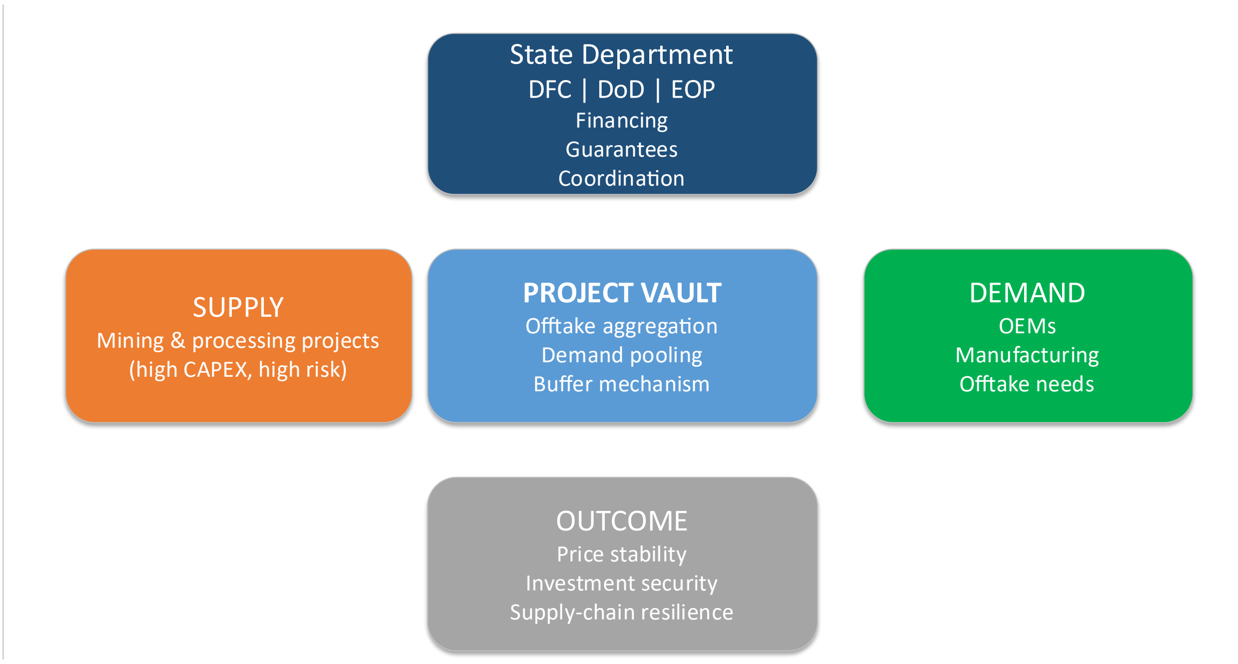
To improve effectiveness, the mechanism is designed to establish a direct link between public support and industrial demand. Unlike traditional reserve models, public authorities do not determine stockpiling priorities independently. Instead, commitments made by original equipment manufacturers (OEMs) signal the minerals required and the volumes needed for their production. When the reserves are released, they go directly to the companies that made the upfront purchase commitments, instead of being sold on the open market. Following the recent announcement, this market-led approach is expected to be supported by up to **USD 10 billion** from the EXIM, alongside approximately USD 1.67 billion in private equity.

[87] See EXIM, Week in Review: Project Vault and the U.S. Strategic Critical Mineral Reserve, 6 February 2026; Evan Musolino, Atlantic Council, Key questions on how Project Vault can secure minerals supplies, 17 February 2026.

The mechanism aims to address a persistent coordination gap in the sector. Upstream projects often struggle to secure financing without predictable demand. At the same time, downstream manufacturers remain reluctant to commit in the absence of reliable future supply[88].

Project Vault therefore matters for three main reasons. First, it extends reserve logic beyond the traditional defence-centred stockpile model. Second, it seeks to address one of the main structural weaknesses of critical minerals markets outside China, namely weak demand certainty and high price volatility. Third, it shows that resilience-building is being pursued in a more active way. It is therefore better understood as a transitional buffer that stabilises markets while alternative supply chains are being developed.

Figure 6: Project Vault as a demand-anchoring and market coordination mechanism



Source: The authors.

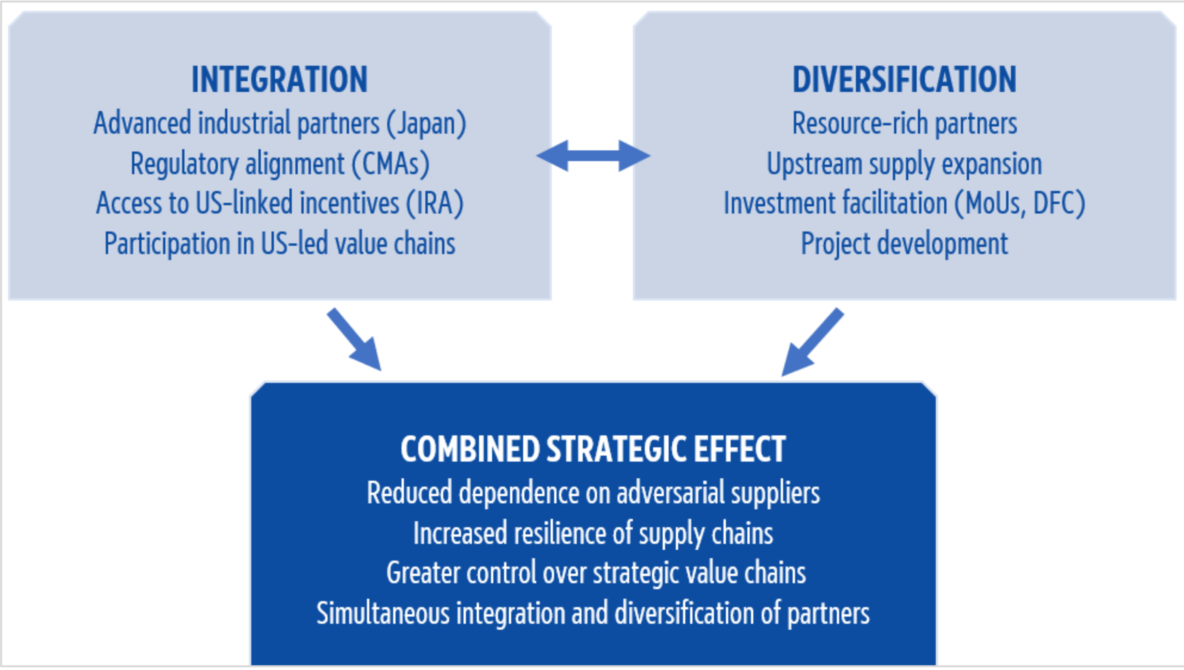
This financial architecture does not rely on a single instrument. While Project Vault addresses demand-side uncertainty by anchoring offtake expectations, financing tools, particularly those deployed through the DFC, operate on the supply side by reducing investment risk. Taken together, they help bridge the gap between capital and production by making projects both bankable and commercially viable[89].

The DFC supports mining and processing projects in partner countries through equity investments, loans and political risk insurance, particularly in emerging and resource-rich economies, linking strategic priorities more directly to investment decisions.

88 See CSIS, Project Vault: A Minerals Security Backstop, 11 February 2026; and Evan Musolino, Atlantic Council, Key questions on how Project Vault can secure minerals supplies, 17 February 2026.

89 See DFC, Annual Reports 2023–2025, and American Journal of International Law. 2025; 119(1):168-174, The United States Takes Actions to Secure Supply Chains for Critical Minerals.

Figure 7: Dual logic of US external strategy



Source: The authors.

Table 4: External policy mapped across the value chain

Stage	Instruments	Key actors	Function
Upstream (extraction, mining)	MoUs DFC financing MSP project pipeline Geological cooperation	State Department DFC USGS Partner governments	Secure and diversify access to raw materials, while supporting project development in partner countries.
Midstream (processing, refining)	IRA tax incentives (45X) Critical Minerals Agreements DPA support Industrial subsidies	Treasury / IRS DOE USTR Private sector	Strengthen domestic and allied processing capacity and reduce reliance on concentrated refining hubs.
Downstream (manufacturing, demand)	Project Vault OEM offtake agreements targeted industrial policy tools Federal procurement	OEMs DOD EOP	Improve demand visibility and support the scaling of domestic and allied production.

Source: The authors.

3.4.3. Bilateral agreements: structure and rationale

The 2026 Critical Minerals Ministerial and the bilateral frameworks associated with it link the new domestic security approach to allied coordination and external policy alignment. This gives the US administration a more flexible instrument which allows the United States to shape cooperation around specific materials, projects, financing schemes or export conditions.

Bilateral agreements connect domestic policy instruments, such as tax incentives and industrial support with broader cooperation initiatives, such as the Minerals Security Partnership.

Unlike multilateral arrangements, they allow for more targeted cooperation across specific segments of the value chain, including extraction, processing or downstream manufacturing[90].

As noted earlier, the role of the **USTR** becomes more operational in this context. Trade policy is increasingly deployed not primarily for market access, but to support supply-chain alignment and partner integration.

The IRA has reinforced this logic. By linking eligibility for key subsidies to sourcing conditions, access to the US market depends on compliance with defined supply-chain criteria[91]. In several cases, the resulting arrangements are not broad trade instruments at all. Their function is more targeted, granting partner countries access to specific parts of the US industrial and subsidy framework, particularly in sectors linked to critical minerals and battery supply chains.

The **US-Japan Critical Minerals Agreement**, signed in 2023 exemplifies this approach. Limited in scope, it covers a defined set of battery materials (lithium, cobalt, nickel, graphite and manganese) and addresses export restrictions alongside labour and environmental standards[92]. Its practical effect matters more than its formal reach: materials originating in Japan may qualify under parts of IRA subsidy framework linked to the IRA, linking bilateral trade cooperation directly to US domestic industrial policy.

Cooperation was further strengthened through the US-Japan Action Plan for Critical Minerals Supply Chain Resilience adopted in 2026[93]. It expands cooperation into areas such as stockpiling, investment, geological mapping and responses to supply disruptions. It also includes cooperation on third-country projects, reflecting a growing interest in advancing supply-chain development beyond the bilateral relationship itself.

The partnership with Australia is structured somewhat differently. The **Climate, Critical Minerals and Clean Energy Transformation Compact** (2023) brings together resource cooperation and broader industrial and energy objectives. The focus here is on supply expansion and the development of mining and processing projects, particularly in rare earths and battery materials[94]. Hence, integration into US industrial schemes is not the primary concern. The ultimate aim is rather straightforward: securing upstream supply from a stable and reliable ally.

Other arrangements, including **memoranda of understanding** (**MoU**) with resource-rich countries, such as Argentina, Peru, the Democratic Republic of the Congo (DRC) and Zambia, place greater emphasis on upstream investment, infrastructure and the development of local value chains. These agreements tend to be less formal and more flexible, but they can play an important role in facilitating project development[95].

The US-Ukraine Reconstruction Investment Fund, established in 2025, reflects a different type of partnership with its own particular characteristics. Partly financed through future revenues from minerals and oil and gas projects, the agreement grants the US preferential offtake rights, while Ukraine retains ownership of its natural resources. Its implementation remains uncertain though, given the continuing security situation, outdated geological data and damaged energy infrastructures.

90 American Journal of International Law. 2025; 119(1):168-174, The United States Takes Actions to Secure Supply Chains for Critical Minerals.; European Parliamentary Research Service (EPRS), EU-US Critical Minerals Agreement, November 2023.

91 EPRS, EU-US Critical Minerals Agreement, November 2023.

92 Ibid.

93 USTR, United States-Japan Action Plan for Critical Minerals Supply Chain Resilience, 19 March 2026.

94 Climate Energy Finance, Raw Power: China locks-in global dominance of critical minerals and metals with $120 billion outbound investment surge, 19 March 2026.

95 See Deberdt R, IFRI, The United States' Strategy for Securing Critical Minerals Supplies Can It Meet the Needs of the IRA?, 2024; American Journal of International Law. 2025; 119(1):168-174, The United States Takes Actions to Secure Supply Chains for Critical Minerals.

More recently, the long-anticipated EU-US strategic partnership on critical minerals was signed in April 2026. The MoU on the strategic partnership[96] and the accompanying action plan for critical minerals supply-chain resilience[97] extend transatlantic cooperation across the full value chain, including exploration, extraction, processing and recycling. The new framework also aims to promote investment coordination and joint research, enhance stockpiling cooperation and improve coordination in response to supply disruptions.

An important component concerns investment screening and acquisitions linked to critical minerals and rare earth assets, reflecting growing concerns on both sides of the Atlantic regarding strategic dependencies and supply-chain vulnerabilities. The action plan goes even further by referring to possible trade and market-based instruments currently under consideration, including border-adjusted price floors, standards-based markets, price-gap subsidies and offtake agreements. The proposed arrangements remain at this stage non-binding and do not establish financing obligations or preferential treatment. Despite growing transatlantic coordination, important questions remain open regarding the most effective instruments for addressing long-standing weaknesses in critical minerals markets. This, however, does not diminish the significance of the agreement, which constitutes the most structured EU–US critical minerals cooperation framework to date and could potentially open the way to stronger coordination on supply-chain resilience and market stabilisation.

3.4.4. Pax Silica

The launch of Pax Silica further illustrates how this policy is extending beyond critical minerals in the narrow sense. The initiative is significant less for the specific material itself than for the broader policy direction it illustrates. The US approach treats strategically important supply chains as systems to be organised through alliances, standards and targeted investments, rather than relying solely on market mechanisms. In March 2026, the US announced the USD 250 million Pax Silica Fund, which aims to provide foreign assistance funding for critical minerals initiatives across every layer of the supply chain. At the time of writing, Greece, Finland and Sweden had joined the Pax Silica initiative.

Table 5: Pax Silica signatories

Signatories of Pax Silica			
Argentina	Australia	Chile	Costa Rica
El Salvador	European Union	Finland	Germany
Greece	India	Israel	Japan
Kazakhstan	Netherlands	Norway	Panama
Philippines	Qatar	Republic of Korea	Singapore
Sweden	United Arab Emirates	United Kingdom	

Source: The authors based on US Department of State's Pax Silica webpage.

[96] Memorandum of Understanding between the European Union and the United States of America on a Strategic Partnership on Critical Minerals, signed on 24 April 2026.

[97] European Commission and USTR, EU–US Action Plan for Critical Minerals Supply Chain Resilience, 24 April 2026.

Table 6: Main bilateral agreements between the United States and third countries on critical minerals

Partner	Year	Agreement	Core focus
Argentina	2024	Critical Minerals MoU	Lithium supply; upstream investment
Argentina	2026	Framework Agreement	Upstream investment; project financing; lithium supply
Australia	2023	Climate, Critical Minerals and Clean Energy Transformation Compact	Resource development; industrial coordination
Australia	2025	Follow-up framework	Project pipeline; rare earths; financing
DRC	2025	Strategic Partnership Agreement	Investment coordination; stockpiling; exploration
DRC/ Zambia	2023	EV battery value chain MoU	Mining; processing; local value chains
EU	2026	MoU on a strategic partnership on critical minerals	Strategic cooperation across the critical minerals value chain
EU	2026	Action plan for critical minerals supply-chain resilience	Supply chain resilience through standards-based markets; possible price support tools and offtake mechanisms
Japan	2023	Critical Minerals Agreement	Regulatory alignment; battery minerals; subsidy eligibility
Japan	2026	Action Plan for Critical Minerals Supply Chain Resilience	Investment coordination; stockpiling; third-country projects
Mexico	2026	Critical Minerals Action Plan	Trade coordination, investment support, price floors and joint supply-chain development
Peru	2024	Critical Minerals MoU	Mining cooperation; investment facilitation
Norway	2024	Market-oriented minerals cooperation	Standards; governance
UK	2026	Critical Minerals MoU	Supply chain cooperation; standards alignment; investment coordination

Source: The authors, based on U.S. Department of State and USTR official materials on bilateral critical minerals agreements (2023–2026); American Journal of International Law, *United States Takes Actions to Secure Supply Chains for Critical Minerals*, 2025; CSIS, *Critical Minerals Ministerial Introduces New International Cooperation Strategy*, 2026.

The institutional system described in this section can be as follows:

Table 7: Main institutional roles in the US critical minerals policy architecture

Institution	Role	Main instruments
White House / EOP	Strategic leadership, cross-government coordination and implementation oversight	• EOs • Inter-agency reviews • National Energy Dominance Council (NEDC)
Department of the Interior / USGS	Definition of critical minerals list and mineral intelligence	• Critical minerals list • Geological mapping; resource assessments • National Mineral Information Center • Data and supply-risk analyses
Department of Energy	Leads industrial and technological development across critical minerals supply chains	• Critical materials assessments • Advanced Energy Project Credit (Section 48C) • Advanced Research Projects Agency–Energy • Advanced Materials Manufacturing Technologies Office
Department of Defense	National security and defence-industrial resilience	• (DLA) • National Defense Stockpile (NDS) • Defence Production Act • Grants, loans, and economic incentives through the Industrial Base Analysis and Sustainment Program to establish domestic industrial capacity (landmark example partnership with MP Materials)
Department of the Treasury / IRS	Fiscal design and incentive administration	• Tax-credit rules • Sourcing thresholds • Eligibility criteria • FEOC restrictions • IRS compliance guidance and enforcement
Office of the USTR	Trade policy interface and external supply-chain alignment	• Critical minerals agreements • Bilateral trade frameworks • Executive agreements
Department of State	External diversification and alliance management	• Minerals Security Partnership (MSP) • Forum on Resource Geostrategic Engagement (FORGE) • Pax Silica • Project Vault • Bilateral frameworks and action plans • Diplomatic coordination
Congress	Legislative framework, appropriations and oversight	• American Mineral Security Act (AMSA) • Energy Act of 2020 • Infrastructure Investment and Jobs Act (IIJA) • CHIPS and Science Act • Inflation Reduction Act (IRA) • Rare Earth Magnet Security Act (REMSA) • Oversight of executive agencies Refinement bills;

Source: The authors.

4. COMPARATIVE POLICY-DESIGN ANALYSIS: THE UNITED STATES VS THE EU

KEY FINDINGS

The United States'support for critical minerals is far larger and more flexible than the EU's. US federal agencies mobilise an estimated **EUR 46 billion** (**USD 53 billion**) in public support for the 2024-2026 period, while the EU channels only about **EUR 5-6 billion** in clearly identifiable CRM-related funds. The EU's approach is also slower and narrower, relying heavily on grants and loans, with limited sovereign risk-sharing, and persistent delays arising from complex procedures and permitting bottlenecks.

Regarding **stockpiling**, the United States' National Defense Stockpile (NDS) and EXIM-backed Project Vault have been compared, in this study, with the EU's forthcoming CRM Centre and Japan's JOGMEC. The US system is centralised and anchored in long-standing legislation, whereas the EU's architecture remains under development, dependent on coordination among the 27 Member States. JOGMEC stands out as a leading model, combining, in a single agency, market intelligence, direct financial support across the value chain, and physical reserves.

On **price support**, the contrast is equally visible. The United States aims to rely on trade-linked **price floors** and adjustable tariffs to protect domestic producers and anchor prices. However, implementing price floors in isolation is not sustainable in the long-term. A more effective approach involves establishing collective price floors with allies, such as through the United States' FORGE framework. The EU focuses on price stabilisation via **demand aggregation** and coordinated national stockpiles, which help to smoothen supply shocks but do not guarantee long-term revenues for project developers. This leaves CRM projects vulnerable to the **bankability gap**: banks still face major uncertainty about future cash flows, in this regard.

Contracts for Difference (**CfDs**) are a powerful "middle-way" instrument, modelled on the renewable-energy sector, which could help to de-risk investments in CRM projects. When combined with stockpiling and joint purchasing, CfDs can create a coherent toolkit for de-risking CRM projects, lowering the cost of capital and aligning public support with market mechanisms.

4.1. Funding: contrasting scale and instruments

As highlighted in Section 3, in the United States, the capital supporting critical minerals initiatives flows through a network of federal agencies. While the **DOE** and **DOD** handle the bulk of domestic industrial acceleration, the **DOC** and the **USDA** provide targeted support for specific sectors. Meanwhile, agencies like the **DFC** and the **EXIM** have emerged as prominent platforms for financing the high-stakes journey from raw material extraction to finished manufacturing, both domestically and overseas. Unprecedented efforts by these actors combine a variety of instruments, in this regard, including direct equity, debt, guarantees and offtakes or price floors.

Table 8 attempts to quantify the main initiatives currently deployed by US agencies to support critical minerals. Regarding **IRA tax credits**, the actual costs of the measures are notoriously difficult to estimate.

The share of critical minerals in the IRA's Section 45X (Advanced Manufacturing Production Credit) is unknown, and unanticipated discoveries of domestic deposits could significantly increase IRA spending[98].

For this study, we use the 2023 Goldman Sachs estimate[99] of USD 193 billion spending on Section 45X for 2023–2032, then assume a lower bound of 10 % of spending going to critical minerals projects.

Table 8: Summary of ongoing and announced support for critical minerals in the United States

Entity	Origin	Estimated amounts	Type
DOD	Defense Production Act (DPA, Title III)	• FY2024: USD ~239 million • FY2025: USD ~249 million • FY2026: USD ~29 million	Grants
	One Big Beautiful Bill Act	USD 5 billion via the Industrial Base Fund (IBF)	Grants and purchase commitments
		USD 2 billion for the National Defense Stockpile Transaction Fund	Procurement contracts, direct purchase
		USD 0.5 billion for the Office of Strategic Capital (OSC)	Loans and loan guarantees
DOE	Notices of Funding Opportunity (NOFOs)	Intent to issue notices of funding opportunities totalling nearly USD 1 billion, of which is already anticipated: • USD 275 million for "Mines and Metals Capacity Expansion"; • USD 80 million for "Mine of the Future"; • USD 134 million for "Rare Earth Elements Demonstration Facility".	Grants
	Loans through the Loan Programs Office (LPO)	• USD 2.26 billion for Lithium Americas Corp. for the construction of processing facilities at Thacker Pass, Nevada (see Box 2 in Section 2); • USD 1.36 billion for Energy Source Minerals LLC lithium plant in California; • USD 0.475 billion for Glencore Battery Recycling (lithium, nickel, cobalt and manganese extraction).	Direct loans
	Loan guarantees through the Loan Programs Office (LPO)	• USD 1.26 billion for potash solution mine and processing plant, Michigan; • USD 755 million for NOVONIX synthetic graphite manufacturing facility in Tennessee; • USD 996 million for Ioneer Ltd for lithium carbonate plant in Nevada.	Loan guarantees
USDT (IRS) + DOE	Inflation Reduction Act tax credits (45X)	USD 19.3 billion	Production tax credits
EXIM	Project Vault	USD 10 billion (EXIM) + USD 2 billion (private sector)	Loans (EXIM)

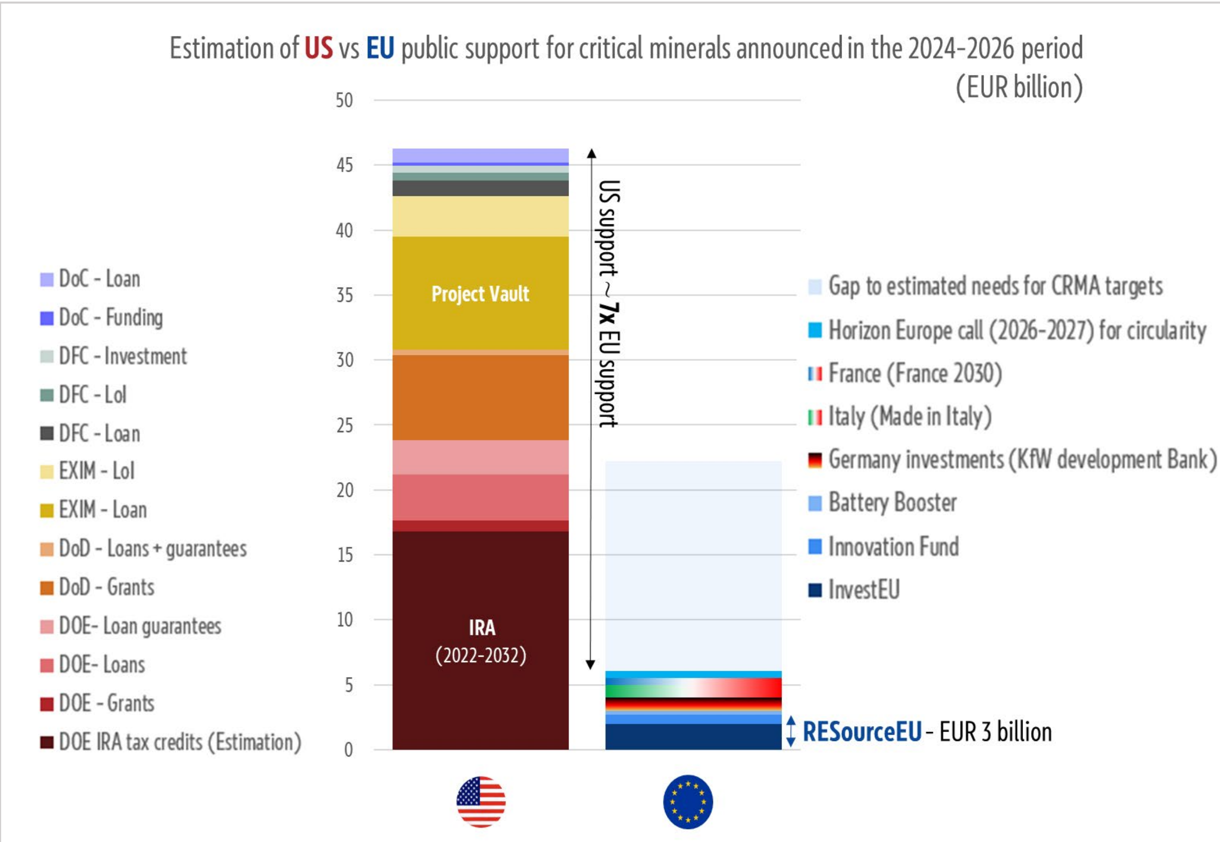
98 Fisher, T. and Loucks, J., The Budgetary Cost of the Inflation Reduction Act's Energy Subsidies, Policy Analysis no 992, Cato Institute, Washington DC, 11 March 2025

99 Della Vigna, M., Bocharnikova, Y., Lee, B., Mehta, N., Singer, B. et al., Carbonomics: The third American energy revolution, Goldman Sachs, 22 March 2023.

Entity	Origin	Estimated amounts	Type
	Letters of Interest for critical minerals projects	• USD 2.2 billion (seven projects in Australia) • USD 0.825 billion for Ivanhoe Electric Santa Cruz Copper Project • USD 0.553 billion for rare earth project in Wyoming • USD 900 million for American Battery Technology lithium project in Nevada • USD 456 million for American Rare Earths rare earth project in Wyoming	LoI
DFC	Critical minerals support	USD 565 million for SVRE Holdings Ltd (Brazil) for rare earth element mining	Loans
		USD 700 million for Cove Kaz Capital (Kasakhstan) for tungsten mine	LoI
	Critical Minerals Consortium	USD 600 million for Orion Critical Minerals Consortium (USD 1.8 billion public-private partnership)	Investment
DoC	CHIPS and Science Act	USD 1.3 billion loan + USD 277 million funding for USA Rare Earth through equity stake	Loan + funding for equity stake

Source: The authors, based on the sources in Annex IV.

Figure 8: Comparison of public support for CRMs in the United States vs the EU (2024-2026)



Source: The authors, based on Table 8 data, the February 2026 press release by the US Department of State entitled '2026 Critical Minerals Ministerial', the RESourceEU Action Plan, the estimate by EITRawMaterial of public and private sector investment needs to reach the CRMA target (a 1/4 leverage effect was considered). Currency conversion is based on an exchange rate of: EUR 1 = USD 1.15.

Delimiting the exact support envelope is a challenge, but the order of magnitude of US support lands close to EUR 46 billion (USD 53.2 billion)[100] in the coming years. In Figure 8, these sums are compared with what the EU is currently implementing to support its own CRM policy.

The contrast is stark, as the comparison shows that the United States'support is **five to ten times greater** than the EU's mobilised funds. Observers such as the IFRI have highlighted[101] how the EU approach appears inadequate, slow and fragmented, compared to US efforts:

- **The scale is insufficient**: as a whole, approximately EUR 5-6 billion (mostly repackaged from existing MFF/NextGenerationEU envelopes, such as the Innovation Fund and EIB lending) can be traced to CRM policy, while the costs of achieving the CRMA targets are estimated at EUR 80-100 billion by EIT RawMaterials[102], therefore requiring EUR 17-22 billion in additional public support (assuming a 3.5 leveraging factor);
- **The EU is limited in the instruments it uses**: grants dominate but fail to address the chicken-and-egg financing gap, for which equity is critical. The EIB, although it can technically deploy equity through the EIF, remains a debt-focused organisation[103].;
- **The deployment is slow**: much remains unspent due to complex processes. Permitting bottlenecks, risk aversion and a lack of strategic project pipelines hinder final investment decisions.

4.2. Stockpiling

The United States and the EU are both expanding their stockpiling mechanisms to protect their supply chains from shocks. While both look to Japan's long-standing JOGMEC[104] model for inspiration, their methods differ in speed, funding and philosophy.

4.2.1. Key differences

- **Speed**: The EU's proposal for the EU CRM Centre was still pending at the time of writing, while the US proposal was launched in February 2026, indicating a slower EU pace compared to the United States;
- **Budget**: About EUR 12 billion is dedicated to NDS + Project Vault on the US side. The IFRI recommends a **EUR 15 billion budget**[105] for the planned EU CRM Centre, whereas the order of magnitude of additional public support needed to meet CRMA targets (which may not necessarily be channelled through the planned EU CRM Centre) is estimated at **EUR 17-22 billion**, based on the observation summarised in Figure 8;
- **Centralisation**: JOGMEC and Project Vault are centralised entities with clear budgets. The EU model is decentralised, relying on the cooperation of each of the 27 Member States;

[100] Based on an exchange rate of EUR 1 = USD 1.15.

[101] IFRI, Financial Tools for Boosting Resilience of CRM Value Chains and Strategic Stockpiling, March 2026.

[102] EIT Raw Materials, EIT RawMaterials Position on Framework Programme 10: Securing Europe's competitiveness through innovation and education in raw materials.

[103] The EIB offers a high-risk/quasi-equity financing instrument called venture debt.

[104] Japan Organization for Metals and Energy Security.

[105] IFRI, Financial Tools for Boosting Resilience of CRM Value Chains and Strategic Stockpiling, March 2026.

- **Instruments**: The United States and Japan use state banks to take direct ownership or provide equity. The EU mostly uses the EIB/EBRD[106] to provide loans, which adds debt to company balance sheets, rather than sharing the risk;
- **Design**: It is interesting to note that the **NDS** has no direct EU-wide equivalent, existing or planned. However, a 2022 ITRE study, published after the European Parliament resolution on critical raw materials, advocated for an EU-wide stockpile, following Russia's full-scale invasion of Ukraine. This reflects both preparedness needs and industrial demands, leading to the **EU CRM Centre** initiative to secure critical minerals supplies. In the United States, **Project Vault** serves a similar role for industry resilience.

Table 9: Stockpiling critical minerals – US, EU and Japan models

	NDS	Project Vault	CRM Centre	JOGMEC
Lead agency	Defense Logistics Agency (DLA)	EXIM Bank + private traders	CRM Centre	METI[107]
Launch year	1939 (current form: 1990s)	2026	Announced for 2026	2004 (stockpiling since 1970s)
Value	EUR 784 million[108] (USD 908 million)	EUR 11.2 billion (USD 12 billion)	-	Undisclosed
Target uses	Military and defence (in case of national emergencies affecting defence needs)	Industry (import replacement in case of market disruption)	Clean energy, digital tech, defence and manufacturing, + Member States in case of supply disruption	Industry (import replacement, 60-180 days of supply)
Governance	Federal government	Public-private partnership	Supranational coordination	Government agency under METI
Materials covered	Defined by the US President[109], overlaps largely with other lists	60 (USGS critical minerals)	34 (CRMs from CRMA list)	35 Defined by the government[110]
Material form	Mostly unprocessed minerals	Processed, usable grades	Processed or semi-processed grades	Processed or semi-processed grades
Funding	Annual congressional budget, through the NDS Transaction Fund	EXIM loans + private capital (Boeing, GM, Google) + Fees	EIB/EBRD loans, EU Innovation Fund, Battery Booster, national funds	Government budget
Mechanism	Release if emergency is declared through an Executive Order	Fixed-price draw/replenish	Releases through IMERA toolbox	JOGMEC assesses urgency and national interest before approving allocations

Source: The authors, based on the sources in the footnotes.

106 EBRD announced an EU €100 million for a critical raw materials investment facility in 2024.

107 METI is Japan's Ministry of Economy, Trade, and Industry.

108 Total liability and equity for FY 2026 is reported at USD 908.1 million; see the Fiscal Year 2026 Budget Estimates, published by the US Department of Defense in June 2025.

109 Strategic and Critical Materials Stock Piling Act, Appendix B: the strategic and critical materials stock piling act, as amended through Public Law 118-31 of 22 December 2023.

110 JOGMEC, JOGMEC's current activities and support measures for stable supply of mineral resources, 4 July 2023.

4.2.2. Strategic considerations

Taking a step back, it can be argued that the US approach relies primarily on strengthening supply resilience through strategic stockpiling. The aim is to ensure that critical inputs remain available in the event of a disruption, without necessarily reshaping the underlying supply-chain structure. The EU may not wish to duplicate this approach on the same scale, because large-scale stockpiling is expensive, inflation-prone and logistically complex. Moreover, storage alone does not resolve structural dependence on a small number of suppliers or create new domestic capacity; it only postpones potential shocks.

Strategic autonomy should be about addressing the underlying vulnerabilities in supply chains. The JOGMEC path appears stronger in this regard, because it combines three core functions under one institution:

- market intelligence (system-wide monitoring of supply risks, prices and concentration);
- financial de-risking (supporting upstream and downstream projects through equity, guarantees and direct financing);
- physical stockpiling (managed emergency reserves that can be deployed in crises).

This integrated model allows Japan to act coherently across the entire value chain, rather than treating intelligence, finance and storage as separate silos. Taking this path, however, would require a more robust institutional design for the CRM Centre, including sufficient powers, clear budget lines and close integration with de-risking instruments.

4.2.3. The operationalisation of an EU stockpiling framework

The new EU-proposed decentralised stockpiling framework uses centralised data and legal mandates to strengthen monitoring capacity, coordinate decentralised strategic public and private stocks, and reinforce corporate preparedness. This architecture can be split into an intelligence arm, providing policy oversight and strategic guidance, and a technical arm, providing market analysis, coordinated monitoring, stock releases, demand aggregation and joint purchases.

4.2.4. Monitoring and oversight

Strategic stocks are raw material volumes held by public or private operators that can be released in the event of a supply disruption. Under the CRMA, Member States are required to monitor their strategic stocks and report their status to the European Commission.

Reports must include aggregated stock levels for each strategic material, supply outlooks and the specific rules governing their management. This information is centralised in the Raw Materials Information System, a digital platform maintained by the European Commission, which tracks supply, demand and global reserves. The European Critical Raw Materials Board (CRM Board) subgroup on strategic stocks aggregates national data to maintain a comprehensive EU-wide storage map.

4.2.5. Systemic readiness

To ensure systemic readiness, the European Commission establishes benchmarks for the EU's safe stock levels and compares them with current inventories. The CRM Board[111] issues a non-binding opinion to Member States to encourage convergence, including the build-up of strategic reserves.

Every three years, or in response to sudden supply risks, the European Commission conducts stress tests on the **systemic vulnerability** of the EU's strategic raw materials supply chains and their exposure to supply risks. If a significant risk of market distortion or fragmentation is identified, it alerts the Member States, the CRM board and the EU governance bodies, and advises them regarding crisis vigilance or crisis management mechanisms.

Box 6: The CRM Board and its subgroups

The CRM Board was established by the CRM Act and entered into force on 23 May 2024.

The board is composed of high-level representatives from each EU country and the European Commission, and is chaired by a senior official with direct responsibility for critical raw materials policy from the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW).

For specific topics, the board meets in subgroups, which are in principle attended by the deputy high-level representatives, supported by the relevant thematic experts.

The subgroups established by the CRMA are:

1. Coordination on the financing of strategic projects;
2. Public knowledge and participation;
3. Exploration of critical raw materials;
4. Circularity, resource efficiency and substitution;
5. Monitoring of critical raw materials supply chains;
6. Strategic stocks of strategic raw materials.

The board can decide to create additional subgroups, when necessary.

The European Parliament is a permanent observer to the CRM Board. Its representatives sit both on the CRM Board and in its subgroups.

Source: European Commission, 2026.

4.2.6. Company preparedness

To ensure company preparedness, Member States identify large companies using strategic raw materials for the manufacture of green and digital transition products.

Every three years, these companies must perform a risk assessment of their strategic raw materials supply chains.

[111] The CRM Board is composed of high-level representatives from each Member State, who are supported by deputies, and the Commission. The board acts at the request of the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), in compliance with the CRM Act and its rules of procedure.

Where significant vulnerabilities to supply disruptions are identified, they are expected to implement mitigation measures, including exploring the diversification of supply chains or the substitution of strategic raw materials.

4.2.7. Coordination

When the CRM board identifies a systemic vulnerability, such as a 90 % reliance on a single non-EU country for a certain mineral, it can trigger collaborative measures in the toolbox provided by the **Internal Market Emergency and Resilience Act** (IMERA), such as information and priority-rated requests to large companies, coordinated stock releases, demand aggregation and joint purchases.

As announced in the Resource EU Action Plan, the new European CRM Centre will facilitate the creation of strategic stocks of both primary and secondary materials, advise the Member States on when to buy or release stocks based on price volatility or supply disruptions, and aggregate demand from companies to purchase materials in bulk, which are then distributed to national or private stockpiles.

4.2.8. Crisis management

In times of crisis, based on a proposal from the Commission, the Council can activate the internal market vigilance or emergency modes under the IMERA toolbox[112], which enable the Commission to: request information on production capacities and stocks, and on supply-chain disruptions or shortages; carry out joint purchases; mandate voluntary[113] priority-rated requests; and coordinate stockpiling distribution.

The IMERA measures must be exceptional, limited to crisis situations and should not affect areas of national competence, such as national security. Member States are responsible for implementing their provisions, and for coordinating with the EU and with other Member States.

4.2.9. CRM stockpiling pilot

The Commission and several Member States are collaborating on a pilot project for CRM stockpiling. This project will serve as a testing ground for logistical protocols and conditions for purchasing, storing and releasing supplies during market disruptions, while aligning with industry efforts and available financing instruments. Once complete, its operations will be integrated into the CRM Centre[114].

4.2.10. Stockpiles in EU Member States

A recent DG GROW survey reveals a diverse landscape of stockpiling strategies and mechanisms in the EU. While some countries have centralised multipurpose agencies, others rely on specialised agencies dedicated to specific sectors, such as oil and gas, defence or emergency situations.

The survey identified four primary mechanisms for stockpiling management by Member State governments:

1. direct control: physical stockpiles stored in government-owned or rented warehouses;
2. mandatory stocks: obligatory stocks that industrial actors are legally required to maintain;

[112] See the European Parliament briefing on the Internal Market Emergency and Resilience Act, European Parliament, February 2024.

[113] Under the IMERA, suppliers of crisis-relevant goods may still reject priority-rated requests (Recital 59). When accepted, the obligation to perform the priority-rated request takes precedence over any performance obligation under private or public law (Article 29 IMERA).

[114] The Commission proposal is still pending at the time of writing.

3. contractual reserves: strategic supplies managed by industry under government contracts;
4. reserved production capacity: contractual agreements ensuring idle industrial production capacity for crisis response.

Many Member States have clear legislative frameworks for release-to-market protocols, defining the conditions under which strategic stocks are allocated and distributed to ensure internal market stability during supply disruptions.

4.3. Price floors and other price-support instruments

A floor price acts as a safety net for investors. It ensures that a project remains profitable enough to repay its debts. Without this certainty, banks are often unwilling to lend the large sums needed to build refineries or mines, given the frequent practice of dominant players (notably, China) of flooding the market at lower prices to make competing projects commercially unviable.

Floor prices can be used by governments to support domestic markets and increase the resilience of their supply chains. Some characteristics matter when designing such a support mechanism, namely: how and when the support would be triggered, and who would ultimately pay if the mechanism were activated.

4.3.1. US: price floors supported by trade measures

The United States has moved toward an explicit policy of price intervention to protect its domestic industry from global price crashes.

The Presidential Action of 14 January 2026 recognised price volatility in critical minerals markets as a vulnerability that undermines US supply chains. It directed the Secretary of Commerce, in coordination with the US Trade Representative, to consider **price floors** for trade in critical minerals.

In February 2026, the United States announced[115] its plan to establish "reference prices" for essential minerals. The centrepiece of the strategy is the FORGE (see section 3.4). This framework is designed to create a preferential trade zone for critical minerals among the United States and its allies. For allies within this zone, the reference prices would act as a **guaranteed price floor**. This gives developers of mining projects the stability they need to secure bank loans, as they know their revenue will not vanish if global prices dip.

4.3.2. Tariffs for the implementation of price floors

In practice, the way that these price floors will materialise is through **adjustable tariffs**. A major point of contention is whether the US government will subsidise the gap when market prices fall below the floor, or if manufacturers (such as EV or defence companies) will be forced to buy at the higher floor price, potentially making their end products less competitive globally. This, of course, means that it is ultimately the domestic consumer or the taxpayer who pays the price for safeguarding the domestic value chain.

From a security standpoint, paying this premium (the difference between the market price and the price floor) is a form of insurance against supply-chain disruptions, but that does not mean that the passing on of this cost should be taken lightly.

[115] Northey, H. and Bikales, J., White House entices allies with critical minerals plan, E&E News by Politico, 4 February 2026.

Economists warn[116] that price floors are notoriously difficult to manage and can lead to unintended consequences.

Some of the challenges are:

- **Right-sizing the industrial footprint**: critics argue that price floors can lead to oversupply. If the floor is set too high, companies will oversupply minerals because they are guaranteed a profit, leading to massive stockpiles that the government (or the taxpayer) must eventually pay to store;
- **Price discovery deficit**: experts point out that, unlike gold or oil, many critical minerals are not traded on transparent, liquid exchanges.

  Setting a "fair" price floor for niche minerals like gallium or specific rare earth oxides is technically difficult and prone to lobbying by industry groups.

A way to counter or minimise these downsides might be to start small. As mentioned in a 2026 IFRI study: "*these [price] floors can distort competition or be costly for governments if they are set too high and in a rigid manner. Therefore, they should be considered only for niche products in specific cases, while other mechanisms are to be privileged. Such prices should also be correlated with the actual production costs of downstream industries, which can be monitored and estimated".*

4.3.3. If you want to go far, go together

The United States cannot indefinitely bankroll price floors alone[117]. By creating a preferential trade zone with 54 nations, the financial weight is distributed. In addition, the United States is seeking to create a **critical mass of demand**. This bloc must be large enough to set its own "fair" reference prices, effectively forcing the global market to react to its standards, rather than the other way around.

On the other hand, some experts fear this will create a fragmented global economy: a high-cost market (FORGE nations) and a low-cost non-aligned market (China and its partners). This could lead to trade disputes at the WTO.

4.3.4. EU: focus on price stabilisation

In contrast to the financial guarantee of a floor price, the EU's strategy focuses on **mitigating price volatility** through demand aggregation and the use of strategic reserves to influence market volume. By concentrating demand and stockpiling material, the EU aims to prevent the extreme price spikes and predatory dumping that threaten EU CRM projects.

4.3.5. Joint purchasing

Under the CRMA framework, the EU has introduced the **Raw Materials Mechanism** (RMM) as part of the EU Energy and Raw Materials Platform to aggregate demand from European industrial consumers. This is a central digital platform launched by the European Commission to strengthen the supply of 17

[116] Boudreaux, Donald J., On the negative consequences of price floors, The Daily Economy, 21 July 2022.

[117] US House Committee on Natural Resources hearing entitled Unleashing America's Mineral Potential: The Critical Minerals Commodity Supply Chain, held on 25 March 2026. Dr Gracelin Baskaran (Director, Critical Minerals Security Program, Center for Strategic and International Studies) stated: "We need to work with our allies Australia, EU, Japan, South Korea, UK, India. We can create a market of 2.6 billion consumers, and we have frameworks, the FORGE framework for example, ... to do that".

SRMs, such as lithium, cobalt and rare earths. Its first call for buyers and suppliers was announced on 13 April 2026[118].

By coordinating the purchasing power of EU firms, the mechanism facilitates the negotiation of long-term offtake agreements with global suppliers, often featuring more predictable pricing terms. However, the system remains a purely voluntary matching platform. Unlike some international competitors, the EU does not yet act as a direct buyer of last resort using public capital to clear the market during price collapses.

4.3.6. Stockpiling

Complementing demand aggregation, the EU is developing a coordinated framework for strategic reserves to act as a **physical hedge** against supply disruptions and price manipulation.

Rather than establishing a single stockpile, the EU's approach relies on the Member States to monitor and coordinate their national stocks of strategic raw materials, under an EU-level coordination framework that includes regular monitoring and resilience assessments.

These stocks serve a dual purpose. Firstly, they provide an immediate emergency resource during geopolitical and supply-chain shocks. Secondly, by ensuring that a minimum level of inventory is always available within the EU, these stocks reduce the likelihood of panic buying, which often drives prices to unsustainable levels.

However, a significant gap remains in the **counter-cyclical use** of these reserves; currently, there is no centralised EU mandate to buy surplus material in cases of an excess of global supply and thereby prevent the price crashes that have often led to the mothballing of domestic European mines.

4.3.7. Lack of revenue-stabilisation tools

While joint purchasing and stockpiling are suitable tools for improving market liquidity and supply security[119], they fail to address the core requirement of project finance: **bankability**. For a mining or refining project to secure the financing required for construction, lenders require a high degree of certainty regarding long-term cash flows. While the EU's current tools mitigate some risks, they leave the revenue floor dangerously exposed. The fundamental issue is that neither joint purchasing nor stockpiling provides a legally binding **price guarantee**.

- Joint purchasing via the RMM functions primarily as a matching service. While it aggregates demand, it does not fundamentally alter the underlying commercial risks, as it relies on private off-takers. If an OEM faces financial distress or shifts its technology, the aggregated demand can evaporate. In addition, most joint purchasing arrangements currently being negotiated are on a short-term time frame, while banks typically require offtake agreements that cover the entire debt-repayment period (often 10 to 15 years);
- Stockpiling, on the other hand, is mostly a reactive tool, rather than a proactive financial instrument[120]. It cannot prevent a sustained structural price collapse caused by global oversupply or predatory dumping. Ironically, large strategic stocks can even hurt bankability.

[118] European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Commission launches platform to aggregate demand of raw materials and boost diversification, 13 April 2026.

[119] Nicoli, F. and Beetsma, R., Joint public procurement as a tool for European Union industrial policy, Bruegel, 23 July 2024.

[120] Stockpiling can be used as a proactive instrument, when associated with active management.

Lenders, if they perceive that a government might dump its stockpile to lower consumer prices, may view this as a potential downward pressure on the project's future revenues, thereby increasing the perceived risk.

To reach its 2030 targets, the EU must recognise that market-shaping tools are necessary for security, but revenue-stabilisation tools are a prerequisite for investment.

4.3.8. The "Middle Way": Contracts for Difference mechanisms

The transition by the EU to a domestic CRM supply chain faces structural hurdles almost identical to those overcome by the renewable energy sector over the last decade. Both industries are characterised by massive, front-loaded capital expenditure (CAPEX) and low or moderate operating costs, meaning their financial viability is entirely dependent on long-term revenue stability rather than short-term market fluctuations.

The renewable energy sector has successfully navigated this hurdle by moving away from volatile spot-market pricing toward **two-way Contracts for Difference** (**CfDs**) (see Box 8).

By guaranteeing a fixed strike price for 15 to 20 years, governments effectively decoupled project revenues from the erratic swings of wholesale electricity markets. This shift allowed offshore wind and solar developers to swap high-cost speculative equity for low-cost senior debt, as commercial banks could finally model a predictable revenue stream.

Box 7: Contracts for Difference

A **Contract for Difference** (CfD) is a long-term contract between a project developer (the seller) and a public entity (the counterparty, such as an EU-backed agency).

It relies on a **strike price**, i.e., a fixed price per unit of material. This is typically set through a competitive auction to ensure the project covers its operational costs and provides a fair return on investment.

Then, at the time of production, a **reference price** (a prevailing market price) is used as a comparison.

Finally, a **difference payment** occurs:

- **If the reference price is lower than the strike price**: The public counterparty pays the producer the difference, ensuring the mine or refinery remains solvent during price crashes;
- **If the reference price is higher than the strike price**: The producer pays the excess revenue back to the public counterparty. This clawback mechanism protects taxpayers and can be used to fund future CRM initiatives.

In the energy sector, CfDs have been the standard for de-risking capital-intensive infrastructure for over a decade and are set as the preferred support instrument since the Electricity Market Design Regulation.

Source: The authors. See also the January 2026 study entitled "Overview of the diffusion of Power Purchase Agreements and Contracts for Difference across Member States", produced by Trinomics for the European Parliament's Committee on Industry, Research and Energy.

By applying two-way CfDs to CRMs, public support can effectively de-risks the project's debt-service capacity, allowing commercial lenders to offer lower interest rates and longer tenors.

CRMs even have the advantage (unlike renewable electricity) of being storable, meaning that CfD mechanisms could even be associated with a stockpiling approach; governments can decide to buy the production when the material price falls below the strike price, and stockpile it for future use.

The IEA, in its Global Critical Minerals Outlook 2025, advocated for "well-designed market-based mechanisms" akin to CfDs, in the form of a cap-and-floor system.

In addition to unlocking the necessary investment, this also decreases the cost of capital (which is typically 50 % higher in new projects, compared to incumbent producers)[121].

4.3.9. No one-size-fits-all solution

Ultimately, the global race for CRM security demonstrates that there is no silver bullet for value-chain resilience. The US approach, leaning heavily on trade-based price floors and protective tariffs, prioritises rapid domestic industrialisation at the risk of higher costs for end-consumers and potential trade friction. Conversely, the EU's current focus on demand aggregation and stockpiling can help to manage supply shocks, but does not solve the bankability gap for new projects.

CfDs offer a sophisticated compromise by mimicking the success of the renewable energy transition, yet even this requires high-quality price discovery and careful design to avoid market distortion. For a robust CRM policy, the goal should not be to choose one single instrument, but to create a complementary toolkit[122]: **joint purchasing for volume**, **stockpiling for physical security**, **and revenue-stabilisation tools for financial de-risking**.

Table 10: The price-stabilisation toolkit

Instruments	Description and examples
Tariffs	Governments can apply adjusted tariffs. If an imported mineral is priced below a certain threshold, a tax is added to bring its cost up to the floor price. This protects domestic producers from being undercut by cheap foreign exports. **Example**: FORGE initiative and reference prices announced by the US.
Offtake agreements	An offtake agreement in CRM projects is a contract where a buyer commits to purchase some or all of the future output from that production. It makes financing and investment easier by showing there identified demand for its product. A government agency (or a state-backed entity) could be the buying counterpart in such an agreement, and commit to buy a fixed amount of a mineral at a set price for several years. **Example**: long-term offtake agreement[123] between JOGMEC and Caremag for HREE.

[121] International Energy Agency, Global Critical Minerals Outlook 2025 – Policy mechanisms for diversified mineral supplies, 21 May 2025.
[122] World Economic Forum, 2026, Making Critical Minerals Bankable: Policy Tools to Unlock Investment.
[123] JOGMEC, Equity and Debt Financing to Caremag SAS - Project participation to diversify rare earth sources, 2024 (revised on 17 March 2025).

Instruments	Description and examples
Stockpiling	A government can act as a 'buyer of last resort'. When prices crash, the government buys the surplus to build a reserve.
Contracts for difference (CfDs)	The government agrees on a strike price with a company. If the market price is lower, the government pays the company the difference. If the market price is higher, the company pays the surplus back to the government. **Example**: renewable energy projects, hydrogen projects, decarbonisation projects[124].

Source: The authors.

[124] Trinomics, "Overview of the diffusion of Power Purchase Agreements and Contracts for Difference across Member States", European Parliament, January 2026.

5. PARLIAMENTARY COMMITTEES

KEY FINDINGS

In July 2025, the European Parliament adopted a resolution on rare-earth export controls, urging the Commission and the Member States to fast-track the CRMA.

The European Parliament's Committee on the Internal Market and Consumer Protection (**IMCO**) can advance the CRM agenda in several ways. The Foreign Subsidies Regulation (FSR) allows scrutiny of Chinese-backed midstream processing and may help prevent the internalisation of foreign state-backed support within the single market. External industrial policies, notably US tax incentives, may also have an impact on investment patterns and affect competition within the EU market.

IMCO can also promote a coordinated EU-wide financing tool to counter asymmetric national support that fragments the single market. Within the digital single market, it can ensure that the Cyber Resilience Act and related conformity-assessment frameworks embed CRM-supply-chain resilience as a market-access condition, discuss competition-law guidance for the RMM's joint purchases and explore a safe-harbour regime similar to the AggregateEU gas model.

For its part, the European Parliament's Committee on Industry, Research and Energy (**ITRE**) could discuss instruments to improve projects' bankability, such as two-way CfDs and buyer-of-last-resort mandates, while exploring the increase of public funding beyond the current EUR 5–6 billion to the EUR 17-22 billion needed for 2030 targets.

The design of a robust stockpiling system, coupled with circular-economy measures, ESG-linked procurement, defence-sector preferences and long-term power-purchase agreements, could also be examined to mitigate the stability premium and unlock the scale of CRM projects essential for Europe's green and digital transitions.

5.1. Parliament position

In July 2025, Parliament adopted a resolution[125] on REE export restrictions, urging the Commission and the Member States to speed up the implementation of the CRMA. MEPs deemed China's actions to be unjustified and coercive, given the country's quasi-monopolistic position regarding supply chains. The resolution also expressed concern about requirements to disclose sensitive data when applying for export permits, which could endanger the EU's security and technological leadership. The resolution stressed the need to **activate domestic mining projects** and determine the **minimum level of strategic stock REEs listed as SRMs**[126]. MEPs also expressed a wish to see swift progress in concluding **bilateral partnerships on raw materials** with countries that meet high sustainability and human rights standards.

5.2. Relevance for IMCO

The **Committee on the Internal Market and Consumer Protection** (IMCO) has a distinctive entry point into the CRM policy. Under its formal mandate (covering the functioning and integrity of the internal market, the harmonisation of technical standards, the promotion and protection of consumers'

[125] European Parliament resolution of 10 July 2025 on tackling China's critical raw materials export restrictions (OJ C, C/2026/1447, 31.3.2026, ELI: http://data.europa.eu/eli/C/2026/1447/oj).

[126] Neodymium, praseodymium, terbium, dysprosium, gadolinium, samarium and cerium.

economic interests, and the enforcement of single market rules, including in the digital single market[127]), IMCO is directly relevant to several aspects of both the EU's CRMA and the comparative US-EU policy framework analysed in this study. The findings of this study carry implications that extend beyond industrial or trade policy. It raises questions concerning how markets are structured, regulated and governed within the single market.

Moreover, the evolution of CRM markets into strategic assets has created governance challenges in which IMCO's competences would most directly engaged.

5.2.1. Single market integrity and the Foreign Subsidies Regulation

The Foreign Subsidies Regulation[128] (FSR) is the most directly actionable IMCO instrument in the CRM domain, and its relevance is not confined to the headline cases of state-subsidised acquisitions. Adopted in 2022 and fully applicable since October 2023, the FSR empowers the Commission to investigate and remedy distortions in the single market caused by foreign public subsidies.

In the CRM context, two categories of distortion are particularly relevant.

Firstly, **Chinese-backed midstream processing investments in EU Member States** – including in battery materials, rare earth separation, and graphite processing – may qualify as foreign-subsidised concentrations under Articles 20–21 FSR. The CRMA's Strategic Projects framework does not currently assess the extent of foreign subsidisation of project sponsors or investors. IMCO is therefore well placed to examine whether the Strategic Projects framework should incorporate safeguards to mitigate the risk that European processing capacity conceals a de facto dependence on Chinese state-backed capital within the Single Market[129].

Secondly, beyond Chinese-backed investments, other foreign industrial support schemes may also have indirect implications for competition within the single market, e.g. US industrial support schemes - including the **IRA's Advanced Manufacturing Production Credit** and the **CHIPS and Science Act**. Such schemes may also have indirect implications for competition within the single market. They constitute foreign subsidies that have demonstrably distorted investment decisions by EU manufacturers of batteries, EVs and semiconductors, pulling production toward the US[130]. While the FSR does not apply to such external policies, IMCO would be the appropriate forum for assessing whether EU companies benefiting from them operate on distorted terms within the single market.

More fundamentally, the FSR should be understood not only as a corrective instrument applied after a distortion has materialised, but also as a tool for preventing the internalisation of external strategic dependencies within the single market.

This risk is most acute in the midstream segment of critical raw materials value chains and in situations where the support of a foreign state-backed actor becomes integrated into EU-based investment projects, thereby shaping outcomes from within the EU.

[127] See the Rules of Procedure of the European Parliament, 10th parliamentary term, May 2026, Annex VI – Powers and Responsibilities of Standing Committees, Section XII: Committee on the Internal Market and Consumer Protection (IMCO).

[128] Regulation (EU) 2022/2560 of the European Parliament and of the Council of 14 December 2022 on foreign subsidies distorting the internal market (OJ L 330, 23.12.2022, p. 1, ELI: http://data.europa.eu/eli/reg/2022/2560/oj).

[129] See European Parliament resolution of 10 July 2025 on tackling China's critical raw materials export restrictions (OJ C, C/2026/1447, 31.3.2026, ELI: http://data.europa.eu/eli/C/2026/1447/oj).

[130] See Center for Strategic and International Studies, "Impacts of the One Big Beautiful Bill Act on the Mining Sector", 9 July 2025, and Hunton, "Navigating the One Big Beautiful Bill Act: Metallurgical Coal Added as "Critical Mineral" for Section 45X Tax Credits While Phasing out Credits for Other Applicable Critical Minerals", 8 July 2025.

5.2.2. Intra-EU investment distortion from asymmetric national CRM support

EU Member States possess different fiscal capacities and provide a variety of dedicated instruments (such as national raw materials funds or sovereign investment vehicles) to support CRM extraction, processing and recycling projects at the scale required. The Commission's own RESourceEU Action Plan acknowledged that "Member States are encouraged to leverage their domestic funds on CRMs to ensure the prompt roll-out of projects contributing to the EU value chain resilience"[131], which confirms the existence of differentiated national fund structures rather than a harmonised EU-level instrument.

EU State-aid rules are designed to prevent such differentiation from fragmenting the Single Market, and the Commission retains authority to grant exceptions where strategic objectives warrant them. Within IMCO's mandate, the narrower question is whether the current combination of national instruments - applied at different scales and through different mechanisms across Member States - produces the coherent EU-level investment environment that the CRMA's objectives require, or whether complementary EU-level instruments are needed alongside existing state-aid disciplines.

IMCO's engagement here could contribute to a more coordinated, EU-level approach to CRM investment support[132]. If such coordination is implemented, however, through national state schemes of uneven fiscal capabilities, it risks reinforcing existing asymmetries. Conversely, the absence of coordination would likely lead to even greater divergence. The key policy challenge is therefore not coordination per se, but that it must be organised at the level at which the underlying market failures occur. To that end, IMCO could contribute directly to the design of EU-level instruments adequate for the safeguarding of single market integrity.

From a market-governance perspective, the US DPA offers a useful point of contrast, as it authorises the federal government to prioritise contracts and expand production capacity through direct interventions, including financing and purchase commitments. While EU instruments such as IMERA primarily focus on coordination and crisis monitoring, the DPA highlights a more interventionist and direct model, by which state measures actively reorganise the market. The 2025 CRMA amendments proposal (which includes shifting the centralised identification of large companies subject to supply chain audits to EU level[133]) represent a partial response to this fragmentation risk in the regulatory domain.

The **financial support domain raises an analogous question**: whether EU-level instruments under a future sovereignty fund[134] or a dedicated CRM financing envelope are needed to complement the regulatory harmonisation already under way.

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[131] See Commission communication of 3 December 2025 entitled "RESourceEU Action Plan - Accelerating our critical raw materials strategy to adapt to a new reality", (COM(2025)0945).

[132] See European Court of Auditors, Special Report 04/2026: Critical raw materials for the energy transition – Not a rock-solid policy, Publications Office of the European Union, 2026.

[133] See European Commission, Proposal for a Regulation amending Regulation (EU) 2024/1252 (CRMA Amendment), COM(2025)946, 3 December 2025, Article 24 and recitals 12–15.

[134] See Gros, D., "A European Sovereignty Fund - Investing in Europe's Future and Security", Economic Governance and EMU Scrutiny Unit, European Parliament, July 2024.

5.2.3. Public procurement as a demand-side CRM instrument

IMCO's responsibility for the Digital Single Market regulatory framework[135] creates a structural link to CRM policy. Hardware-level requirements presuppose the availability of secure, CRM-intensive supply chains.

The hardware infrastructure on which digital and AI systems depend is itself deeply CRM-intensive: gallium nitride semiconductors for 5G and radar, rare earth permanent magnets for data centre cooling systems, cobalt for server battery backup, tantalum for high-temperature electronics, and indium tin oxide for displays and photovoltaic cells[136]. As new strategic priorities arise, IMCO can contribute to answer the question of whether the single market's digital product regulatory framework adequately incorporates CRM supply-chain resilience as a conformity, market access or procurement condition becomes more relevant.

This also highlights a broader and underexplored aspect of EU policy: the role of demand-side instruments. As the US experience demonstrates, such instruments can play a crucial role in restructuring existing supply chains. IMCO holds the competences to deploy an analogous logic within the single market. Product regulation, conformity assessment and public procurement could potentially trigger the integration of CRM supply-chain resilience as a condition for market access, thus complementing industrial policy instruments.

5.2.4. US tax credit architecture and single market fragmentation risk

While the FSR addresses distortions that materialise within the single market, external industrial policies such as the IRA present a structurally distinct but analytically related challenge: distortions that originate externally, but which indirectly reshape competitive conditions and investment decisions within the EU market. The IRA's fiscal incentive architecture (particularly the Section 45X Advanced Manufacturing Production Credit and the Section 30D Clean Vehicle Credit) created a structural pull on EU battery, EV and clean-tech investment toward the United States between 2022 and 2025. The Clean Vehicle Credit has been increasingly excluding EU-originating critical minerals and processed materials from US automotive supply chains, since qualifying vehicles required a minimum share of battery minerals extracted or processed in the United States or in a country with a free trade agreement with it – a criterion which excluded the EU, in the absence of a Critical Minerals Agreement[137].

The 2025 One Big Beautiful Bill Act's subsequent partial rollback of these incentives[138] (introducing a phase-out for critical minerals under Section 45X beginning in 2031, with the credit reduced to 75 % of its baseline value in 2031, 50 % in 2032 and 25 % in 2033, before full elimination after December 2033) has reduced but not eliminated this pull effect. Significant IRA commitments already made remain in place and the broader **US industrial policy environment continues to favour onshoring**.

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135 See Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act) (OJ L, 2024/1689, 12.7.2024, ELI: http://data.europa.eu/eli/reg/2024/1689/oj), Article 53 (Obligations for providers of general-purpose AI models).

136 See US Geological Survey, Mineral Commodity Summaries 2025, January 2025; see also International Energy Agency, Global Critical Minerals Outlook 2024, May 2024.

137 See Recommendation for a Council decision authorising the opening of negotiations of an agreement with the United States of America on strengthening international supply chains of critical minerals (COM(2023)0327).

138 See US Congress, H.R. 1 — One Big Beautiful Bill Act, Public Law 119-21, signed 4 July 2025, Section 70514 (45X phase-out for critical minerals, 2031–2033) and Sections 70502–70503 (termination of Section 30D and 45W clean vehicle credits effective 30 September 2025). For analysis, see Bipartisan Policy Center, 2025 Reconciliation Debate: One Big Beautiful Bill Act Energy Provisions, July 2025; and IRS, New Clean Vehicle Credit (30D): *Not allowed for any vehicle acquired after 30 September 2025*, IRS OBBBA Provisions summary.

From IMCO's perspective, the primary concern is the internal market consequences of the US policy: specifically, whether EU manufacturers who have shifted production to the United States to access IRA credits, or who have structured their supply chains around FEOC-compliant sourcing to qualify for those credits[139], are now operating on terms that distort competition within the single market upon re-import or in cross-border industrial partnerships.

IMCO may examine whether the EU's existing market access conditionalities (including rules of origin, carbon border-adjustment mechanisms, and FSR provisions) are adequate for addressing these distortions, or whether additional single market instruments are needed. The EU-US Critical Minerals Agreement (CMA) negotiations[140] offer the most direct means: the objective is to grant the EU an equivalent status to US free trade agreement partners, so that CRMs extracted or processed in the EU can be used in vehicles eligible for federal or state-level credits. Despite mutual commitments to intensify the negotiations, the CMA remains pending, and its future is uncertain following the re-election of Donald Trump. A well-designed CMA should include provisions on equivalent standards and reciprocal market access that prevent US **Foreign Entity of Concern** (**FEOC**) and **Prohibited Foreign Entity** (**PFE**) rules from being used as a de facto barrier to EU-sourced CRM exports to the US[141].

5.2.5. Single market access conditionalities for CRM

A recurring tension in EU CRM policy is the **interaction between supply security objectives and EU competition law**[142]. While competition and State-aid policies fall under the competence of the European Parliament's Committee on Economic and Monetary Affairs (ECON), the single market dimensions discussed are squarely within IMCO's mandate.

The **Raw Materials Mechanism** (RMM) – launched on 18 November 2025, and covering all 17 strategic raw materials[143] under the CRMA – pools the purchasing requirements of European industrial off-takers in order to facilitate long-term offtake matching with European and global suppliers [144, 145, 146]. The mechanism does not intervene in negotiations, contracts or pricing, which take place outside of the platform.

Aspects of competition law concern the cooperation that companies may engage in, through or alongside with the RMM under Article 101 and 103 TFEU. In a targeted consultation of the Commission launched in 2025, industry respondents requested further guidance on the application of EU competition rules for joint purchasing, offtake agreements, sustainability and recycling agreements in

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139 See US Department of Energy, DOE Releases Final Interpretive Guidance on the Definition of Foreign Entity of Concern, 3 May 2024. See also Congressional Research Service, Foreign Entity of Concern Requirements in the Section 30D Clean Vehicle Credit, CRS Insight IN12322, 30 September 2024.

140 The European Commission's negotiating mandate is set out in Council Decision (EU) 2023/1560 of 20 July 2023 authorising the opening of negotiations with the United States of America for an agreement on strengthening supply chains for critical minerals. As of April 2026, trade representatives from both sides held what Bloomberg reported as a "very positive" meeting, with an agreement described as close.

141 See European Parliament, Legislative Train Schedule, EU-US Critical Minerals Agreement, updated January 2026.

142 See Hornkohl, L. and Pelekis, D., State aid control as a coordinating instrument for EU industrial policy in the internal market, Yearbook of European Law, 1 April 2026.

143 The RMM is not strictly limited in practice to only those materials in all operational contexts.

144 See European Commission, EU Energy and Raw Materials Platform – Raw Materials Mechanism, launched 18 November 2025. Legal basis: Regulation (EU) 2024/1252 (Critical Raw Materials Act), Article 25 (system for demand aggregation and offtake facilitation).

145 See also European Commission, Registration opens for the Raw Materials Mechanism under the EU Energy and Raw Materials Platform, 18 November 2025. The RMM covers all 17 strategic raw materials listed in Annex I to the CRMA, with commercial negotiations taking place outside of the platform without European Commission involvement.

146 See Commission communication of 3 December 2025 entitled RESourceEU Action Plan (COM(2025)0945), Section 3 (Raw Materials Mechanism and joint purchasing).

the CRM sector[147]. Several respondents called for greater legal certainty on the application of EU competition rules to certain sustainability projects[148].

Drawing on its oversight role over single market rules, IMCO may examine whether the current design of the RMM provides sufficient legal certainty under EU competition law. In particular, it could consider whether clearer guidance or a safe-harbour framework for the joint purchasing of critical raw materials is warranted.

Such guidance could draw on the bespoke competition law framework developed for the AggregateEU gas purchasing mechanism, thereby enabling the RMM to operate with greater legal certainty for participating companies[149].

Moreover, standardisation and conformity assessment present a further avenue through which IMCO may wish to connect to the EU CRM strategy. By defining technical standards and conformity requirements, the EU can have a direct impact on supply-chain configurations and indirectly shape market conditions, thereby using the implementation of standards as an instrument of industrial policy.

IMCO's political mandate spans two objectives, which will increasingly interact as CRM markets become more significant: defending open and competitive markets, and ensuring that those markets are structured in a way that promotes resilience, diversification and strategic autonomy. These objectives are not inherently in conflict. IMCO is well placed to develop the instruments that can serve both and the EU's CRM strategy represents a concrete and timely opportunity to do so.

5.2.6. Internal Market Emergency and Resilience Act

The Internal Market Emergency and Resilience Act[150] (IMERA) constitutes the EU's principal legislative **instrument for responding to crises that threaten the functioning of the internal market**. It builds on lessons from the COVID-19 pandemic, the energy supply crisis triggered by Russia's war of aggression against Ukraine, and the 2021-2022 semiconductor shortages that exposed the fragility of Single Market supply chains.

IMERA's impact on critical raw materials is mostly indirect but significant for supply chains: IMERA is a crisis-management framework designed to keep the internal market functioning during emergencies and major disruptions.[151] In terms of legislative complementarity, the CRMA builds resilience ex ante by strengthening and diversifying critical raw material supply chains through strategic projects, benchmarks, monitoring and demand aggregation[152]. IMERA, by contrast, **protects those supply chains during a crisis**. It **ensures coordinated EU action**, **preserving the functioning of the internal market**, and preventing the unilateral national restrictions that have historically been among the most damaging responses to supply shocks.

[147] See European Commission, DG Competition, Critical raw materials — competition policy fact-finding and consultation on cooperation, 2025. Respondents requested guidance on joint purchasing, joint offtake agreements, and joint sustainability agreements; the Commission indicated it may issue a policy brief on compatibility with EU competition rules.

[148] See European Commission, Summary of the contributions received after the targeted consultation on different forms of cooperation on CRMs, including joint purchasing, joint offtake agreements and joint sustainability or recycling agreements, 2025.

[149] See the EU Energy and Raw Materials Platform for context on the AggregateEU gas joint purchasing precedent (2023–2025), which required bespoke competition law guidance to operate; the RMM raises analogous issues for CRM buyers.

[150] Regulation (EU) 2024/2747 of the European Parliament and of the Council of 9 October 2024 establishing a framework of measures related to an internal market emergency and to the resilience of the internal market (IMERA). See OJ L 2024/2747, 8 November 2024.

[151] European Parliament Legislative Train Schedule, Single Market Emergency Instrument / IMERA, Procedure 2022/0278(COD).

[152] Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials (Critical Raw Materials Act, CRMA), OJ L 2024/1252, 23 May 2024.

Together, they **form the EU's integrated framework for raw material security and strategic autonomy**: the CRMA acts as the structural foundation, and IMERA as the emergency safeguard[153].

The operational link between the CRMA and IMERA runs through the monitoring architecture. CRMA Article 23 establishes a permanent system of Member State monitoring of strategic raw material supply chains, with early warning mechanisms and bottleneck identification[154]. Where this monitoring reveals a credible threat of a Single Market disruption, IMERA Title II permits the Council to activate vigilance mode, enabling enhanced monitoring of crisis-relevant supply chains and the build-up of strategic reserves.

Where the disruption materialises, IMERA Title III emergency mode unlocks priority-rated requests to economic operators for crisis-relevant products, fast-track conformity assessment procedures, and derogations from product-specific rules.

The relevance of IMERA to CRMs is not merely prospective: it has been thrown into sharp relief by events in 2025 that preceded IMERA's date of application. China introduced two waves of **export controls on rare earth elements** (**REEs**) – in April and October 2025 – covering seven and subsequently twelve heavy rare earth elements respectively, with the second wave carrying extraterritorial reach over internationally produced goods containing Chinese-sourced REE materials or manufactured using Chinese technologies[155]. The economic impact was immediate and severe: European REE prices reached up to six times those in China following the April 2025 controls, and European carmakers, electronics producers and defence supply chains faced production halts as permanent magnet availability collapsed[156]. The April–October 2025 REE episode was the first real-world test of this configuration: had IMERA already been operational, the vigilance threshold would plausibly have been crossed in mid-2025, with emergency mode under consideration by October 2025[157].

IMCO is uniquely positioned in this architecture. As the committee responsible for both the internal market crisis-response framework and, through its oversight role, for the Single Market conditions in which CRM supply chains operate.

5.3. Relevance for ITRE

5.3.1. De-risking and financing CRM projects

Stakeholder interviews, CRMA impact assessments[158] and ECA findings[159] have highlighted that one of the fundamental challenges to achieving the 2030 CRMA targets is **project bankability**.

153 The CRMA/IMERA complementarity is explicitly framed in European Commission, RESourceEU — Securing Europe's Access to Critical Raw Materials, COM(2025) 945 final, 3 December 2025, which positions IMERA as the crisis-response instrument activatable 'whenever necessary' to protect the internal market against CRM supply chain disruptions (p. 12). See also European Parliamentary Research Service (EPRS), Internal Market Emergency and Resilience Act (IMERA), 2023.

154 Regulation (EU) 2024/1252, Article 23 (monitoring and stress testing of strategic raw material supply chains).

155 European Parliamentary Research Service (EPRS), China's Rare-Earth Export Restrictions, EPRS At a Glance PE 779.220, November 2025.

156 IEA, 2025, With new export controls on critical minerals, supply concentration risks become reality.

157 European Commission, RESourceEU Action Plan — Accelerating our critical raw materials strategy to adapt to a new reality, COM(2025)945, 3 December 2025, p. 19: "From Q2 2026 and whenever necessary, the Commission will mobilise the IMERA toolbox to protect the internal market against supply disruptions on the CRM value chain."

158 Commission staff working document of 16 March 2023 entitled Impact assessment report accompanying the Proposal for a Regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020 (SWD(2023)0016).

159 European Court of Auditors, Special report 04/2026: Critical raw materials for the energy transition – Not a rock-solid policy, 2 February 2026.

Reaching these goals would require a more robust financial architecture capable of de-risking long-term investment, providing the **stability** and **scale** necessary for achieving and maintaining EU strategic industrial autonomy.

Implementation of revenue-stabilisation mechanisms for CRM projects

- Modelled on their success in the renewable energy sector sector under Directive 2018/2001 (RED II), **two-way CfDs** could be introduced[160] as a mechanism for providing revenue certainty, with the aim of de-risking projects and securing private project financing. The CRM Financing Hub[161] is designed to coordinate specific system interventions with which the introduction of such CfD would align;
- More sophisticated schemes could be examined on a case-by-case basis. For example, a CfD could be paired with a "**buyer of last resort**" mandate, where the backing authority purchases surplus production during global price crashes to prevent the mothballing of domestic projects, similar to a price floor mechanism[162]. Conversely, during periods of high demand, it could exercise a "**right of first refusal**" or priority offtake rights, to ensure that strategic industries remain supplied.

Bridging the funding scale gap

The current scale of EU public support (EUR 5-6 billion) is five to ten times smaller than US efforts, and falls far short of the estimated EUR 17-22 billion in public support needed to reach the EU's 2030 targets. Public capital could be leveraged to **attract private investment**, by accepting lower rates of return and longer-term positions than traditional commercial banks.

5.3.2 Sustaining competitiveness despite the "stability premium"

Decreasing risk always comes with a premium

Resilient, diversified CRM supply will be inherently more expensive than simply sourcing from China-dominated markets. **Building resilient supply chains therefore comes with unavoidable additional costs that must be explicitly addressed**. These costs should not, however, be considered in isolation. The cost of inaction (of failing to secure a diversified value chain) is substantial; even a short-term shortage of any of the CRMs can halt entire European manufacturing and energy-transition value chains[163].

160 At the time of writing, this is an instrument considered by ITRE members in the "Amendments to the Critical Raw Materials Act" file; see the Legislative Observatory, 2025/0385(COD).

161 IEA, (last updated) 31 May 2026, RESourceEU Action Plan.

162 In the February 2026 IFRI report, entitled "Financial Tools for Boosting Resilience of CRM Value Chains and Strategic Stockpiling", the authors indicate: "This mechanism is most appropriate in rather small markets like the rare earth elements (REE), with opaque price formation, high processing complexity and high capital requirements, where diversification is particularly difficult due to domination by a single player or because these are companion metals whose production is not sensitive to price signals".

163 Commission proposal of 4 March 2026 for a regulation establishing a framework of measures for the acceleration of industrial capacity and decarbonisation in strategic sectors and amending Regulations (EU) 2018/1724, (EU) 2024/1735 and (EU) 2024/3110 (COM(2026)0100).

Limiting the stability premium

As highlighted in Section 0, public authorities could actively reduce cost gaps and de-risk investment, thereby reducing the cost of capital. Nonetheless, industry and ultimately consumers may still have to absorb a share of the burden.

Additional EU-level measures have the potential to reduce the overall cost of resilient supply chains, such as:

- boosting **CRM circularity** (see Section 5.3.6);
- introducing **ESG**[164] **and defence** procurement criteria (see paragraph 0); or
- establishing **strategic stockpiling mechanisms** (see paragraph 0).

Addressing high energy prices

As with most ongoing and upcoming policy files, energy costs are the elephant in the room for the ITRE Committee. The ambitious targets for domestic capacity collide with the reality of Europe's high industrial power prices.

Energy can represent a substantial share of operating costs in CRM refining, particularly for electricity-intensive steps like copper refining, graphitisation of carbon material, lithium conversion and rare earth processing[165]. The literature and policy sources also argue that **refining**, not mining, is often where the energy burden becomes most material.

There is a clear risk that diversification efforts fall short if the cost of refining a material in Europe is significantly higher than the cost of importing it from a dominant supplier. High energy prices therefore discourage private investment in the mid-stream segment of the value chain, where margins are already thin.

To bridge this gap and maintain industrial competitiveness, the ITRE Committee could examine several policy levers:

- Although CRM projects are final electricity consumers with theoretical access to long-term, fixed-price power purchase agreements (**PPAs**) under the 2023 Electricity Market Design reform, in practice, barriers remain[166]: PPA providers typically require off-takers to have robust balance sheets, while CRM ventures usually struggle to meet stringent credit requirements. Establishing a **dedicated framework** that provides EU- or Member State-backed credit guarantees for "Strategic CRM Projects" would de-risk these contracts. By unlocking access to long-term, fixed-price PPAs, CRM projects could achieve the price certainty necessary to satisfy lenders and achieve true project bankability;

[164] ESG stands for "Environmental, Social and Governance".

[165] Mining SEE, Powering the metals economy: why electricity costs will shape Europe's new critical minerals refining industry, 12 March 2026, provides the following estimations:

For copper refining, energy costs may represent 20 to 30 % of operating costs;

For graphite processing, energy costs can reach 30 % of production costs;

For lithium conversion, energy costs represent 10 to 15 % of operating costs.

For rare earths, Discovery Alert, Advanced Heavy Rare Earth Separation Technologies and Market Developments, 7 November 2025, states that: "[for] traditional heavy rare earth separation [...] energy costs comprise 25 to 35 % of total production expenses".

[166] Zachmann, G., and Heussaff, C., Phased European Union electricity market reform, Bruegel, 2023.

- Leveraging the benefits of **flexibility** to reduce electricity costs. Some refining processes, such as electrowinning, can be adjusted to match energy availability[167]. By modulating their power intake (reducing demand during peak hours and increasing it when renewable supply is high) these facilities act as "industrial batteries".

5.3.3. Leveraging ESG, defence and decarbonisation to strengthen CRM value chains

Integrating ESG criteria, defence-related procurement and decarbonisation strategies can help CRM sourcing move from a price-driven exercise into a resilience-based model. Such policy tools can be activated to incentivise diversified, low-carbon EU supply chains.

From price-only to resilience-based procurement

Moving away from decisions based only on price and, instead, focusing on strengthening resilience in procurement, is essential to ensure **stable demand for diversified CRM** (both in the public and private sectors). ESG and resilience conditions under the Net-Zero Industry Act[168] (**NZIA**) can play a concrete role in facilitating this shift. For example, public support schemes (such as for EVs) can be linked to requirements that companies source critical inputs from at least two suppliers or to cap dependency on a single supplier to a maximum percentage. Procurement criteria could also **reward the use of recycled or secondary raw materials**, with measurable recycled content thresholds treated as a positive scoring factor alongside supply diversification.

This creates a direct market signal incentivising investment in EU-based recycling capacity while simultaneously reducing the aggregate demand for virgin primary materials. Alternatively, specifications could incorporate material efficiency and recyclability requirements at the design stage. This reduces long-term material dependency for maintenance and replacement cycles and creates a sustained domestic demand signal for secondary CRM producers.

Additional tools, such as 'Made-in-Europe' clauses for access to EU funding or preferential treatment for projects with diversified supply chains under the proposed Industrial Accelerator Act (**IAA**), can further incentivise firms to internalise the cost of resilience rather than treating it as optional.

By linking financial support, regulatory benefits or priority processing status to criteria such as a minimum share of EU-based production, reduced dependence on single-country suppliers, or measurable progress in using recycled materials, the IAA can make resilience a core condition for eligibility and scoring. This, in turn, strengthens the business case for investing in diversified CRM supply chains, encourages the development of EU-based midstream capacity, and supports a more stable, diversified CRM value chain across the EU.

Defence as an anchor for securing CRM demand

The defence and security-related procurement framework offers another powerful anchor for demand for domestically produced or diversified CRMs.

167 Australian Renewable Energy Agency, Intermittent Dynamic Electrowinning Using Renewable Energy.

168 Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724 (OJ L, 2024/1735, 28.6.2024, ELI: http://data.europa.eu/eli/reg/2024/1735/oj).

As defence-procurement rules are to be revised in 2026, they could explicitly include **provisions to favour diversified supply chains**[169] and to support re-shoring or near-shoring of CRM production where strategic autonomy is at stake. This can take the form of resilience-based scoring in tenders, set-aside quotas for EU-sourced CRMs, or dedicated funding for defence-related pilot refineries and processing capacities.

By treating security of supply as a core requirement, the EU can create a predictable demand base that helps de-risk midstream investments and absorbs part of the "stability premium".

Stranded-asset risk and the stability premium in a low-carbon transition

As the EU-ETS and CBAM regimes tighten, high-carbon, non-compliant midstream facilities are at increasing risk of becoming stranded assets[170]. Refineries, smelters and chemical separation plants that rely on unabated fossil-fuel combustion or inefficient electricity-intensive processes face higher compliance costs, reduced competitiveness in comparison to low-carbon competitors, and a shrinking window of financial viability. In this context, the "stability premium" should not only be understood as compensation for supply-chain diversification, but also as a **necessary upfront investment in low-carbon**, **energy-efficient technologies** that preserve the long-term viability of EU-based capacity.

Such investments reduce exposure to rising carbon prices and CBAM-related costs, while simultaneously lowering operating emissions and aligning with the EU's climate-neutrality objectives. By internalising part of the decarbonisation transition now, the EU can avoid committing to a midstream infrastructure that would otherwise become obsolete or unprofitable within the coming decades.

5.3.4. Importance of identifying the entire supply chain of CRMs

Scientific literature and consulted stakeholders point at the lack of macro-level guidance in the current supply-chain analysis and existing policy frameworks[171]. The complexity of the value chain from the start (raw materials) to the downstream application (end-use technologies) requires a crucial extension of the view over the entire supply chain of a specific critical minerals, rather than just one sector.

This includes the whole life cycle of the material and the end-use technology. The lithium battery-based supply chain is a classic example, where China lacks some of the necessary primary resources – such as cobalt – but has secured its global dominance in every part of the midstream and downstream supply chain by having a total share in purification and smelting technology of all the materials[172].

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[169] Tothova, L. and Clapp, S., EU joint defence procurement, European Parliamentary Research Service, March 2026: 'European Council President António Costa highlighted a broad consensus among EU leaders on the strategic imperative to strengthen Europe's defence sector, including by mapping and reducing critical dependencies through diversification and applying a European preference to safeguard key capabilities. The defence readiness roadmap notes that at least 55 % of total investment should go to Europe by 2030. Across EDIRPA, SAFE and EDIP, the 'buy European' principle is expressed through a 35 % rule. To receive EU support, the cost of components originating from non-associated third countries may not exceed 35 % of the estimated total component cost'.

[170] Caldecott, B., Tilbury, J., Carey, C., Stranded Assets and Scenarios, University of Oxford: Smith School of Enterprise and the Environment, January 2014: "Stranded assets are assets that have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities. They can be caused by a range of environment-related risks and these risks are poorly understood and regularly mispriced, which has resulted in a significant over-exposure to environmentally unsustainable assets throughout our financial and economic systems. Current and emerging risks related to the environment represent a major discontinuity, able to profoundly alter asset values across a wide range of sectors".

[171] Helbig, C., Gemechu, E.D., Pillain, B., Young, S.B., Thorenz, A. et al., Extending the geopolitical supply risk indicator, *Journal of Cleaner Production*, 20 November 2016.

[172] Greitemeier, T., Kampker, A., Tübke, J., Lux, S. et al., China's hold on the lithium-ion battery supply chain: Prospects for competitive growth and sovereign control, *Journal of Power Sources Advances*, Vol. 32, April 2025.

As described in section 0, the White House has identified the need for an entire supply-chain evaluation and incorporated it into its manufacturing and defence industrial base supply-chain resilience during President Trump's first term[173]. Mapping the whole supply chain and identifying the choke points is a part of the US strategy to achieve independence from foreign suppliers across the board. Besides the government-backed databases and projects (CMiO database, USGS-run Critical Minerals Mapping Initiative), commercial databases (Exiger – a supply chain management provider) help the government and companies track and secure critical minerals supply chains.

To identify and prevent bottlenecks, the US Government is investing in AI, as seen in the recent Critical Minerals and Materials to Unlock Supply initiative (CM²US) hosted under the DOE[174]. Early success stories of start-ups in the United States using AI to drastically speed up the mining discovery process have already emerged, including the use of algorithms trained on massive amounts of existing data to pinpoint hydrothermal systems likely to hold mineral deposits (Earth AI) or the generation of thousands of underground maps using geological data (Terra AI). Exiger uses an AI model to break down and analyse entire supply chains and risks by acquiring commercial datasets.

Under the CRMA, the EU sets the monitoring and stress-testing of CRM supply chains as a priority, regarding supply-chain resilience, but it does so through a more regulatory and centralised approach (Raw Materials Information System).

Several actions could be considered to identify and meaningfully target CRMs across entire supply chains:

- **Standardise supply-chain reporting**: extending the EU battery passport (Battery Regulation) to other downstream products holding global shares in the EU market;
- **Invest in stress-test methodology**: already flagged in the CRMA as an important action, the EU must invest in mapping entire value chains to be able to identify critical points and plan accordingly;
- **Build real-time monitoring capacity**: structure the access to shipping data and price signals to identify weak points in the supply chain through private-public initiatives;
- **Involve AI in identification**: currently, the EU is lagging in the use of AI in this sector. Imbedding AI capabilities through EU funded initiatives would unlock the necessary policy steps in the future.

5.3.5. The EU's potential across the value chain

To realise its full potential and ensure the resilience of its CRM supply chain, the EU may consider the following actions across the successive stages of the value chain:

- **Upstream**: improve geological mapping data (exploration) to find new mineral deposits sites, incentivise sustainable mining and utilise unrealised domestic mining potential;
- **Midstream**: secure access to feedstock through domestic production, recycling and international agreements, lower energy prices given the highly energy intensive nature of the

[173] US Department of Defense, Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States: Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806, September 2018: "The industrial base encompasses the extraction and refinement of primary materials, the manufacturing of components and parts, and the integration and sustainment of defense platforms and systems".

[174] AMES National Laboratory AI-Powered National Lab collaboration launches to secure US critical minerals supply, 12 December 2025. The initiative (under the Genesis Mission) brings together 12 US DOE national laboratories and is supported by private-sector partners.

processes involved, scale up the existing midstream capabilities, invest in emerging technologies;

- **Downstream**: secure existing industrial capabilities in advanced manufacturing and materials (advanced materials, battery components, clean industry applications), recycling, sustainable and low-carbon processing, and innovative technologies in areas where foreign players (mostly China) do not hold monopolies.

Upstream

The EU extracts a small number of raw minerals and metals, and its output remains limited relative to global production. Estimation of the EU's current share in the global production of raw materials range from 5 % to 8 %, depending on the sources. Despite this overall low figure, the EU maintains a significant global share for specific materials[175]:

- **Strontium**: Spain extracts **34** % of the global supply;
- **Feldspar**: Italy, Spain, France, Czechia and Germany account for **14** % of global production;
- **Tungsten**: Austria, Portugal and Spain contribute **3** % of the global supply;
- **Nickel**: Finland and Greece are major EU sources, with Finland doubling production recently to supply **38** % **of EU consumption**;
- **Hafnium**: France is the main producer of hafnium (Framatome). Together with the United States, it holds a significant majority of the global market share[176]. It is not mined, but recovered as a by-product of nuclear-grade zirconium production.

On the other hand, for many critical minerals, the EU does not have its own primary production, and so remains fully exposed to the risks foreign supply: molybdenum, titanium, magnesium, boron and REEs. Some industries (silicon metal and manganese) have seen serious decline in production capacity in the EU, with the silicon industry operating at approximately 30 % of its installed capacity today and covering about 15 % of the EU’s own needs, with the rest being imported from China.

Large silicon metal producer Ferroglobe (France and Spain) recently announced the suspension of its entire production in Europe, citing the detrimental effects that soaring energy prices and global overcapacity have had on the sector, and advocating for urgent strategic safeguard measures against collapsing demand and falling prices driven by low-cost imports[177]. MEPs have expressed their concern[178, 179, 180] to the European Commission on the exclusion of silicon metal from the list of elements in the implemented regulation imposing them for other ferroalloys[181].

175 European Commission, Study on the critical raw materials for the EU 2023 – Final report, Publications Office of the European Union, 2023.

176 Consegic Business Intelligence, 2025.

177 industriAll, Critical Raw Material Sectors Warn of Collapse Without EU Action, 13 November 2023.

178 European Parliament, Parliamentary question for written answer on silicon metal, 14 April 2026.

179 European Parliament, Parliamentary question for written answer on the situation of the silicon industry in Europe and in France, 15 September 2025.

180 European Parliament, Parliamentary question for written answer on the potential inclusion of silicon metal and calcium silicon in ferroalloy safeguard measures, 25 February 2026.

181 Commission Implementing Regulation (EU) 2025/2351 of 18 November 2025 imposing a definitive safeguard measure with regard to imports of certain ferro-alloying elements. (OJ L, 2025/2351, 18.11.2025, ELI: http://data.europa.eu/eli/reg_impl/2025/2351/oj).

The Commission has selected several strategic projects for CRM extraction, focusing mostly on lithium (Finland, France, Czechia, Portugal and Spain), and tungsten, cobalt, platinum group metals, nickel and copper (Spain).

According to the USGS, the Europe has vast unrealised potential regarding lithium resources (Germany, Czechia, Serbia, Spain, Finland, Austria), which could secure about 30 % of its 2030 targets[182]. Additionally, there are further prospects for cobalt production[183] (Finland, the Balkans, central and northern Europe) as well as for rare earth elements[184] (Sweden, Norway, Finland, the Balkans).

Accurate geological mapping is a prerequisite for identifying viable extraction sites for CRMs. Currently, general exploration remains underdeveloped across many EU regions, leaving the true extent and quality of deposits largely unknown. This knowledge gap can be attributed to decades of underinvestment; with the EU accounting for only **2 % to 3 % of global exploration spending**, the bloc lacks a comprehensive understanding of its local resource potential.

To improve the consistency of geological data across the continent, the EU has championed several harmonisation initiatives. Central to this effort is **EuroGeoSurveys**, an umbrella organisation representing national geological surveys, which maintains an open-access infrastructure for pan-European maps and datasets. A key pillar of this strategy is the **Geological Service for Europe**[185], a project backed by nearly EUR 20 million in Horizon Europe funding and designed to centralise and standardise subsurface information.

Some countries (mainly the United States and China) have started looking into exploring deep-sea mining[186].

Midstream

The weakest point in the value chain of CRMs in the EU lies in scaling up the midstream sector. This part of the chain refers to refining, purifying and converting raw minerals or ores into industrial materials (alloys, powders, oxides) used in subsequent manufacturing processes.

The choke point of this step is scaling up the processing capacity, which would reduce the present gap between the technology and its industrial-scale deployment. Even if the upstream capacity is ramped up in the future, unless the EU finds the way to bridge the midstream gap, its dependency on non-EU actors, in this regard, will never be resolved.

As with most supply-chain activities involving CRMs, China dominates midstream processing and the EU's dependence on Chinese-refined CRMs exposes it to vulnerabilities in key sectors, such as the automotive, defence and clean and renewable energy sectors. China is the lead refiner of 19 out of 20 important strategic minerals, with an average market share of 70 % [187]. In the cases of some minerals, Europe's dependency even exceeds 85 %: germanium, tungsten, gallium and natural graphite.

182 Transport & Environment, The Critical Raw Materials Act must tackle supply problems in line with European values – T&E position paper on how the EU Commission's draft law can be improved, 26 April 2026.

183 Horn, S., Gunn, A.G., Petavratzi, E., Shaw, R.A., Eilu, P. et al., 2021, Cobalt resources in Europe and the potential for new discoveries, *Ore Geology Reviews*, Vol. 130, March 2021.

184 Goodenough, K. M., Schilling, J., Jonsson, E., Kalvig, P., Charles, N. et al., Europe's rare earth element resource potential: An overview of REE metallogenetic provinces and their geodynamic setting, *Ore Geology Reviews*, Vol. 72, Part I, January 2016.

185 EuroGeoSurveys, Strategic Research and Innovation Agenda – Building a Geological Service for Europe, March 2025.

186 Executive Order 14285 of 24 April 2025 ordered agencies to fast-track permitting processes for seabed mineral exploration and commercial recovery projects, and expand public-private involvement in deep-sea mining operations.

187 International Energy Agency, Global Critical Minerals Outlook 2025, 21 May 2025.

The EU does have some midstream processing abilities (mostly in battery-grade refining and battery chemicals), but its capacity for this is still limited. It relies heavily on imported quality-grade and refined chemicals and minerals, such as manganese and gallium. Some steps have been taken towards increasing refining capacity, with Neo Performance Materials – Europe's largest permanent rare earth magnet factory – which opened in Estonia in 2025.

However, given the current key bottlenecks (outlined in Annex I), EU production cannot compete on price alone, and must find a way to address the critical midstream gap, possibly by looking into:

- **Scaling up and strengthening existing capacities**: production of ferroalloys, natural and synthetic graphite, battery-grade chemicals, rare earth permanent magnets;
- **Innovating in emerging processing technologies**: e.g. hydrometallurgical methods, direct lithium extraction, direct recycling methods, CRM substitution (silicon replacing graphite in EV batteries), geothermal lithium technology, novel synthetic graphite;
- **Increasing recycling rates** to ease the demand pressure on virgin materials;
- **Developing mineral-specific approaches**;
- **Creating hubs for CRMs**: Neo Performance Materials having opened near the existing rare earth separation facility in Estonia, which is producing the necessary raw materials, is a leading example.

Downstream

The EU holds a competitive position in downstream, high-value manufacturing and specialised materials, supported by a strong industrial base. European industry is particularly advanced in high-performance and engineered materials, precision components for aerospace and defence, and certain segments of metals and industrial processing. There is major potential for the EU to develop further downstream activities, such as low-carbon ferroalloy production and battery-grade chemicals. It is also one of the world's largest markets for clean technologies, and accounts for a large number of high-value innovations and holds patents on inventions in several technologies: wind, heat pumps, electrolysers, photovoltaics, batteries and CCUS (carbon capture utilisation and storage)[188, 189].

In order to be competitive and ensure the resilience of the supply chains, the policies could focus on:

- **Fully identifying supply chains** (upstream and midstream);
- **Securing access to CRMs and refined products** across supply chains; and
- **Scaling up existing technologies**: advanced materials, emerging battery innovation, clean industry applications.

188 Widuto, A., Clean tech in the energy sector, European Parliamentary Research Service, January 2025.

189 Joint Research Council, 'European Climate Neutral Industry Competitiveness Scoreboard 2022', 2023.

Box 8: The road to a European battery value chain

The EU's strong policy support for battery production and recycling presents a unique opportunity to establish a sustainable, circular and sovereign battery manufacturing ecosystem. At the heart of this strategy is the Battery Booster Package[190], which aims to accelerate investment and industrial scale-up across the entire European battery value chain – from raw materials to end-of-life recycling. However, China's dominance in global midstream and downstream CRM processing (with the exception of nickel[191]) and the recent sectoral crises, such as the bankruptcy of Northvolt, highlight the vulnerabilities of the European battery supply chain. Despite these hurdles, Europe retains clear ways of diversifying its supply chain and achieving battery independence. Its main competitive advantage lies in innovation across the supply chain[192].

Upstream processes

The EU faces a significant lack of primary resources, relying entirely on imports of CRMs needed for nickel manganese cobalt battery production. However, it strategically holds significant shares in global extraction facilities – particularly for nickel, cobalt and manganese, though not for lithium[193].

Besides acquiring primary resources, to mitigate this dependency, the EU is leveraging:

- emerging technologies and innovation, such as the Vulcan Energy project in Germany, which plans to use direct lithium extraction to produce 24 000 tonnes of lithium hydroxide[194];
- resource recovery from mining waste and tailings ("remining"[195]), such as the recently launched project in Czechia, which is based on the remining of manganese, demonstrating the potential of circular mining processes[196].

Midstream processes

The EU has significant potential in the midstream processing of key battery metals, but needs to ramp up domestic projects to avoid competition for the same elements.

Some key leverage points for the EU, in this regard, are its knowledge and technology in:

- midstream processing of battery materials (e.g. nickel-based, sodium-ion cathode materials)[197];
- midstream reintegration of recovered materials into battery production[198].

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190 European Commission, 'Commission takes action for clean and competitive automotive sector', 16 December 2025.

191 International Energy Agency, The global midstream and downstream battery supply chain, 2024, last updated 17 October 2025.

192 Commission communication of 17 May 2017 entitled "Europe on the Move – Sustainable Mobility for Europe: safe, connected and clean", (COM(2018)0293).

193 Greitemeier, T., Kampker, A., Tübke, J., Lux, S. et al., China's hold on the lithium-ion battery supply chain: Prospects for competitive growth and sovereign control, *Journal of Power Sources Advances*, Vol. 32, April 2025.

194 European Investment Bank, Germany: Vulcan Energy secures €250 million EIB financing for landmark lithium project, 3 December 2025.

195 See the report by the Joint Research Council entitled Recovery of critical and other raw materials from mining waste and landfills, 2019: "Four of these chapters address technological processes for the recovery of different materials from mining tailings and industrial waste, as in the case of the Penouta mine, the CHROMIC project, biohydrometallurgy at the Kasese mining site, and the REDMUD project".

196 Euro Manganese, Chvaletice Manganese Project.

197 European Economic and Social Committee, Enhancing EU strategic autonomy and developing a greener and bluer economy: the potential of the sodium battery manufacturing sector, 18 February 2026.

198 Critchley, L., Sustainable Battery Recycling Innovations Across Europe, Battery Technology, 19 March 2019.

The EU could continue to direct midstream production support through instruments such as the Battery Booster. BASF's Black Mass plant in Germany is an example of the potential of this technology[199].

Downstream processes

The downstream segment of the supply chain remains the EU's main supply vulnerability. China dominates more than 90 % of the sodium-ion battery production chain[200]. European battery cell capacity is currently expanding mainly through foreign investment[201]. Given the large number of European players in this segment (machinery, battery packs, assembly), the EU could consider ramping up targeted public and private investment in scale-up and in emerging technologies.

Source: The authors, based on the sources in the text.

5.3.6. Recycling and circular economy-based supply chains

Circularity is viewed as a strategic leverage point for the EU, complementing midstream processing and reducing demand for primary, refined and processed CRMs, and could be benchmarked through recycling efficiency, collection and waste channelling, product lifetime extension, and reduction indicators of overall mineral consumption.

Alternative materials

A recent market shift from fluoresecent lights to light emitting diodes (LEDs) followed by the next generation technology CRM-free organic-LEDs (with the exception of indium) showed the potential that substitution materials have in reducing the consumption of CRMs in wide adopted technology[202]. Alternative materials can replace CRMs at the material or technology/component level.

At the material level, research has shown several minerals exhibiting promising properties indicating to significant potential for CRM replacement such as cobalt – manganese[203], indium – graphene[204], lithium – zinc[205], gallium – silicon-based metal[206] etc.

When an alternative to a CRM is considered, it is important to note that:

- Possibility of a substitution is highly dependent on the nature of the end-use product/application;
- Earth abundance, mineable reserves and security of supply of the alternative material need to be considered;
- Improving critical material efficiency and chemical processes during manufacturing should also be considered where CRM substitution is not feasible.

199 BASF, BASF starts commercial operation of Black Mass plant for Battery Recycling in Schwarzheide, Germany, 3 June 2025.

200 International Energy Agency, Global Critical Minerals Outlook 2025, 21 May 2025.

201 Jugé, M., Keliauskaitė, U., McWilliams, B., Tagliapietra, S., Europe has a solid basis for battery and electric vehicle manufacturing growth, Breugel, 16 December 2025.

202 Pavel, C. C. et al., 2016, Critical raw materials in lighting applications: Substitution opportunities and implication on their demand.

203 Fang, K. et al., 2021, Understanding the feasibility of manganese substitution for cobalt in the synthesis of nickel-rich and cobalt-free cathode materials.

204 Arvidsson, R. et al., 2016, Energy and resource use assessment of graphene as a substitute for indium tin oxide in transparent electrodes.

205 Parker, J. F. et al., 2017, Rechargeable nickel3d zinc batteries.

206 Imthurn, G. P., 2009, Silicon-on-sapphire, a replacement for gallium arsenide?.

The battery sector leads in the development of CRM-free technologies, with cheaper nickel-rich, sodium-ion or cobalt and nickel-free lithium iron phosphate batteries gradually replacing cobalt-rich lithium ones. Regardless, Li-ion batteries can not be fully replaced in large-scale storage applications; their relatively lower performance must be weighted against the much lower supply risk of the raw materials and substantial investment potential of the alternative technology (prior to the 2023 EU list update, nickel was not even considered a CRM)[207].

The substitution of CRMs in low-carbon technologies such as wind turbines, photovoltaics and electric vehicles is also being extensively researched, with the replacement of REEs being of great interest. Progress in magnet manufacturing techniques, wind generator design and development of alternative REE-free generators are all promising strategies for reducing the use or REEs in wind turbines[208]. Ferrite magnets have successfully replaced REEs ones in home appliances. However, their utilisation in clean or low-carbon technologies is not feasible due to significantly lower strength and resistance. In addition to alternatives, another approach to reducing CRM overall demand is increasing material efficiency through advanced (novel) manufacturing techniques, e.g. 3D printing.

Whenever substitution would either not be technically or economically feasible at the material level, a change at the technology level in the midstream processes could be considered instead. Induction motors (instead of REE permanent magnet motors) are being considered by car manufacturers and multipolar synchronous generators or hybrid drive generators could potentially replace magnets inside wind turbine generators.

Recycling

Recovery of more than a third of the CRMs faces serious technological challenges, in particular from electronic devices. **For some CRMs**, **recycling technologies do not yet exist** or the processes are not economically feasible, requiring additional research for the discovery of novel processes.

Vast majority of today's CRMs are recovered through pyrometallurgy and hydrometallurgy processes, with both methods being highly efficient, but also costly and, more importantly, energy intensive. Novel techniques such as organic acid extraction, deep eutectic solvents, bioleaching and direct recycling (for example "cathode to cathode" recycling of batteries) are promising affordable and sustainable alternatives.

In general, European recycling chains are well established for metals such as aluminium, copper and nickel. However, recycling other CRMs presents several challenges, as highlighted in a 2026 report by the European Court of Auditors (see Annex I):

- The need for complex separation technologies;
- Collection relying on streams of heterogeneous waste materials; and
- A persistent lack of recycling feedstock (e.g. platinum group metals, permanent magnets).

The EU's recycling potential spans several sectors and products.

- The most promising segment is battery recycling capacity, where the EU could achieve the recycling of all EU-disposed batteries by the end of 2030, given the right conditions[209] –

[207] Intellectia Stock News, 2026, Surge in Sodium-Ion Battery Demand Makes Salt a Hot Commodity.

[208] Pavel, C.C. et al., 2017, Substitution strategies for reducing the use of rare earths in wind turbines.

[209] Bünting, A., Sprung, C., Dietrich, F., Bierau-Delpont, F., Vorholt, F. et al., 2023, Resilient Supply Chains in the Battery Industry, published by VDI/VDE Innovation + Technik GmbH, on behalf of the German Federal Ministry for Economic Affairs and Climate Action, March 2023.

see Box 8. Many strategic projects launched under the CRMA address the battery supply chain;

- Decommissioned wind turbines are a great source of permanent magnets, with recent advances in technology showing that all magnet components can be recycled;
- There are currently no viable developed techniques for recycling CRMs from solar modules, except for silicon.

The EU holds real potential in CRM recovery, provided it maintains existing recycling infrastructure and invests in emerging technologies. Due to a large number of wind turbines and solar panels that will be decommissioned by 2035, the EU needs to be forward-thinking when it comes to recycling of low-carbon technologies. Besides closed-loop recycling (materials are recycled in the same application), which will be limited in the short-term for low-carbon technologies due to the relatively long lifetime of technologies, the potential exists in **secondary recovery** – e.g. from industrial and municipal waste. Number of projects such as waste incineration plants in the Netherlands, Denmark, Switzerland, Sweden and Poland show the potential of this process. In addition, projects such as LIFE INSPIREE[210], which opened Europe's first industrial-scale plant for recycling REEs from waste electrical and electronic equipment), and REECOVERY[211], which focuses on recovering rare earths, cobalt, and copper from acidic mining water, show the EU's potential and edge in recycling and material recovery.

Growing US federal support for the circular strategies for critical raw materials is seen through the bipartisan support of the Promoting Resilient Supply Chains Act of 2025 and the Intergovernmental Critical Minerals Task Force Act[212, 213]. The DOE in its one-billion-dollar worth of NOFOs announced support for projects to advance battery recycling, recovery from mining and metal byproducts and recovery of critical minerals from industrial waste water[214].

All the considerations of this section also apply **to recycling projects**. For example, CfD instruments could be explicitly extended to secondary raw material producers and recyclers, not only primary extraction and refining projects. Recycling facilities face comparable revenue uncertainty to mining ventures, since price volatility of recovered materials undermines project bankability in precisely the same way. Similarly, joint purchasing mechanisms coordinated at EU level (potentially through the CRM Centre) could further aggregate demand for recycled content, providing the offtake certainty that recycling projects currently lack.

5.3.7. CRM list: where to start?

The EU's CRM list comprises 34 elements, 17 of which are classified as strategic raw materials (SRMs), making it a challenge to determine which supply chains, if any, should take priority.

While all listed materials are deemed critical, limited funding renders it impractical to secure the extraction or production of each.

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210 European Commission LIFE Public Database, Industrial Production of mixed Rare Earth Elements oxides and carbonates from spent magnets recycling, project reference LIFE22-ENV-IT-INSPIREE/101113882.

211 The REECOVERY project is funded by EITRawMaterials.

212 US Congress, Promoting Resilient Supply Chains Act of 2025, HR2444, 119th Congress.

213 US Congress, Intergovernmental Critical Minerals Task Force Act, HR3198, 119th Congress.

214 DOE announced actions to secure American critical minerals and materials supply chain.

By assessing existing downstream capabilities, emerging technologies within the EU, and stakeholder insights, several key areas have been identified as of high importance to the EU's industrial and market landscape:

- **Permanent magnets**, given their widespread use across many products in critical industrial sectors, and the EU's complete reliance on China throughout the entire supply chain;
- **Clean-energy technology**, owing to the EU's competitive advantage in high-level technology, downstream capacities and its supportive regulatory and industrial framework;
- **Thin film technology**, essential in the semiconductor and electronics sectors (particularly in chip production and processing technology), and the clean-energy industry (notably in emerging photovoltaic technologies), offering opportunities to diversify highly locked-in supply chains.

5.3.8. Fit-for-purpose stockpiling

Stockpiling could play a strategic role in the EU CRM framework by complementing existing financial instruments and strengthening the security of supply. The CRMA already tasks the Commission, under Article 20, with developing benchmarks for safe levels of Union strategic stocks, and the IMERA mechanism (Articles 27–31) provides a coordination framework that can be activated in vigilance or emergency mode. If paired with tools such as CfDs, stockpiling mechanisms could act as a **buyer of last resort**, providing counter-cyclical price support by purchasing domestic production during periods of depressed global prices.

Beyond buffering supply disruptions, such stockpiles could function as an **active physical hedge** within a broader risk management toolkit. Greater involvement of downstream manufacturers in defining stockpile composition would ensure alignment with industrial needs, improving both efficiency and strategic relevance. In this way, stockpiling could move beyond passive reserves toward a more dynamic instrument supporting market stability, investment certainty and resilience across the value chain.

Sizing CRM stocks for the EU

The 2022 study on CRM for the ITRE Committee used a 60-day time frame, and estimated the ideal quantity, for this time frame, of stockpiles of products containing CRMs by dividing the annual EU import by six. This **60-day strategic reserve** of CRM stocks would require an investment of between EUR 6.45 billion and EUR 25.8 billion[215], which is compatible with the proposed budget of the EU CRM Centre.

This valuation clearly depends on the scope of the products considered: the lower estimate focuses only on the raw materials for the energy transition, while the upper estimate encompasses around 300 traded product groups (raw materials, intermediate and final products), essential to the green and digital transition.

However, a 60-day CRM stock would be insufficient for disruptions to highly concentrated supply chains. JOGMEC stockpiling maintains a 60-day target for domestic metal consumption, including 18-

[215] These estimates are in 2021 prices.

day (voluntary) private[216] and 42-day (mandatory) public reserves, though 30 days is considered sufficient for certain metals.

This 60-day model was originally established in 1986 and considered the standard for decades. However, in 2020 Japan announced the review of its stockpile target volume methodology and volume evaluation based on public stockpiles alone. For certain minerals subject to high geopolitical risk, such as REEs and cobalt, the domestic metal consumption target could be set to 180 days[217, 218]. According to certain analysts[219], the reserve targets of different mineral categories should range between **120-365 days** for semiconductor materials, battery materials, defence applications and REEs, to even include multi-year reserves for specific materials.

In the CRMA, the Commission was tasked with developing draft benchmarks for safe levels of EU strategic stocks, taking into account the total annual EU consumption of the strategic raw materials concerned.

Table 11: Potential value and volumes of EU stockpiles

Stockpile composition	Value (EUR billion, 2021 prices)	Volume (million tonnes)
Critical and non-critical raw materials needed for the energy transition	6.45	1.13
Set of 137 product groups designated by the European Commission as strategically important	23.7	5.55
Product groups, (raw materials, intermediates and final products) shaping the green and digital transition	25.8	8.6

Source: Rietveld, E. et al., Strengthening the security of supply of products containing Critical Raw Materials for the green transition and decarbonisation, Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament, December 2022.

Limitations of the EU approach to stockpiling

Current policy maintains strategic stockpiling as a national competence, limiting the EU's role to coordination, rather than centralised management.

Recitals 46 and 50 CRMA clarify that that the provisions on monitoring and strategic stocks in the CRMA do not imply the harmonisation of national laws and do not replace existing mechanisms[220]. Article 23(8) CRMA further clarifies that Member States cannot be obliged to hold or release strategic stocks.

Although the use of the IMERA toolbox would allow for the coordination of the development of such strategic stocks in the event of a crisis activated by internal market vigilance or an emergency, EU countries and companies are not required to build up their strategic stocks ahead of a supply disruption.

[216] Argus Media, Japan to strengthen control over rare metal reserves, July 2020.

[217] International Energy Agency, "International Resource Strategy – National stockpiling system", last updated 9 April 2025.

[218] Rietveld, E. et al., Strengthening the security of supply of products containing Critical Raw Materials for the green transition and decarbonisation, Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament, December 2022.

[219] Hidayat, M., Critical Minerals Reserve Implementation Strategies for Strategic Security, *Discovery Alert*, 16 April 2026.

[220] See especially recital 50 CRMA: 'The provisions on monitoring and strategic stocks included in this Regulation do not entail the harmonisation of national laws and regulations and do not replace existing mechanisms.'

These inherent limits, and the EU's consequently decentralised operational architecture, could prevent a rapid and coherent response to supply shocks, as the EU lacks a cohesive, single European reserve.

In a crisis situation, the efficacy of this centralised coordination mechanism could be also hampered by the administrative complexity of the CRM Centre and the IMERA activation process, or by conflicting disaggregated industrial or national incentives[221], which could create additional delays.

Beyond management issues, it must be noted that as stockpiling operates mainly as a temporary buffer, it fails to address the EU's fundamental short-term lack of domestic extraction and processing capacity, nor can it substitute for EU efforts[222] to develop diversified supply sources. While the designation of strategic CRM projects aims to rectify this vulnerability, the chronic lack of public acceptance of mining remains threat to execution, thereby potentially compromising the EU's ability to mitigate unexpected supply-chain disruptions.

Finally, the delays in developing new CRM processing projects could limit the effectiveness of EU stockpiling. The temporal mismatch between sudden supply-chain disruptions, which require immediate solutions, and the long lead times required for new processing projects, taking several years to become operational, could render the EU stockpiling mechanism effective only in the medium term.

Accelerated mobilisation of recycling and urban mining streams, which could be scaled more rapidly than greenfield extraction or refining projects, could partially mitigate for the lead-time mismatch between supply disruptions and new processing capacity. Ensuring that the IMERA crisis response toolbox explicitly incorporates secondary material mobilisation could improve the EU's short-term response capacity.

The US model, with its centralised stockpiling system and, especially, faster project approval timelines, could seem initially better positioned to react to short- and medium-term supply-chain disruptions.

[221] For a proposal in favour of an EU strategic reserve, see Gros, D., A European Sovereignty Fund - Investing in Europe's Future and Security, Economic Governance and EMU Scrutiny Unit, European Parliament, July 2024. For a review of all stockpiling positions, see Righetti, E. and Rizos, V., Reducing supply risks for critical raw materials – Evidence and policy options, Centre for European Policy Studies, January 2024.

[222] International Energy Agency, Designing an effective strategic stockpiling system for critical minerals, 27 January 2026.

Table 12: Summary of proposed considerations for IMCO and ITRE

Proposal	Relevant Instrument	Timeline
Foreign subsidy screening in the context of CRM investments and Strategic Projects.	Foreign Subsidies Regulation (FSR) implementation framework + CRMA Strategic Projects	Ongoing
EU-level coordination of CRM investment support as a single market integrity question.	State-aid framework + CRMA amendments + future Sovereignty Fund / EU-level CRM financing discussions	Medium-term
CRM resilience criteria into digital product conformity and procurement frameworks linked to the digital single market.	Cyber Resilience Act+ new EU public procurement framework	Medium-term
Internal market effects of the external industrial subsidy regimes, particularly the US IRA framework.	FSR review process + CBAM implementation + EU-US CRM negotiations	Medium-term
Guidance and possible safe-harbour mechanisms for CRM joint purchasing and off-taking cooperation.	CRMA Raw Materials Mechanism (RMM) + EU competition law framework + AggregateEU precedent	Short-term
Introduce revenue-stabilisation mechanisms for CRM projects (two-way CfDs, 'buyer of last resort', etc.).	CRMA amendments	Short-term
Establish specific credit guarantee schemes for Strategic CRM Projects to enable access to long-term fixed-price power purchase agreements and unlock their bankability. Acceleration of Strategic Project deployment.	InvestEU	Medium-term
Enable and incentivise flexible operation in power-intensive refining so plants can reduce energy costs.	Electrification Action Plan[223]	Medium-term
Tie public support and funding access to supply-chain diversification incentives in CRM.	Net-Zero Industry Act (NZIA) Industrial Accelerator Act (IAA)	Medium-term
Expand EU supply-chain intelligence by strengthening reporting (similar to Battery Regulation provisions), funding value-chain stress tests, requiring or purchasing company data, and embedding AI tools to detect vulnerabilities early.	CRMA monitoring framework Ecodesign for Sustainable Products Regulation (ESPR) Horizon Europe (e.g. Geological Service for Europe)	Medium-term
Explore an EU-coordinated stockpiling scheme that stabilises the market in a counter-cyclical manner, alongside financial instruments, while scaling reserve levels for critical materials.	IMERA CRMA strategic stock provisions CRM Centre proposals	Medium- to long-term

[223] Still to be announced at the time of writing.

6. CONCLUSION

This study examined the evolution of US critical minerals policy from 2017 to 2026. It focused on five questions.

1. How did the strategy evolve?
2. Which institutions and instruments implemented it?
3. Where are the value-chain vulnerabilities concentrated?
4. How does the US approach compare with the EU framework?
5. How do both actors link market access, industrial policy and supply-chain security?

The analysis also draws on a qualitative policy-mapping methodology and a value-chain assessment, leading to conclusions on each policy question followed by three cross-cutting findings, focusing on implications for policy design in both the EU and US jurisdictions:

a) China as a structural third actor;
b) geopolitical supply-chain leverage and industrial policy;
c) closing the financing, institutional and governance gaps.

6.1. US critical minerals strategy: from framework-building to direct market intervention

The evidence reviewed in the study suggests three broad phases in US critical minerals policy between 2017 and 2024.

The first (2017–2020) established definitional and institutional foundations through EO 13817 and the Energy Act of 2020, prioritising geological mapping, assessment of import dependence, and inter-agency coordination on market-shaping ambition.

The second (2021–2022) embedded critical minerals within a broader industrial agenda and moved from vulnerability assessments to actively shaping supply chains. In particular, laws like the IIJA, CHIPS and Science Act and IRA linked minerals to domestic manufacturing, technological competitiveness and climate goals through financial incentives and local content requirements.

The third phase (2023–2024) shifted attention towards implementation: reform of permitting procedures, inter-agency coordination, and the Minerals Security Partnership's structured allied diversification framework.

Since 2025, the US approach appears to have moved beyond coordination and incentives towards more direct market-shaping tools, including equity investment, reference-price mechanisms and stronger executive coordination. The One Big Beautiful Bill Act retains selected supply-side interventions aimed at expanding domestic production capacity while eliminating or accelerating the phase-out of key IRA-era demand-side incentives. It includes provisions under Sections 45X and 30D on dismantling the incentive structure that had underpinned earlier midstream investment commitments across critical minerals value chains[224].

[224] S&P Global Market Intelligence, Inflation Reduction Act: Impact on North American Metals and Minerals Market: post-IRA, US energy-transition demand for lithium will be 15% higher by 2035 than projected pre-IRA; 14% higher for nickel; 13% for cobalt, 2024.

The Congressional Budget Office (CBO) estimated that the relevant provisions of H.R. 1 would generate approximately USD 1.3 trillion in reductions in direct federal spending over the 2025–2034 period, resulting in significant budgetary savings[225]..

6.2. US institutional architecture: distributed mandates, centralised coordination

Six federal agencies share responsibility for U.S. critical minerals policy, each operating under a distinct legislative mandate:

- USGS defines the criticality list and provides geological intelligence;
- the DOE finances industrial and technological development, including the loan programmes;
- the DOD manages defence-industrial readiness through the National Defence Stockpile and instruments under the Defence Production Act;
- the Treasury exercises gatekeeping authority over IRA incentives through foreign entity of concern (FEOC) restrictions and annual sourcing thresholds under Section 30D;
- the State Department and the USTR manage the external dimension through bilateral critical minerals agreements and the FORGE reference-price framework.

The division of labour has historically been functional rather than hierarchical: no single agency held authority over the others, and until recently no mechanism existed to resolve conflicts between them. The NEDC, established in 2025, changed that by creating a centralised entity capable of setting priorities across agencies and resolving jurisdictional overlap. Its stated purpose is to streamline and accelerate US energy and natural resources policy, including critical minerals. It is chaired by the Secretary of the Interior, with the Secretaries of Energy, Defense and other cabinet members serving as members. However, its weakness is that this new statutory clarity does not automatically produce coherence at policy level.

The EU's equivalent architecture – DG GROW, the CRM Board, the EIB, responsible national authorities, and the forthcoming CRM Centre – lacks statutory integration of comparable depth. No EU body currently combines the market intelligence, equity-backed financial de-risking and physical stockpile management that, for example, JOGMEC successfully exercises within a single institution under a single ministry in Japan. The expected CRM Centre could represent a structural opportunity to close this design gap, but only if given an equity-investment mandate, counter-cyclical buyer-of-last-resort authority, and a budget that reaches the EUR 15 billion threshold that IFRI's analysis identifies as a minimum in order to operate effectively.

6.3. Value-chain assessment: the criticality of the midstream gap

The study finds that, for many of the sectors examined, the most acute vulnerabilities are not extraction alone but processing and refining capacity. The value-chain framework developed in Section 2 produces a structural finding consistent across all five sectors examined – defence, space, semiconductors, transport and clean energy.

[225] Congressional Budget Office, Estimated Budgetary Effects of H.R. 1, the One Big Beautiful Bill Act, June 2025, available at cbo.gov/publication/61461; see also CSIS, Impacts of the One Big Beautiful Bill Act on the Mining Sector, 30 July 2025; see also: The Congressional Budget Office's Request for Appropriations for Fiscal Year 2027, February 2026.

The dominant supply vulnerability lies at the midstream processing stage, not at the upstream extraction stage. Geological endowment does not resolve processing dependency.

For example, the United States holds North America's largest known lithium deposit at Thacker Pass, but remained more than 50 % import-dependent for lithium compounds in 2024 because domestic refining capacity had not yet been developed at commercial scale[226].

China controls approximately 90 % of global rare earth separation, 74 % of lithium processing and refining[227], and, according to the IEA, 70-75 % of cobalt refining[228]. These shares substantially exceed China's proportional role in global mining output and reflect accumulated processing capacity, targeted industrial policy and supply-chain integration rather than geological advantage alone. Diversification focused only on extraction will therefore not resolve this dependency unless it is matched by comparable investment in processing and refining capacity[229].

6.4. Comparison of US and EU governance models

Both the EU and the US have adopted hybrid governance models combining market mechanisms with strategic intervention. However, the scale and instrument design of their approaches differ substantially. Based on the aggregation of CRM-related grants, loans, guarantees and tax-support instruments identified across the agencies mapped in Table 8, total US public support over the 2024–2026 period is estimated at EUR 46 billion (USD 53 billion), while identifiable EU-level commitments amount to approximately EUR 5-6 billion[230]. Against investment requirements for achieving the CRMA 2030 targets – which EIT RawMaterials has suggested could approach EUR 80-100 billion when public and private needs are combined – a gap of five to ten times is substantial[231].

The potential cause examined in this study is the lack of a binding revenue-stabilisation instrument. Neither joint purchasing nor coordinated national stockpiling provides the long-term cash-flow certainty that project lenders require to underwrite construction debt for greenfield mining or processing facilities. Two-way contracts for difference, modelled on their proven application in renewable energy de-risking are presented as one possibility for a technically appropriate instrument to close this gap within the existing EU legislative framework[232].

6.5. Market access, industrial policy and security: conditioned openness and critical minerals agreements

Through FEOC restrictions and IRA sourcing thresholds, the US has redefined the criteria for market eligibility: eligibility now depends on compliance with supply chain sourcing and ownership requirements, rather than on price alone[233].

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226 USGS, Mineral Commodity Summaries 2025, January 2025; Section 2.1 (this study); US DOE*, Lithium Americas Closes $2.26 Billion DOE ATVM Loan*, October 2024.

227 CSIS, China's New Rare Earth and Magnet Restrictions Threaten U.S. Defense Supply Chains, October 2025.

228 IEA, Global Critical Minerals Outlook 2025, May 2025.

229 European Commission, Critical Raw Materials Act Impact Assessment, 2023. See also Section 2.7 of this study.

230 These estimates should be read as indicative policy-support envelopes rather than realised expenditures.

231 Figure 8 and Section 4.1 (this study); EITRawMaterials leverage assumption: 3.5×; EUR 80–100 billion total investment need per EITRawMaterials estimate, implying EUR 17–22 billion public support requirement.

232 European Parliament ITRE Committee, Draft report 2025/0385(COD); Trinomics, Overview of the diffusion of Power Purchase Agreements and Contracts for Difference across Member States, study for ITRE Committee, 2026; see also Section 4.3.8 (this study).

233 US Department of Energy, Final Interpretive Guidance on the Definition of Foreign Entity of Concern (FEOC), May 2024; US Congress, IRA of 2022, Section 30D, sourcing thresholds increasing annually, 2024.

The FORGE framework extends this logic through cooperation with partner countries. The 24 April 2026 MoU and action plan mark a material step forward in transatlantic supply chain cooperation, establishing the first agreed bilateral instrument architecture.

The EU-US action plan on critical minerals covers the full value chain and identifies the following for joint examination: border-adjustment mechanisms, standards-based market approaches, price-gap support measures, offtake arrangements, common mining and processing standards, stockpiling strategies and rapid-response mechanisms for supply disruptions[234].

These instruments map closely onto the recommendations in Sections 4.3 and 5.2 of this study, and their inclusion in the agreed framework represents a material advance over the pre-April 2026 position in which the CMA remained pending with no agreed instrument architecture. Two qualifications are warranted.

- The MoU and action plan are non-binding instruments: the action plan explicitly identifies its purpose as preparatory to "concluding a binding plurilateral agreement on trade in critical minerals", which has not yet been achieved[235];
- The action plan's reference to price-support and border-adjustment tools raises separate legal questions. Internally, joint purchasing, offtake and sustainability agreements may require assessment under EU competition rules. Externally, any border-adjusted price-floor mechanism would also need to be examined under WTO rules, including GATT and subsidy disciplines[236].

In the short term, setting up CRM stockpiles would complement, rather than replace, longer-term measures such as domestic mining, recycling and friend-shoring, because it can be implemented faster and at lower cost while new supply chains are still being developed[237].

6.6. Cross-cutting finding I: China as structural third actor

The bilateral framing of this study's comparative analysis understates a structural feature of the policy landscape: the competitive dynamic is triangular. China holds a key position and dominates in key midstream and downstream sectors, reflecting long-term industrial policy choices as well as resource endowments increasingly used as instruments of geopolitical leverage.

Since 2024–2025, China's CRM governance has also become less transparent. Non-public issuance of mining and smelting quotas suggests that opacity itself now forms part of the sector's strategic management, raising uncertainty for foreign firms and policymakers without requiring formal export-control announcements. This shift sits alongside China's increased control over rare earth production, processing, export licensing and related technologies[238].

[234] European Commission, Press Release IP/26/862, 24 April 2026: The action plan covers: border-adjusted price floors, standards-based markets, price-gap subsidies and offtake agreements; common standards for mining, processing and recycling; investment promotion; joint research and innovation; stockpiling strategies; and rapid-response mechanisms. Both parties intend to continue this work in the G7 and FORGE.

[235] USTR, press release, 24 April 2026. A binding Critical Minerals Agreement has not been concluded as of May 2026.

[236] Section 4.3.2 (this study); GATT Article XI; SCM Agreement.

[237] Demarais, A. and Gros D., Internationale Politik Quarterly, German Council on Foreign Relations, The Case for Setting Up an EU Critical Minerals Stockpile, May 2026.

[238] Woods, D., A Stackelberg model of China's rare earths strategic lead, Journal of Chinese Political Science, doi.org/10.1007/s11366-025-09921-w, 24 April 2026; Nguemgaing, H., Kannan, S., Spiller, B. and Toman, M.A., The Strategic Game of Rare Earths: Why China May Only Be in Favor of Temporary Export Restrictions, Resources for the Future Issue Brief, 7 October 2025.

The 15th Five-Year Plan further embeds these policies in a wider strategy of supply-chain security, technological self-reliance, and protection of strategic manufacturing capabilities[239]. Stockpiling by the EU and the US should accordingly be understood as an active competitive instrument rather than a passive emergency reserve: it buys the time within which alternative midstream capacity can reach commercial viability.

The experience of Molycorp's 2015 bankruptcy at Mountain Pass illustrates the vulnerability of non-Chinese rare earth projects when exposed to price volatility, although the outcome reflected multiple factors, including falling rare earth prices, debt burdens and competitive pressures from Chinese producers rather than a single causal mechanism[240].

6.7. Cross-cutting finding II: the speed mismatch between supply-chain leverage and industrial policy response

Neither the EU nor the US have resolved the structural mismatch between the speed at which supply-chain leverage can be deployed and the timescales associated with a democratic industrial policy. Globally, major mines that began operations between 2010 and 2019 required on average more than 16 years from discovery to first production. For the US specifically, S&P Global puts the current average at approximately 29 years – the second-longest after Zambia[241]. EU permitting for CRMA strategic projects is capped at 27 months but runs substantially longer in practice. Industrial purchasers of specialised inputs typically hold two to four weeks of inventory. This asymmetry opens a vulnerability window that cannot be closed through policy design alone during any given escalation cycle.

The IEA's January 2026 analysis uses **six months of import cover** as the baseline for modelling the costs of an effective stockpiling system. Here, "*import cover*" refers to maintaining stockpiles sufficient to replace six months of imports that are sourced predominantly from a single foreign supplier and would therefore be most vulnerable to supply disruptions. A benchmark that neither the EU nor the US currently meets for the full range of strategic materials[242]. China's 15th Five-Year Plan[243] confirms that Beijing has internalised this logic on the supply side. The question for EU and US policymakers is whether an equivalent institutional commitment will be made before the next escalation cycle closes further the available response window.

6.8. Cross-cutting finding III: closing the financing, institutional and governance gaps

The analysis converges on a finding that conditions any effective policy response: the challenge is not managing a commodity market exposed to ordinary supply risk but navigating a geopolitical competition in which one side has deliberately deployed state capital, regulatory power, informational opacity and differential domestic pricing to render competing supply chains commercially unviable before they reach scale.

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239 People's Republic of China, 15th Five-Year Plan for National Economic and Social Development (2026–2030), adopted 12 March 2026; Hart, M. et al., Atlantic Council, Five takeaways for US policymakers about China's new five-year development plan, , 31 March 2026.

240 The Wall Street Journal - How China Took Over the World's Rare-Earths Industry, 19 October 2025.

241 IEA, The Role of Critical Minerals in Clean Energy Transitions, 2021, S&P Global Market Intelligence, Mine Development Times: The US in Perspective, July 2024, S&P Global update, April 2025.

242 IEA, Designing an effective strategic stockpiling system for critical minerals, January 2026.

243 People's Republic of China, 15th Five-Year Plan for National Economic and Social Development (2026–2030), adopted 12 March 2026 (translated: Industrial Info Resources, 2026); Hart, M. et al., Atlantic Council, Five takeaways for US policymakers about China's new five-year development plan, 31 March 2026.

Three gaps require simultaneous attention:

- A **financing** gap: suitable revenue-stabilisation instruments are necessary for project bankability, which appears as the most salient bottleneck to improve domestic production. Contracts for difference are proposed as a potential instrument to address this need. There is also a significant shortfall in the overall scale of capital mobilised; closing this gap requires both deploying de-risking tools to ensure project bankability and substantially increasing public and blended financing capacity to match the capital intensity and strategic nature of CRM projects;
- An **institutional** gap: rather than positioning itself as an extension of a current coordination model, the CRM Centre should ideally mirror JOGMEC in terms of its integrated mandate, equity authority and budget, which has been a successful model in Japan;
- A **governance** gap: the current policy framework policy reflects a misalignment between internal market rules and strategic supply security objectives. The fragmented governance across EU, national, and industrial levels limits coherence in implementation. Addressing this gap requires a more integrated framework that aligns trade, industrial, and sustainability policies, and strengthens the EU's capacity to translate strategic objectives into enforceable market signals that support investment in secure and diversified CRM value chains. At the EU-level, instruments such as the Foreign Subsidies Regulation can prevent the internalisation of concentrated foreign supply within the single market; product regulation under the Ecodesign for Sustainable Products Regulation, conformity assessment frameworks and public procurement conditionalities are the demand-side levers that can anchor investment in non-concentrated supply chains.

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ANNEX I: THE EU CRM STRATEGY

KEY FINDINGS

Since the **2008 Raw Materials Initiative**, the EU's CRM policy relied on a strategy based on three pillars:

- global diversification;
- domestic supply; and
- resource efficiency.

The 2024 Critical Raw Materials Act (**CRMA**) formalised this with 2030 targets for strategic raw materials: 10 % domestic extraction, 40 % processing, 25 % recycling, and no more than 65 % from any single non-EU country.

Other mechanisms include the European Raw Materials Alliance (**ERMA**), fast-tracked **strategic projects** (60 had been approved by mid-2025, both inside the EU and in non-EU countries), and 15 partnerships with resource-rich nations like Australia, South Africa, Ukraine and Greenland.

Geopolitical shocks, such as the 2025 export controls on rare earth resources from China, underscore vulnerabilities: the EU remains 100 % import-dependent for rare earth processing, with low recycling rates for most CRMs.

The most recent advances are underlined in the 2025 **RESourceEU Action Plan**, and include a pledged mobilisation of **EUR 3 billion**, amendments to the CRMA for centralised oversight and stockpiling, and a forthcoming European CRM centre.

However, in 2026, the European Court of Auditors warned of persistent bottlenecks in permitting, financing and implementation, questioning the 2030 goals.

The EU policy framework

50 years of EU CRM policy

As early as 1975[244], the EU institutions found ground to '*justify a serious examination of possible future problems in the supply of raw materials for Europe*'. At the time, they addressed post-oil crisis vulnerabilities through geological exploration and substitution research, but interest waned as global prices stabilised.

Several decades later, the rapid industrialisation of emerging economies (particularly China), prompted the 2008 Raw Materials Initiative (RMI). It established a three-pillar strategy that would then repeatedly be found, in one form or another, in all the subsequent raw materials policies of the EU:

- **global markets**: ensuring a level playing field in access to resources in non-EU countries;
- **domestic supply**: establishing the right ecosystem for a sustainable supply of raw materials from European sources;
- **resource efficiency**: boosting recycling and the circular economy.

This framework also introduced the first list of Critical Raw Materials in 2011.

[244] Communication from the Commission to the Council of 5 February 1975, The Community's supplies of raw material, COM(75)50.

Over the following years, as the EU committed to the green transition requiring the large-scale deployment of renewable energy technologies such as wind turbines, batteries and solar panels, expectations for a sharp rise in demand for CRMs further increased the challenges associated with long-term CRM supply.

Amid import reliance exceeding 90 % from non-EU countries for many CRMs[245], and especially for rare earths, the 2020 action plan on critical raw materials outlined 10 non-legislative actions structured around four pillars: supply diversification, domestic capacity building, circularity via recycling and substitution, and enhanced foresight through partnerships. It also established the **European Raw Materials Alliance** (ERMA), and identified 30 materials in the fourth CRM list (adding bauxite, lithium, strontium and titanium).

The 2024 EU CRMA

The **CRMA** set measures to produce and process more of essential materials withing the EU. It focused on reducing foreign reliance and strengthening resilience through sustainable practices and a circular economy.

New lists

The CRMA established a new subset of materials: strategic raw materials (**SRMs**). This category identifies the specific elements considered vital to the technologies driving the green and digital transitions. While the existing methodology for CRMs looked mostly at current supply risks, the "strategic" label was added to account for **future demand** of flagged materials with projected global supply/demand imbalances.

2030 targets for strategic raw materials

The CRMA sets out quantifiable (though non-binding) targets to secure the EU's resource independence. By 2030, the framework intends to meet the following targets:

- extract at least **10 %** of the EU's annual SRM consumption **domestically**;
- process at least **40 % of SRMs within the EU**;
- generate at least **25 % of SRMs from recycled materials**; and
- **ensure that no more than 65 %** of the EU's annual consumption of any SRM **comes from a single, non-EU country**.

Strategic projects

The legislation also establishes a framework for designating and supporting "**strategic projects**" to boost the EU's supply of critical raw materials. These projects target extraction, processing, recycling or substitution of strategic raw materials listed in Annex I to the CRMA. These projects must meet criteria in Article 6 and Annex III, including significant contributions to supply security, technical feasibility, sustainability, and (for non-EU projects) mutual benefits with the host country.

[245] European Commission, Study on the EU's list of Critical Raw Materials, 2020: "For example, China provides 98 % of the EU's supply of rare earth elements (REE), Turkey provides 98 % of the EU's supply of borate, and South Africa provides 71 % of the EU's needs for platinum and an even higher share of the platinum group metals iridium, rhodium, and ruthenium".

Designated projects gain public interest status, enabling fast-tracked permitting (e.g. a maximum of 27 months), a single point of contact and improved financing access, while still requiring compliance with EU environmental and social laws.

By mid-2025, the Commission approved lists of strategic projects both in the EU (by March 2025, 47 projects[246] for an expected overall capital investment of EUR 22.5 billion) and non-EU countries (by June 2025, 13 projects[247] for an overall capital investment of EUR 5.5 billion)[248]. The table below summarises the historical evolution of the EU CRM policy.

History of the main EU policies on critical and strategic raw materials

Year	Policy / outcome	Description
2008	Raw Materials Initiative	• First integrated EU strategy to address external access, internal supply, and demand-side measures in a coherent way. • Established the framework for identifying CRMs based on economic importance and supply risk. • Covered all raw materials used by European industry except materials from agricultural production and materials used as fuel.
2011	First CRM list	• Identified **14** materials as 'critical' to the EU economy.
2014	Second CRM list	• Expanded the list to **20** materials using the same methodology and split the group of rare earth elements (REEs) into heavy and light REEs because of the difference in their supply and demand issues.
2017	European Battery Alliance	• Highlighted the acute supply risks for battery-specific minerals such as lithium, cobalt, nickel and manganese.
2017	Third CRM list	• Expanded the list to **27** materials, applying a new methodology. • A total of 9 materials were added, and 2 (chromium, magnesite) were dropped based on updated assessments of economic importance and supply risk across 78 candidates.
2020	Action plan on CRMs	• Outlined 10 non-legislative actions across 4 objectives to increase supply security, resilience and sustainability. • Launched a European Raw Materials Alliance.
2020	Fourth CRM list	• Expanded to **30** materials, adding bauxite, lithium, strontium and titanium while dropping helium.
2023	Green Deal Industrial Plan	• Proposed the Critical Raw Materials Act (CRMA) and the Net Zero Industry Act.
2023	Fifth CRM list	• Released as part of the legislative package for the CRMA. • Expanded to **34** CRMs. • Removed indium and natural rubber from the list.

[246] European Commission, Commission Decision of 25.3.2025 recognising certain critical raw material projects as Strategic Projects under Regulation (EU) 2024/1252 of the European Parliament and of the Council, 2005.

[247] European Commission, Commission Decision of 4.6.2025 recognising certain critical raw material projects located in third countries and in overseas countries or territories as Strategic Projects under Regulation (EU) 2024/1252 of the European Parliament and of the Council, 2005.

[248] DG GROW, Selected strategic projects, 2025.

Year	Policy / outcome	Description
		• First list to include a strategic raw materials (SRMs) category: **16** SRMs were identified.
2024	Critical Raw Materials Act	• The CRMA became law in May 2024, setting 2030 targets: 10 % domestic extraction, 40 % processing and 25 % recycling.
2025	EU stockpiling strategy	• Treats CRMs as 'essential goods' (alongside food, water or medicines), moving towards a model of collective storage and shared risk management.
2025	RESourceEU Action Plan	• Announced the mobilisation of EUR 3 billion over 12 months. • Planned the establishment of a European critical raw materials centre to accelerate the achievement of the CRMA objectives.

Source: The authors, based on the Critical Raw Materials Act .

State of play of CRM landscape in the EU

Axis #1: Diversifying imports

The CRMA 2030 targets

2030 target in CRMA	Less than 65 % of every SRM from a single, non-EU country
Conclusion of 2026 ECA assessment:	Efforts to diversify imports are not producing results
Key metric:	10 out of 34 critical raw materials are fully imported

Source: ECA, Special report 04/2026: Critical raw materials for the energy transition – Not a rock-solid policy.

A turbulent geopolitical context

The EU's work on free trade agreements and other external actions has become increasingly important amid growing trade challenges and geopolitical tensions that affect access to critical raw materials. Trade in these materials has at times been disrupted by export restrictions, which have raised concerns about the EU's security of supply. The EU has responded by addressing these issues through bilateral dialogue and by bringing cases before the WTO.

Ukraine

In July 2021, the EU and Ukraine established a strategic partnership to secure supplies of critical raw materials. This agreement aims to integrate Ukraine's vast mineral wealth into European industrial supply chains, given that Ukraine possesses 22 of the 34 minerals[249] the EU considers 'critical'. In particular, Ukraine holds some of Europe's largest reserves of lithium[250].

249 Al-Jazeera, Mapping Ukraine's rare earth and critical minerals, February 2025.

250 Gourevich, I., Econpol, Strategic Raw Materials in Ukraine: Opportunities for Strengthening EU Supply Chains? April 2025.

The Russian invasion has severely hampered this partnership. Heavy fighting and occupation are concentrated in the east and south, where many deposits are located. By early 2025, Russia controlled a significant proportion of Ukraine's energy and mineral wealth. This includes sizable portions of coal, lithium and rare earth deposits. While some recovery occurred in 2024, energy shortages and damaged ports continue to restrict exports.

The partnership has strengthened as the EU seeks to reduce its reliance on China and Russia. In addition, in April 2025, Ukraine signed a deal on minerals with the US[251], which pressured the EU to speed up its own investments in order to avoid being sidelined in the race for Ukrainian resources. Notably, the Balakhivka graphite project was recently approved as a "strategic project" under the CRMA This grants the project faster permits and easier access to EU funding.

Greenland

In the recent years, Greenland has emerged as a central partner in the EU's effort to reduce its dependence on CRMs due to its vast, untapped geological wealth. In November 2023, the EU and Greenland signed a MoU to establish a strategic partnership on sustainable raw materials. Greenland possesses 25 of the 34 materials identified by the EU as critical. Most notably, it holds large reserves of REEs.

In June 2025, the European Commission selected a graphite project in Greenland as a strategic project, granting it access to streamlined permitting procedures and potential financing.

Despite the political alignment, several barriers prevent these minerals from reaching the European market, such as gaps in infrastructure: Greenland lacks a connected road network between towns, leading mining companies to often build their own power plants, ports and housing. The Global Gateway initiative could be used to fund this infrastructure.

Competition at the geopolitical level is also palpable, as China already holds stakes in Greenlandic mining companies. In 2025, Greenlandic officials noted[252] that if European and US investment does not arrive quickly, they may have to look towards Chinese capital to fund their economic development.

Strategic partnerships

The CRMA defines a strategic partnership as a *"commitment between the Union and a third country [...] to increase cooperation related to the raw materials value chain that is established through a non-binding instrument setting out actions of mutual interest"*.

As of early 2026, the EU had signed 15 strategic partnerships with such non-EU countries. These agreements remain non-binding frameworks to develop local industries in partner countries while ensuring a steady flow of materials to Europe.

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[251] Akhveldiana, T., CEPS, Much more than minerals: the US-Ukraine minerals agreement and its geopolitical implications, June 2025.

[252] ArcticToday, Greenland warns it may turn to China if US and EU shun mining investments, 27 May 2025.

The EU's strategic partnerships

Partner country	Date	Partner country	Date
South Africa	November 2025	Zambia	October 2023
Serbia	July 2024	Chile	July 2023
Australia	May 2024	Argentina	June 2023
Uzbekistan	April 2024	Namibia	November 2022
Norway	March 2024	Kazakhstan	November 2022
Rwanda	February 2024	Ukraine	July 2021
Greenland	November 2023	Canada	June 2021
Democratic Republic of the Congo	October 2023		

Source: DG GROW, Raw materials diplomacy.

Trade agreements

The EU has intensified negotiations and modernisation of free trade agreements with various non-EU countries rich in raw material reserves or which possess processing capabilities. By using legal treaties to ban export duties, the EU creates a more predictable environment than through informal partnerships alone.

However, only a limited number of agreements under negotiation contain dedicated chapters on energy and raw materials (**ERM**)[253] that explicitly prohibit export restrictions, taxes or monopolies on raw materials, while promoting sustainable sourcing and investment.

Axis #2: Increase domestic production

Some acute value chain vulnerabilities for the EU have been highlighted by the ECA. It also outlined the distinction between the upstream (extraction) and midstream (refining) segments, which both suffer from extreme dependencies on non-EU countries. Indeed, not only is it crucial to have access to the raw ore (either through domestic mining or from imports), but it is also necessary to have the right industrial infrastructure to process it domestically.

ECA conclusion on EU CRMA domestic extraction and processing targets

2030 target in CRMA	> 10 % of EU annual consumption extracted in the EU > 40 % of EU annual consumption processed in the EU
Conclusion of 2026 ECA assessment:	Financial, legal and administrative bottlenecks slow down domestic production
Key metric:	None of the rare earths used in the EU are processed domestically.

Source: ECA, Special report 04/2026: Critical raw materials for the energy transition – Not a rock-solid policy.

[253] Van der Ven, C. et al, TULIP Consulting, Towards a Better Balance: Leveraging EU Free Trade Agreements to advance responsible and resilient raw materials trade, 2024.

The following points are particularly noteworthy.

- The EU is 100 % dependent on imports as regards extraction *and* processing of REEs;
- More generally, the EU is over 90 % dependent on non-EU countries for 15 raw materials, and for 10 of these, it is 100 % dependent on imports;
- Strontium[254] is a rare success story. Spain is a top global producer and the primary supplier of strontium (celestite) within the EU, providing approximately 99 % of its supply.

Processing

Processing is affected by a lack of technology and a shrinking number of facilities in the EU. Key bottlenecks include:

- lack of exploration;
- lack of technologies and facilities;
- lack of financing;
- lengthy permitting procedures.

Transforming a raw material from an ore, mineral, plant product or waste requires specialised technologies and skills. For example, processing rare earth elements is one of the most complex challenges in modern metallurgy and, over the last few decades, China has become a technology leader in this sector. Currently, 100 % of rare earth processing is done outside the EU, mostly in China.

Axis #3: More efficient use of resources

ECA conclusion on CRMA domestic recycling targets

2030 target in CRMA	> 15 % of EU annual consumption in recycling capacity
Conclusion of 2026 ECA assessment:	There is still not enough substitution or recycling. Recycling is already economically viable for some critical raw materials but still underdeveloped where smaller quantities are used.
Key metric:	10 out of 26 critical raw materials are not recycled at all.

Source: ECA, Special report 04/2026: Critical raw materials for the energy transition – Not a rock-solid policy.

For many materials essential to the energy transition, recycling is almost non-existent. Specifically, the ECA[255] found that 10 out of 26 materials analysed are not recycled at all, and another seven have recycling rates of between only 1 % and 5 %. Copper is the best recycled CRM, with a 55 % recycling rate, followed by tungsten (42 %) and aluminium (32 %).

[254] JRC RMIS, Raw Materials Profiles - Strontium.
[255] ECA, Special report 04/2026: Critical raw materials for the energy transition – Not a rock-solid policy.

The bottlenecks that are cited for this slow ramp-up of the recycling supply chain are:

- **high processing costs** in Europe, making it difficult for recyclers to compete with virgin materials;
- **a lack of sufficient waste volumes** (secondary raw materials) available for large-scale industrial recycling because of low collection rates, and the export of waste containing CRMs out of the EU;
- **complex regulations** and a lack of harmonised standards across Member States;
- **a lack of some specialised technologies and facilities** needed to reprocess complex products (such as used batteries or electronics) into high-purity raw materials.

Current and upcoming legislative measures

Amendments to the CRMA

After the CRMA entered into force in May 2024, the EU faced immediate supply chain pressures, including intensified export restrictions from China on rare earths. In response to this threat, on 3 December 2025, the Commission published the **RESourceEU Action Plan**, which proposed amendments to the CRMA.

The primary goal of the proposed changes is to shift administrative responsibility to the EU level to prevent the single market from fragmenting and to accelerate the recovery of minerals. For that, several key measures are being introduced.

- **Centralised identification of large companies**: under the original 2024 Act, Member States were responsible for identifying "large companies" subject to supply chain audits, but this can lead to inconsistent enforcement. The proposed amendment transfers this power to the Commission**,** which would maintain a single EU-level list of companies to ensure uniform compliance.
- **Mandatory risk mitigation**: the amendment strengthens Article 24 of the CRMA. The companies concerned must stress test their supply chains and, if significant vulnerabilities are detected, the European Commission is now empowered to adopt delegated acts specifying exactly which mitigation measures (e.g. diversification or stockpiling) these companies must take;
- **Expansion of circularity**: the proposal expands the list of products that must comply with recyclability and labelling rules. New categories include hard disk drives and transducers, loudspeakers, civil-use drones and motorised toys;
- **Pre-consumer waste integration**: the proposal includes pre-consumer waste (scrap generated during manufacturing) in the calculation of recycling targets for permanent magnets. Previously, only post-consumer waste (end-of-life products) was counted. This is intended to immediately boost the secondary market, as industrial scrap is easier to process than old consumer electronics;
- **Administrative streamlining for "strategic projects"**: to ensure higher quality applications and better assessment by the Commission, the amendment allows for a limited number of 'cut-off dates' per year, rather than the previous open-ended rolling system.

While the action plan supports all CRMs, its immediate focus is on REEs permanent magnets, battery raw materials and defence-related raw materials.

Critical Raw Materials Centre

The establishment of the European Critical Raw Materials Centre constitutes the second leg of the measures announced in the RESourceEU Action Plan in December 2025. The centre's mission is to move beyond monitoring and to act as a portfolio manager for the EU's mineral interests. It is explicitly modelled after Japan's JOGMEC, which combines state funding with technical expertise to secure long-term supply contracts for private industry.

While the European Critical Raw Materials Board met regularly throughout 2024 and 2025 to select strategic projects, the centre itself is designed to be an executive arm with more assertive market-shaping powers.

The centre will centralise several previously fragmented powers.

- **Market intelligence**: the centre will maintain a real-time risk dashboard for critical materials, providing companies with data on price volatility, global supply concentrations and potential export bans;
- **Joint purchasing**: using the model developed for COVID-19 vaccines and natural gas, the Centre will aggregate demand from European companies. This allows smaller firms to secure supply agreements at competitive prices that would otherwise be reserved for larger firms;
- **Strategic stockpiling**: The centre will coordinate a decentralised EU stockpile.

Current and upcoming legislative files on CRMs

Year	Policy	Description
2025	Amendments to CRMA	Introduces new measures focused on centralising administrative oversight, strengthening corporate risk management, and expanding the scope of circularity rules.
2026*	European CRM Centre	The CRM Centre will act as a portfolio manager (modeled on JOGMEC in Japan) to secure EU mineral supplies. It will provide market intelligence to steer investments, manage, coordinate joint purchasing, and facilitate stockpiling. The related proposal for this is expected in Q3 2026.
2026*	Circular Economy Act	Expected to introduce legislation to further promote recycling and a circular economy within EU industry

* Announced

Source: The authors.

ANNEX II: US LEGISLATION ON CRITICAL RAW MATERIALS

Legislative initiatives 2017-2020

The American Mineral Security Act (2019)

The 2019 American Mineral Security Act (AMSA) was introduced in the Senate but never enacted as standalone legislation. Its provisions were subsequently absorbed into the Energy Act of 2020, enacted as part of the Consolidated Appropriations Act of 2021. The legislation sought to address structural vulnerabilities in the US mineral supply chain by establishing a comprehensive framework for identifying and managing critical minerals. Key provisions included the requirement for a regularly updated critical minerals list, improved coordination among federal agencies and expanded geological mapping to identify domestic mineral resources[256]. The bill also aimed to promote research on mineral processing technologies and substitution materials to reduce dependence on foreign suppliers.

AMSA's principal contribution was agenda-setting rather than operational design. It established the requirement for a regularly updated federal critical minerals list, mandated improved inter-agency coordination and directed expanded geological mapping. These provisions were framing devices, stating that critical minerals warranted a systematic federal response rather than ad hoc departmental action[257].

The Energy Act of 2020

The Energy Act gave statutory weight to the US critical minerals strategy. Enacted as part of the Consolidated Appropriations Act, the law established a comprehensive framework for federal research, development and coordination related to critical materials[258]. It formally mandated the Secretary of the Interior to maintain the critical minerals list through the USGS, expanded federal research support across extraction, processing, recycling and substitution, and strengthened the DOE's Critical Materials Programme. Crucially, it also directed improved collection of geological data, recognising that the US lacked the mapping infrastructure needed to assess its own resource potential. In this respect, the Energy Act was an enabling framework: it created the institutional tools without specifying how they were to be used or what supply-security objectives were to be fulfilled. The act explicitly recognised that many critical minerals are essential for advanced energy technologies, including batteries, renewable energy systems and EVs. As a result, the legislation linked mineral supply security to the broader objectives of US energy transition and industrial competitiveness.

Legislative initiatives 2021-2022

Infrastructure Investment and Jobs Act (2021)

Congress significantly expanded its engagement with raw materials policy through the Infrastructure Investment and Jobs Act (IIJA), adopted in November 2021. While the law is primarily known for its investments in physical infrastructure, it also contains substantial provisions aimed at strengthening domestic battery supply chains and critical minerals production[259].

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[256] CRS, Critical Minerals Resources: National Policy and Critical Minerals List, report R47982, 2026.

[257] CRS, Critical Minerals and U.S. Public Policy, 2019 and Northeast-Midwest Institute, Critical Minerals Legislative Tracker, 2026.

[258] US Congress, Energy Act of 2020, Public Law 116-260.

[259] US Congress, Infrastructure Investment and Jobs Act, H.R. 3684, 117th Congress.

The bill authorised several billion[260] dollars in funding to support domestic battery manufacturing, mineral processing and recycling. A central element of this legislation was the establishment of grant programmes, administered by the US Department of Energy, aiming to strengthen domestic lithium-ion battery supply chains.

These programmes aim to reduce US dependence on foreign suppliers of key battery materials such as lithium, cobalt, nickel and graphite. The legislation also expanded federal support for geological mapping through the Earth Mapping Resources Initiative (Earth MRI), a programme managed by the USGS.

Earth MRI aims to improve the understanding of US mineral resources by mapping geological formations that may contain critical minerals. By combining infrastructure investment with mineral supply chain development, the IIJA reflected an emerging consensus in Congress that access to critical minerals is essential for both industrial competitiveness and national security.

The CHIPS and Science Act (2022)

The CHIPS and Science Act was enacted in August 2022. Although primarily focused on strengthening the US semiconductor industry, the legislation also has important implications for raw materials policy because many advanced semiconductor technologies depend on specialised materials such as gallium, germanium and rare earth elements[261]. It authorised substantial funding for scientific research, advanced manufacturing and technology development. These investments include research programmes aimed at improving the resilience of supply chains for critical materials used in semiconductor production.

In addition to its research provisions, the legislation strengthened the role of the National Science Foundation and other federal research institutions in studying advanced materials. This reflects a broader congressional effort to promote technological innovation as a way to reduce supply chain vulnerabilities.

The Inflation Reduction Act (2022)

The Inflation Reduction Act (IRA) is perhaps the most consequential congressional initiative affecting critical minerals supply chains in recent years. While it is primarily known as a climate and energy policy measure, it contains several provisions that directly influence global supply chains for critical minerals[262]. One of the most important features of the IRA is the introduction of "local content" requirements for electric vehicle tax credits. Under these provisions, electric vehicles qualify for federal consumer tax incentives only if a specified percentage of their battery materials originate from the US or from countries with which the US has a free trade agreement. These requirements gradually increase over time, thereby encouraging manufacturers to restructure their supply chains.

The IRA also introduced the Advanced Manufacturing Production Credit (Section 45X), which provides tax incentives for domestic production of battery components and critical minerals processing. By incentivising domestic manufacturing, Congress has been aiming to stimulate investment in US-based supply chains and reduce dependence on foreign suppliers. Therefore, the IRA represents a shift in congressional policy towards a more active form of industrial policy, combining climate objectives with strategic supply chain considerations.

[260] To specify the amounts for funding, see U.S. Congress, Infrastructure Investment and Jobs Act, Public Law 117-58, Sec. 40207–40208 and Sec. 41003, 2021; US DOE, Bipartisan Infrastructure Law Battery Supply Chain Program Notices of Intent, 2022.

[261] US Congress, CHIPS and Science Act of 2022, H.R. 4346, 117th Congress.

[262] US Congress, Inflation Reduction Act of 2022, H.R. 5376, 117th Congress.

Legislative initiatives 2023-2024

The legislative initiatives of 2023 and 2024 reflect a shift in congressional concern from framework-building towards implementation reform and institutional coordination. The problems being addressed had changed: the framework existed. The challenge was to make it function despite the specific structural constraints identified in the preceding phase.

The Critical Mineral Independence Act (2023)

The Critical Mineral Independence Act of 2023 focused primarily on streamlining the permitting process for mining projects, widely identified in congressional hearings and industry submissions during this period as the most persistent bottleneck limiting domestic mineral production. Introduced in the House of Representatives during the 118th Congress (2023-2025), the bill reflects growing bipartisan concern regarding US dependence on foreign suppliers for critical minerals used in advanced manufacturing, clean-energy technologies, and defence systems[263].

The legislation focuses primarily on mining projects in the US, which frequently face lengthy permitting timelines due to overlapping federal and state regulatory procedures. According to congressional discussions surrounding the bill, permitting delays can extend for several years, thereby limiting the capacity of the US to respond quickly to supply disruptions in critical minerals markets. The rationale behind the legislation is that mineral development in the US often involves complex interactions between multiple regulatory jurisdictions: federal agencies such as the Department of the Interior, the Environmental Protection Agency and the Department of Energy may each have authority over different aspects of a mining project. At the same time, state governments retain substantial regulatory authority over land use and environmental approvals. The proposed measures would therefore serve as a coordination mechanism designed to reduce regulatory fragmentation. It includes identifying bottlenecks in permitting processes, improving the sharing of information among agencies, and recommending policy measures that aim to accelerate mineral development projects.

The Critical Mineral Consistency Act (2024)

Another legislative proposal reflecting congressional engagement with raw materials policy is the Critical Mineral Consistency Act, introduced in the Senate during the 118th Congress. It addressed a less visible but structurally significant problem: the existence of multiple, partially inconsistent federal definitions of "criticality" maintained by different agencies with different assessment methodologies. While the DOI maintains the official federal critical minerals list through the USGS, other agencies, e.g. the DOE, maintain separate lists of materials considered critical.

Legislative initiatives 2025-2026

Rare Earth Magnet Manufacturing Production Tax Credit Act (2025)

The Rare Earth Magnet Manufacturing Production Tax Credit Act illustrates an important shift whereby greater attention has been given to midstream and downstream industrial capabilities. As presented by Members of Congress when introducing the bill, the proposed measure would create a production tax credit for rare earth magnets manufactured in the US, using fiscal incentives to support domestic magnet production rather than relying only on mining expansion[264].

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[263] US Congress, Critical Minerals Independence Act of 2023, H.R. 8440, 118th Congress.

[264] CRS, Critical Mineral Resources: The US Geological Survey (USGS) Role in Research and Analysis report R48005, 2024; see also CRS, Critical Minerals Resources: National Policy and Critical Minerals List, report R47982, 2026.

This is strategically significant because permanent magnets are one of the main bottlenecks in the rare earth value chain. Their production relies on specialised processing and manufacturing capabilities that are concentrated in a small number of countries, creating supply chain vulnerabilities. They are essential for EVs, wind turbines, defence applications and advanced manufacturing, yet production remains heavily concentrated outside the US.

From a policy-design perspective, the bill is noteworthy because it recognises that mineral security cannot be reduced to access to ore or oxide feedstock alone. Even where upstream supply can be diversified, dependence may persist if alloying, magnet fabrication and component manufacturing remain concentrated abroad. In that sense, the act seeks to address a structural weakness in the US supply chain by supporting the industrial stage where much of the value added and strategic leverage are present. Congressional support for such a targeted tax credit also reflects the broader return of industrial policy instruments being approved by Congress, especially where supply chains are linked to national security and technological leadership. Therefore, the proposal points to a broader understanding of raw materials policy in Congress.

One Big Beautiful Bill Act (2025)

The One Big Beautiful Bill Act[265] (OBBBA) signed into law on 4 July 2025, constitutes the most consequential US industrial policy instrument since the IRA of 2022. Enacted through budget reconciliation, it restructures the federal approach to critical minerals through defence appropriations, revised tax credits, tightened foreign-entity restrictions and selective IRA rollbacks. Its net effect on global CRM supply chains is uncertain.

On the supply side, the OBBBA deploys an estimated USD 8.5 billion in federal capital:

- USD 2 billion to expand the National Defence Stockpile (Section 20004[266]);
- USD 5 billion to the Industrial Base Fund for CRM supply-chain investment, including equity stakes in domestic producers;
- USD 1 billion under Energy Dominance Financing (Section 50403); and
- USD 1.5 billion through the Defense Production Act and the Office of Strategic Capital[267].

On the demand side, the OBBBA's implications are more adverse.

- Section 70514 introduces a phase-out of the Advanced Manufacturing Production Credit under Section 45X – a 10 % tax incentive for domestic extraction, processing and recycling of battery and industrial minerals – reducing it to 75 %, 50 %, and 25 % of its baseline in 2031, 2032 and 2033, respectively, before full elimination in 2034[268]. The Congressional Budget Office (2025) further confirms that the 45X phase-out is projected to generate significant fiscal savings precisely because it eliminates incentives that were successfully mobilising private co-investment[269];

[265] US Congress, H.R. 1 – One Big Beautiful Bill Act, Public Law 119-21, 4 July 2025.

[266] The OBBBA is structured as a budget reconciliation bill divided into numbered titles, each corresponding to the Congressional committee responsible for that policy domain - for example, Title I covers Agriculture, Title II covers Armed Services (defence),and Title XI covers Ways and Means (taxation). The section numbers are not arbitrary: they encode both the title and the sequential position of the provision within it.

[267] Center for Strategic and International Studies (CSIS), Impacts of the One Big Beautiful Bill Act on the Mining Sector, 30 July 2025.

[268] Fastmarkets, One Big Beautiful Bill expected to drive mostly positive outcomes for critical minerals sector, 17 July 2025.

[269] Congressional Budget Office (2025), Estimated Budgetary Effects of the One Big Beautiful Bill Act, June 2025.

- Section 70502 terminates early the USD 7 500 IRC 30D electric vehicle credit, removing a structural demand signal for lithium, cobalt and nickel[270]. While market participants contest the magnitude of the EV credit's effect on global battery raw materials, the combined rollback of the 45X and 30D incentive architecture materially weakens the investment rationale for domestic midstream CRM processing – the principal vulnerability in US and EU supply chains alike[271].

For the European Union, the OBBBA creates a dual dynamic. The "*acceleration of US upstream investment and reshoring intensifies competitive pressure on EU industrial and defence CRM strategies*"[272]. However, the "*erosion of demand-side incentives may create openings for allied CRM exporters*"[273].

The act's "*domestic-production bias and PFE architecture risk complicating ongoing EU-US Critical Minerals Agreement (CMA) negotiations*"[274], particularly regarding mutual recognition of equivalent standards and reciprocal market access. The OBBBA is ultimately a contradictory instrument domestically: the "*largest US public commitment to CRM security in decades, whose structural supply-demand mismatch may undermine its own geopolitical objectives*"[275].

Securing America's Critical Minerals Supply Act (2026)

The Securing America's Critical Minerals Supply Act was adopted for the purpose of anchoring critical minerals policy more firmly within the institutional remit of the DOE. According to the House of Representatives' committee material and statements issued after its passage through the House, the bill requires the DOE to assess critical energy resource supply chains, including supply chains for critical minerals and rare earth elements, and to develop strategies to address vulnerabilities associated with disruption or overreliance on adversarial nations. It passed the House in February 2026 and was presented as a measure to strengthen US energy supply chains while supporting next-generation technologies and the defence industrial base.

The bill is significant because it extends the DoE's role beyond support for technology deployment and research giving it a more explicit supply-chain governance function. In doing so, it increases the post-2020 congressional trend of linking critical minerals to energy security, grid resilience and industrial policy rather than treating them as a narrow geological or mining-related issue. This is particularly important in the context of electrification and digitalisation, where mineral dependence affects not only resource availability but also the resilience of manufacturing systems and strategic infrastructure.

At the same time, the legislation demonstrates how congressional concern with critical minerals has become embedded in a broader narrative about strategic competition with China and other adversarial suppliers. The House Energy and Commerce Committee explicitly framed the bill as a response to overreliance on supply chains controlled by adversarial nations[276].

[270] S&P Global Market Intelligence, Inflation Reduction Act: Impact on North American Metals and Minerals Market: "post-IRA, US energy-transition demand for lithium will be 15% higher by 2035 than projected pre-IRA; 14% higher for nickel; 13% for cobalt", 2024.

[271] Hunton, Navigating the OBBBA: Metallurgical Coal Added as Critical Mineral for Section 45X, 8 July 2025.

[272] Herbert Smith Freehills Kramer, The US and EU Approaches to Critical Minerals Explained, February 2026.

[273] Mining.com, Big, beautiful US bill would end tax credit for critical minerals, 4 July 2025.

[274] European Parliament, Legislative Train Schedule, EU-US Critical Minerals Agreement, updated January 2026.

[275] Center for Strategic and International Studies (CSIS), Impacts of the One Big Beautiful Bill Act on the Mining Sector, 30 July 2025.

[276] Chairman of the House Committee on Energy and Commerce statement, of 11 February 2026.

The Securing Essential and Critical US Resources and Elements Minerals Act (2026)

The Securing Essential and Critical US Resources and Elements (SECURE) Minerals Act of 2026[277] marks a shift from permitting and production support alone towards the creation of a strategic market-stabilisation and reserve mechanism. Introduced in January 2026, by group of lawmakers, and passed in March 2026, the bicameral bill establishes a new Strategic Resilience Reserve (SRR)[278] designed to support domestic and allied critical minerals supply chains, reduce US dependence on China and provide greater resilience against supply shocks and price volatility.

The SECURE Minerals Act introduced the logic of strategic reserve governance, drawing on analogies with the Strategic Petroleum Reserve while adapting the concept to the distinctive features of critical minerals markets[279]. In that respect, the bill reflects the growing recognition within Congress that critical minerals markets are often characterised by high concentration, limited price transparency, long project lead times and vulnerability to geopolitical coercion.

The bill is presented as a historic USD 2.5 billion investment to strengthen US resilience and reduce reliance on Chinese-dominated supply chains. Its text and section-by-section summary indicate that the proposed reserve would operate through a dedicated governance structure with powers related to the purchase, storage and sale of critical minerals and materials, thereby supporting supply-chain resilience and market stability. Therefore, the reserve is better understood as a strategic market instrument intended not only to buffer disruptions, but also to improve the commercial conditions for domestic and allied supply[280].

[277] US Congress, SECURE Minerals Act of 2026 H.R. 7126, 119th Congress.

[278] Breakthrough Institute, The SECURE Minerals Act Equips U.S. Critical Minerals Strategy with Powerful and Necessary New Tools, 15 January 2026, for further explanation of the logic of the SRR.

[279] See Senator Todd Young's list of supporters of the SECURE Minerals Act, 16 January 2026.

[280] House of Representatives' Select Committee on China, Background discussion on domination of supply chains by China, 8 January 2026.

ANNEX III: CRITICAL RAW MATERIALS FOR DEFENCE

Which CRMs are used for which defence purposes?

Modern defence systems require CRMs at every stage, from propulsion and guidance to communications, sensors and energy storage. The dependencies are highly specific, technically constrained, and in most cases, non-substitutable within current procurement timelines.

As Executive Order 14272 of April 2025 stated, "a strong national defense depends on a robust economy and price stability, a resilient manufacturing and defense industrial base, and secure domestic supply chains. Critical minerals, including rare earth elements, in the form of processed minerals are essential raw materials and critical production inputs required for economic and national security"[281].

Rare earth permanent magnets: the backbone of precision warfare

Neodymium-iron-boron (NdFeB) and samarium-cobalt (SmCo) magnets sit at the apex of CRM dependency in defence. Their uses include fighter aircraft, submarines, unmanned aerial vehicles, precision-guided munitions, radar, sonar, night-vision systems, satellites and secure communications. Their strategic relevance is particularly linked to high-performance permanent magnets, actuators, sensors, microwave systems and electro-optical components, rather than to bulk material use[282]. A supply disruption affecting rare earth magnet production could thus halt the production of entire weapons programmes.

Dysprosium and terbium serve as performance enhancers in NdFeB magnets, raising their operating temperature ceiling – a non-negotiable requirement for avionics and propulsion environments. Neither has a commercially viable substitute available on a reasonable timescale, and both were subject to Chinese export restrictions in April 2025[283].

Yttrium, gallium and germanium for sensors, radar and electronic warfare

Yttrium occupies a structurally irreplaceable position across the electromagnetic and thermal demands of modern combat platforms. Its incorporation into yttrium iron garnet (YIG) filters enables the precise frequency tuning on which radar discrimination depends — sharpening the resolution and sensitivity of surveillance and targeting systems in contested electromagnetic environments. This capability is embedded in platforms such as the AN/SPY-6 air and missile defence radar aboard US Navy destroyers, where the ability to track and discriminate fast-moving airborne and maritime threats is operationally decisive. Beyond electronics, yttrium's thermal properties extend its reach into the physical structure of weapons systems; yttrium-stabilised ceramics line the jet engines and missile casings of platforms, where sustained performance under extreme thermal and mechanical stress is a basic requirement for survivability[284]. It is enabling these platforms to withstand the extreme temperatures and mechanical stresses encountered during operation.

Gallium and germanium are foundational to infrared optics and radar.

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[281] Harvard Kennedy School: Belfer Center, Critical Minerals Explained: Why They Matter for Geopolitics, Clean Energy & Tech, October 2025.

[282] Todd Lopez, C., DOD Looks to Establish "Mine-to-Magnet" Supply Chain for Rare Earth Materials, March 2024.

[283] Modern War Institute at West Point, Minerals, Magnets, and Military Capability: China's Rare Earth Weaponization Should Be a Wake-Up Call, July 2025.

[284] Foundation for Defense of Democracies, Forging a New Critical Minerals Reality, March 2026. See also: USGS, Interior Department releases final 2025 List of Critical Minerals, November 2025.

The Modern War Institute describes the consequences of China's 2024–25 export restrictions thus: "this blocking action by China followed earlier prohibitions on gallium and germanium, which are foundational to infrared optics and radar systems"[285]. These were the first materials on which China imposed unilateral export controls with the explicit aim of constraining defence-related supply chains in countries regarded as strategic adversaries.

Key CRM-defence system dependencies

CRM	Primary defence application	Key platform / system	Supply risk
Neodymium (Nd)	NdFeB magnets — guidance, radar, electronic warfare (EW)	F-35, AMRAAM, SQQ-89	China: ~90 % magnet output
Dysprosium (Dy) / Terbium (Tb)	NdFeB enhancement at high temperatures	Avionics, propulsion	Export controls Apr 2025
Samarium (Sm)	SmCo magnets — extreme heat environments	AIM-120 AMRAAM, EA-18G Growler	China-dominated processing
Yttrium (Y)	YIG radar filters; ceramic jet engine/missile casings	AN/SPY-6, F-35 engine	High China concentration
Gallium (Ga)	Infrared optics; radar semiconductors	Radar, night-vision, missile seekers	China export controls Aug 2023 (licensing); ban on export to US, Dec 2024
Germanium (Ge)	Infrared optics; satellite communications	Night-vision, satellite sensors	China export controls Aug 2023 (licensing); US ban Dec 2024; extraterritorial rules Oct 2025
Tungsten (W)	Armour-piercing munitions; superalloys	Armour-piercing kinetic energy penetrators; jet engines	China, Russia primary sources
Cobalt (Co)	Battery cathodes; superalloys	Autonomous vehicles; jet engines	DRC mining; China refining
Lithium (Li)	Batteries for autonomous/electric platforms	Drones, unmanned aerial vehicles (UAVs), military EVs	Australia, Chile; China processes
Rubidium (Rb)	Atomic clocks for GPS precision	GPS; data network synchronisation	Limited global production
Tantalum (Ta)	High-temperature electronic components	Comms; targeting electronics	DRC conflict mineral risk
Rhenium (Re)	Superalloy turbine blades	F-22, F-35 engines	Kazakhstan, Chile; tight market

Source: The authors, based on SFA Oxford (2025); USGS Critical Minerals List 2025; Modern War Institute (2025); DiscoveryAlert (2026).

[285] Modern War Institute at West Point, Minerals, Magnets, and Military Capability: China's Rare Earth Weaponization Should Be a Wake-Up Call, *July 2025.*

Structural and thermal superalloys: tungsten, cobalt, rhenium

Unlike commercial applications, military specifications impose stringent purity and traceability requirements that fundamentally alter production economics. Military-grade tungsten demands greater than 99.95 % purity compared to approximately 97 % for industrial applications.

Rare earth processing for defence applications must meet MIL-DTL[286]specifications requiring documented chain-of-custody tracking from extraction through final component manufacturing'[287].

This traceability requirement alone, defined as "chain-of-custody[288] from mine to finished component" – effectively excludes Chinese-processed materials from compliant Western defence supply chains, even where Chinese processing capacity might otherwise be commercially accessible.

Electronics, C4ISR and GPS: tantalum, rubidium, cobalt

The USGS 2025 Critical Minerals list describes the communications-critical applications: Rubidium is used in atomic clocks, which are essential for the Global Positioning System (GPS), data network synchronisation, and scientific applications[289].

Tantalum is used in materials and electronic components that need to withstand high temperatures across targeting and communications electronics. Cobalt is a key cathode material in lithium-ion batteries[290], powering autonomous systems, drones and the increasingly electrified logistics infrastructure of modern military operations. Indium is used beyond consumer electronics, it is essential for infrared imaging systems, night-vision equipment, satellite communications, radar components and other advanced optoelectronic systems used in defence and aerospace applications.in flat-panel displays and touchscreens[291, 292].

NATO list of defence-critical raw materials

In December 2024, NATO released a definitive list of 12 defence-critical raw materials (**DCRMs**). This list represents a formal consensus on the minerals required to maintain a technological edge in modern warfare. The materials on this list are: aluminium, beryllium, cobalt, gallium, germanium, graphite, lithium, manganese, platinum, rare earth elements, titanium and tungsten.

While **the EU includes all of NATO's 12 DCRMs** within its broader CRM framework, it does not treat all of them with the same level of regulatory urgency as the United States does for defence-related supply chains. A small number of materials, such as **beryllium**, are listed as "critical" but not designated as 'strategic' raw materials yet, and therefore benefit from fewer binding capacity and funding-priority mechanisms than materials explicitly prioritised for the green and digital transitions and for defence.

Source: NATO, NATO releases list of 12 defence-critical raw materials, 2024.

[286] Military Detail Specification

[287] According to Discovery Alert, Final 2025 Critical Minerals List: 60 Strategic Resources, November 2025 'military-grade tungsten demands greater than 99.95 % purity compared to approximately 97 % for industrial applications'.

[288] Chain of custody provides the mechanisms that allow organisations to trace, account for and characterise materials along supply chains.

[289] According to the US Geological Survey rubidium is used in the atomic clocks that are key to global positioning systems (GPS), data network syncing and research and development, 2025.

[290] US DOD, Lithium Battery Strategy 2023–2030.

[291] Materion, Niobium and Tantalum: Refractory Metals Powering the Next Generation of Technology, 2025.

[292] Credence Research, Tantalum Capacitors Market report, 2025.

ANNEX IV: LIST OF SOURCES FOR TABLE 8

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  - *US Exim vouches support for Wyoming rare earths project*, March 2025. Available at: https://www.gtreview.com/news/americas/us-exim-vouches-support-for-wyoming-rare-earths-project/;
  - *American Battery Technology Company Receives Letter of Interest from US EXIM Bank for $900 Million for Tonopah Flats Lithium Project*, April 2025, https://americanbatterytechnology.com / press-release/american-battery-technology-company-receives-letter-of-interest-from-us-exim-bank-for-900-million-financing-for-tonopah-flats-lithium-project/;
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- **US Department of Energy**:
  - *Lithium Americas Closes $2.26 Billion US DOE ATVM Loan*, October 2024. Available at: https://lithiumamericas.com/news/news-details/2024/Lithium-Americas-Closes-2.26-Billion-US-DOE-ATVM-Loan/default.aspx;

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- *DOE Announces $996 Million Loan Guarantee to Ioneer Rhyolite Ridge,* January 2025. Available at: https://www.energy.gov/edf/articles/doe-announces-996-million-loan-guarantee-ioneer-rhyolite-ridge-advance-domestic;
- *LPO Announces Conditional Commitment for Project ATLiS for Lithium Hydroxide Production in California,* January 2025. Available at https://www.energy.gov/edf/articles/lpo-announces-conditional-commitment-project-atlis-lithium-hydroxide-production;
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  - US Department of Commerce: National Institute of Standards and Technology, *The Department of Commerce's CHIPS Program Announces a Letter of Intent with USA Rare Earth to Accelerate Its Domestic and Vertically Integrated 'Mine-to-Magnet' Strategy,* January 2026, https://www.nist.gov/news-events/news/2026/01/department-commerces-chips-program-announces-letter-intent-usa-rare-earth.

This study analyses the US critical minerals strategy, mapping its institutional framework, policy instruments and value-chain priorities – such as tax incentives, funding mechanisms, strategic stockpiling and demand-anchoring mechanisms. It provides a comparative analysis with the EU's approach, highlighting differences in scale, coordination and market intervention. Finally, it explains how its findings relate to the specific policy areas of the European Parliament's IMCO and ITRE Committees. The document was prepared by the European Parliament's Policy Department for Economy and Growth and its Policy Department for Transformation, Innovation and Health.