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# Collective security in a fragmented world: avoiding the scramble for critical minerals through coordinated stockpiling

Hugh Miller and Pau Morandi

Policy report  
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Sustainability

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# Summary

When governments race to stockpile critical minerals, they risk creating the very crisis they are trying to prevent.

The energy, digital and rearmament transitions are generating unprecedented and concurrent demand for copper, cobalt, lithium, rare earth elements and other minerals whose supply chains remain highly geographically concentrated and increasingly subject to trade weaponisation. In response, a growing number of governments, including those of Australia, China, India, Japan, South Korea and the US, as well as the EU, have adopted or announced unilateral stockpiling programmes. Without coordination, these programmes will intensify competition for minerals, heighten price volatility and induce the shocks that they are designed to mitigate. **With the US–China rare earth truce expiring in November 2026, the window to coordinate before the next supply shock is closing.**

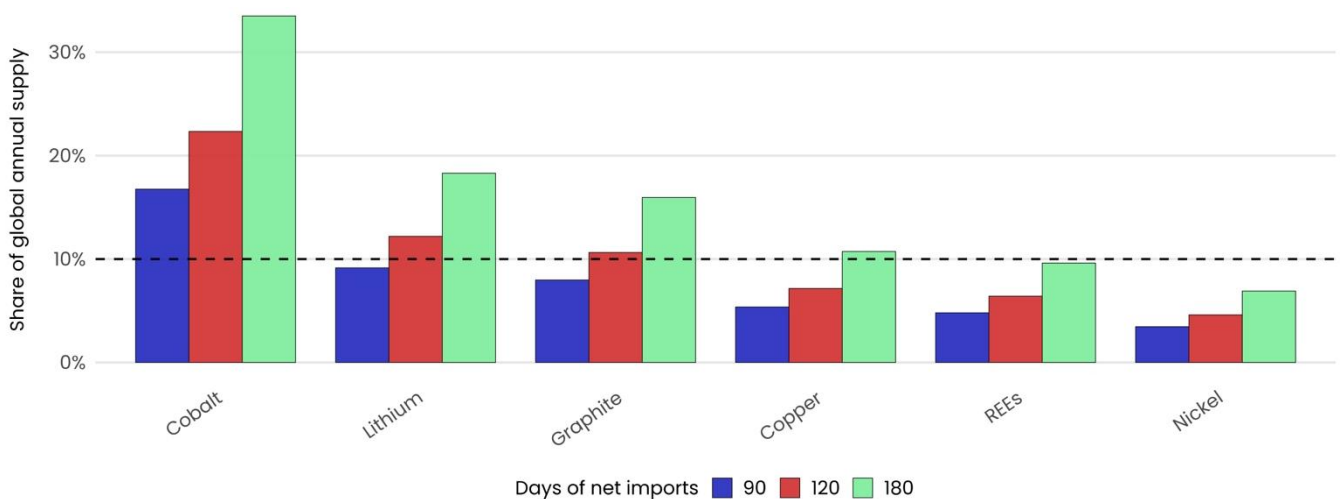
## Key data and takeaways

### Key data

Aggregate stockpile demand from Australia, China, the EU, India, Japan, South Korea and the US could represent up to **34% of global annual cobalt supply** and over **10% of global lithium, graphite and copper supply**, under a 180-day net imports scenario. A simultaneous scramble for limited supplies will distort markets, restrict access for economies with less fiscal capacity and amplify precisely the price volatility that stockpiling is designed to hedge against.

Coordination is not a refinement of national stockpiling strategies – it is the condition under which they do not undermine each other.

Figure S1. Market impact of stockpiling on global supply



Sources: IEA, 2025b; Gaulier and Zignago, BACI: International Trade Database at Product-Level, 2010; authors' analysis. Note: Figure depicts share of global annual supply that would be required to meet stockpiling demand across seven economies (Australia, China, the EU, India, Japan, South Korea and the US) under three calibration scenarios: 90, 120 and 180 days of net imports. REEs: rare earth elements.

### The architecture of coordination

The data point to a clear conclusion: **stockpiling itself is not the risk; the current scramble to secure supplies is.** Coordination offers three advantages no national programme can replicate. First, staggered build-up schedules reduce simultaneous demand shocks. Second, pre-agreed release

conditions improve market predictability. And third, an integrated framework connects short-term stockpiling to longer-term supply diversification.

However, no existing institution combines the mandate, enforcement capacity, technical expertise and governance architecture to anchor such a mechanism. **The International Energy Agency (IEA) comes closest.** It holds binding authority over emergency stocks, operational experience with petroleum reserves, dedicated critical minerals analytical capacity and a formal direction from its **2026 Ministerial Declaration** to expand its critical minerals role. **How should this mandate be operationalised?**

An effective mechanism would require adaptation through an **IEA membership+** framework – expanding participation to include systemically important economies not currently in the IEA, most notably India, while allowing non-members to engage in data sharing, market monitoring and agreed release protocols. A complementary but institutionally separate forum, built around a reformed Intergovernmental Forum on Mining (IGF), would pursue the mechanism’s secondary objective of long-term supply diversification, with equal producer-country representation.

The historical record is unambiguous on this point: **commodity agreements that blur emergency response with price management fail in the long term.** Keeping the two objectives institutionally distinct is not a design preference; it is a condition of the mechanism’s survival. The IEA membership+ framework is designed as a coalition of import-dependent economies, while the reformed IGF would constitute like-minded producers with aligned security interests. China, as both the dominant supplier and a major stockpiling economy, would not be a full participant in the binding emergency response core, but would be invited to engage in data sharing and market monitoring through the IEA’s existing open-door architecture.

### The broader strategy to leverage the impact of stockpiling

The IEA’s own N-1 analysis, modelling supply–demand balances following the removal of the largest single supplier, reveals shortfalls of 60–65% for graphite and rare earth elements by 2035, and a shortfall of approximately 45% for nickel. No volume of emergency stocks can compensate for gaps of this magnitude. **Stockpiling is a bridging instrument, not a solution.** To maximise its effectiveness, it must be embedded within a broader strategy encompassing supply chain diversification, investment in refining capacity and R&D for material substitution.

Policymakers should therefore be explicit that the credibility of any stockpiling commitment depends on parallel progress on structural supply resilience. Without this, there is a risk that **buffer stocks will create a false sense of security that delays rather than supports the longer-term responses the energy transition requires.**

### Takeaways

Action is required. Figure S.2 illustrates a proposed institutional architecture that will construct a robust, effective and internationally coordinated stockpiling mechanism.

#### Short-term priorities

**1. Anchor the mechanism within the IEA, with an expanded membership.** The IEA’s 2026 Ministerial Declaration provides the institutional mandate. An IEA membership+ framework should expand full participation to include India and other like-minded import-dependent economies, while maintaining the IEA’s binding enforcement architecture as the operational core.

**2. Separate emergency response from supply diversification objectives by design.** The primary objective should be emergency response, a credible buffer against acute supply disruptions and geopolitical shocks. A secondary, institutionally separate objective should support long-term supply diversification. The two must not be conflated.

**3. Coordinate stockpile build-up schedules to avoid simultaneous demand shocks.** An internationally agreed framework should establish staggered build-up schedules, shared calibration methodologies

and burden-sharing arrangements proportionate to import dependence. This is the most immediate operational priority given the current pace of unilateral stockpiling commitments.

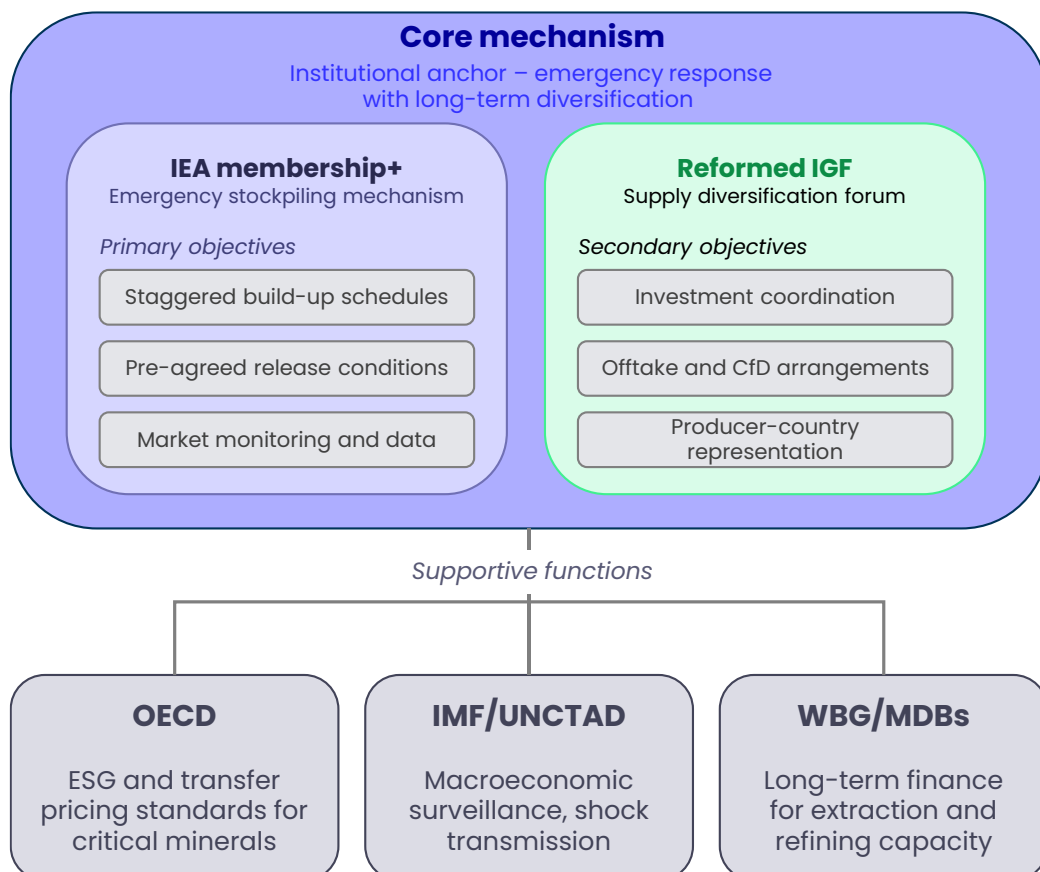
**4. Establish pre-agreed release conditions calibrated prior to the next supply shock, not during it.** Release triggers should be objective and pre-agreed and include severe supply disruptions, major geopolitical events and acute price dislocations, rather than being subject to discretionary deliberation. Release mechanisms should be differentiated by market structure: open market operations for exchange-traded minerals; targeted auctions or conditional direct sales for non-exchange-traded minerals.

### Longer-term priorities

**5. Establish a secondary forum for long-term supply diversification, with equal producer-country representation.** The Forum on Resource Geostategic Engagement's (FORGE's) investment- and market-related functions should be integrated into a reformed IGF with an expanded mandate covering investment coordination, offtake agreements and contracts for difference. Equal producer-country representation is essential for both equitable outcomes and the political legitimacy the mechanism requires.

**6. Assign complementary mandates to other international organisations to support the core mechanism.** The World Bank Group (WBG) should finance refining and extraction capacity in diversification-priority jurisdictions; the International Monetary Fund (IMF) should integrate critical minerals into its macroeconomic surveillance frameworks; and the Organisation for Economic Co-operation and Development (OECD), the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) and the United Nations Conference on Trade and Development (UNCTAD) should expand transfer pricing, environmental, social and governance (ESG) and trade resilience guidance to producer countries. This institutional division of labour supports both dimensions of the dual mandate without creating redundant coordination structures.

**Figure S2. Proposed institutional architecture for coordinated critical mineral stockpiling**



Source: Authors' illustration.

# 1. Introduction

**Major economies are competing for critical minerals.** This is not only growing in magnitude but expanding in scope – trade restrictions are now targeting more than just raw material extraction. Any plausible stockpile is unlikely to cover a large shortfall in supply beyond a relatively brief bridging period. Meanwhile, competitive mining is also contributing to the weakening of socio-environmental safeguards. **Agreement on staggered build-up schedules, shared calibration methodologies and pre-agreed release conditions can reduce the risk of simultaneous demand shocks while providing greater collective security of supply.** This will require careful arrangement and the mechanism should carry a clear security of supply mandate rather than an explicit price management function, paired with institutional architecture capable of supporting both emergency response and longer-term supply diversification.

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## Critical minerals: the macroeconomic landscape

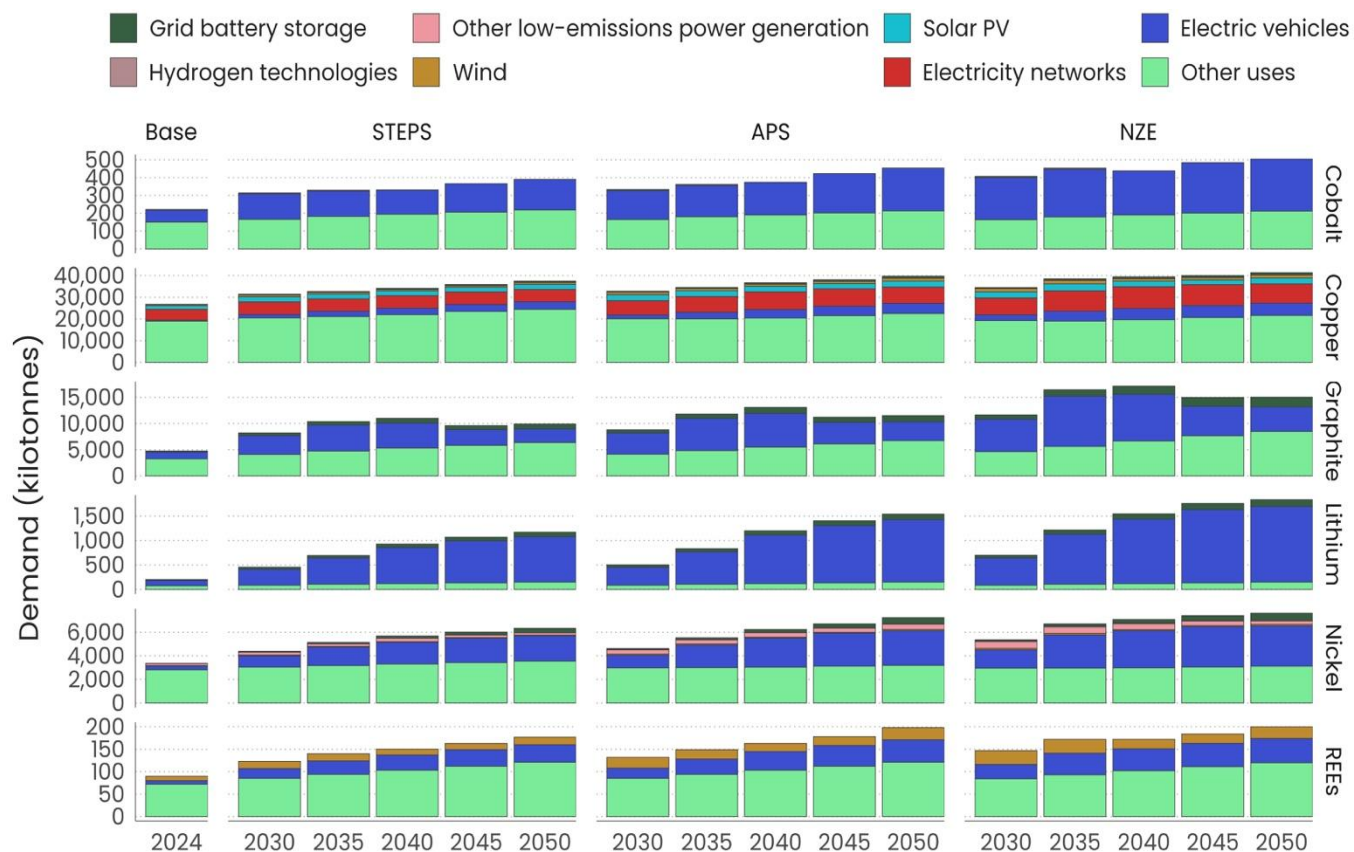
The energy, digital and rearmament transitions depend on **critical minerals**, such as copper, cobalt and lithium. High geographical concentration of supply across the value chain, alongside growing use of trade interventions amid rising geopolitical tensions, is weakening the reliability of globalised trade. In response, governments are considering various strategies to mitigate supply risks. One is stockpiling, as seen in the EU's RESourceEU Action Plan and the US's Project Vault (US\$12bn) critical mineral reserve (EC, 2025; EXIM, 2026). This may enhance national resilience, but uncoordinated increases in stockpiling risk amplifying the very market volatility and supply disruptions they are designed to prevent.

### Global demand for critical minerals is growing

Critical minerals are required across a broad and growing range of strategic technologies. Demand is in many cases urgent, non-negotiable and increasing, particularly in the context of the digital and energy transitions and the push for rearmament across Western economies. Under the International Energy Agency's (IEA) Net Zero Emissions by 2050 Scenario, demand for cobalt, nickel, magnet rare earth elements and graphite is projected to more than double by mid-century, while lithium demand is forecast to increase almost ninefold (see Figure 1.1) (IEA, 2025a). These projections reflect a structural shift in the composition of global commodity demand, one that is unlikely to reverse regardless of the pace of transition.

Beyond the energy sector, the rapid expansion of data centres, advances in artificial intelligence (AI) and next-generation semiconductor technologies are intensifying demand for high-purity metals and rare earth elements (IEA, 2025a; USGS, 2025). Simultaneously, new defence spending commitments across NATO member states are generating additional pressure on markets for specialised alloys, magnet materials and battery chemicals, with global defence spending up 9% year on year in 2024, compared with the 2.7% average growth seen between 2017 and 2022 (JP Morgan, 2026; IISS, 2025). The convergence of these long-term demand drivers means that several mineral markets face simultaneous, cross-sectoral pressures that are qualitatively different from typical commodity cycles, which have historically been driven primarily by aggregate demand and supply shocks operating across commodity classes (Jacks and Stuermer, 2020; Boer et al., 2021).

**Figure 1.1. Projected demand for critical minerals under the IEA scenarios**



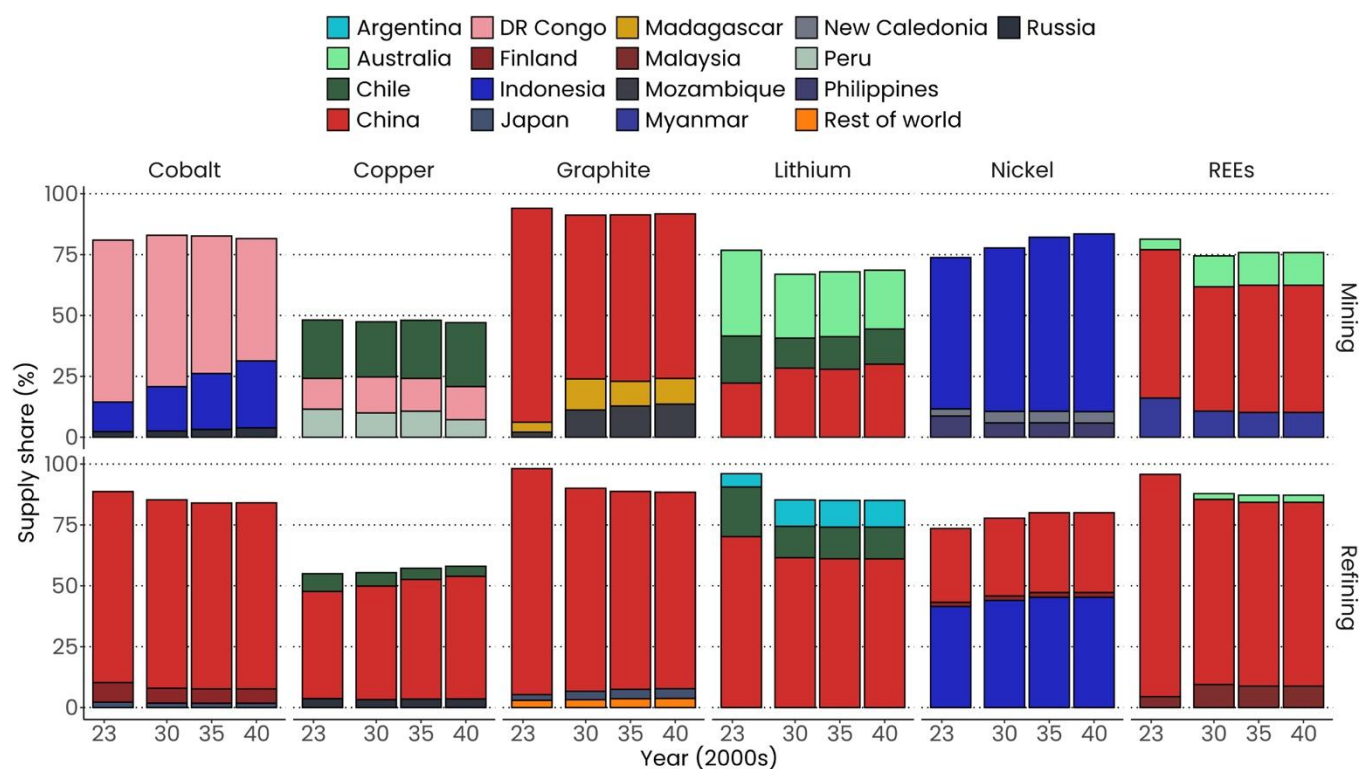
Source: IEA, 2026d, authors' illustration. Note: STEPS, APS and NZE are IEA policy scenarios: Stated Policies Scenario, Announced Policies Scenario and Net Zero Emissions by 2050. REEs: rare earth elements. Other uses: defence and information technologies, among other areas.

The timing of demand matters as much as its scale. The sharp, front-loaded increase in mineral-intensive infrastructure necessary for the build-out phase of the energy transition requires quantities that go way beyond those current supply chains were designed to accommodate. This transitional surge is compounded by parallel investment cycles in digital infrastructure and defence procurement. Yet the current rate of demand acceleration is unlikely to persist indefinitely; as key technologies mature, demand will transition from rapid expansion to more predictable, steady-state growth. Once electric vehicle (EV) fleets approach saturation, for instance, incremental battery demand will increasingly reflect replacement rather than net additions. The challenge is therefore one of managing a concentrated and volatile transitional period in which supply responsiveness is structurally constrained and increasingly vulnerable to weaponisation through trade restrictions.

### Geographically concentrated supply

Critical mineral supply chains are highly geographically concentrated, with the top three producers accounting for more than 50% of global supply at both the extraction and refining stages for most energy transition minerals (see Figure 1.2). Under IEA projections, this concentration is projected to intensify over the coming two decades across nearly all commodities. The risks are most acute at the refining stage, where IEA member countries play only a marginal role for most minerals and are not expected to substantially increase their share of global refining by 2040.

**Figure 1.2. Geographical concentration of extraction and refining of critical minerals**



Source: IEA, 2025a; authors' illustration.

The diversification strategies being implemented by some import-dependent economies – see, for example, the EU's Critical Raw Materials Act, the UK's Critical Minerals Strategy and the US's Inflation Reduction Act – may result in the supply chain being more diverse than the IEA's estimates predict (European Parliament, 2024; US Congress, 2022; Department for Business and Trade, 2026). However, these policies face a structural cost constraint: the lower operational costs of mining and refining in major producing countries, particularly for non-IEA member countries. (See the appendix for further analysis.)

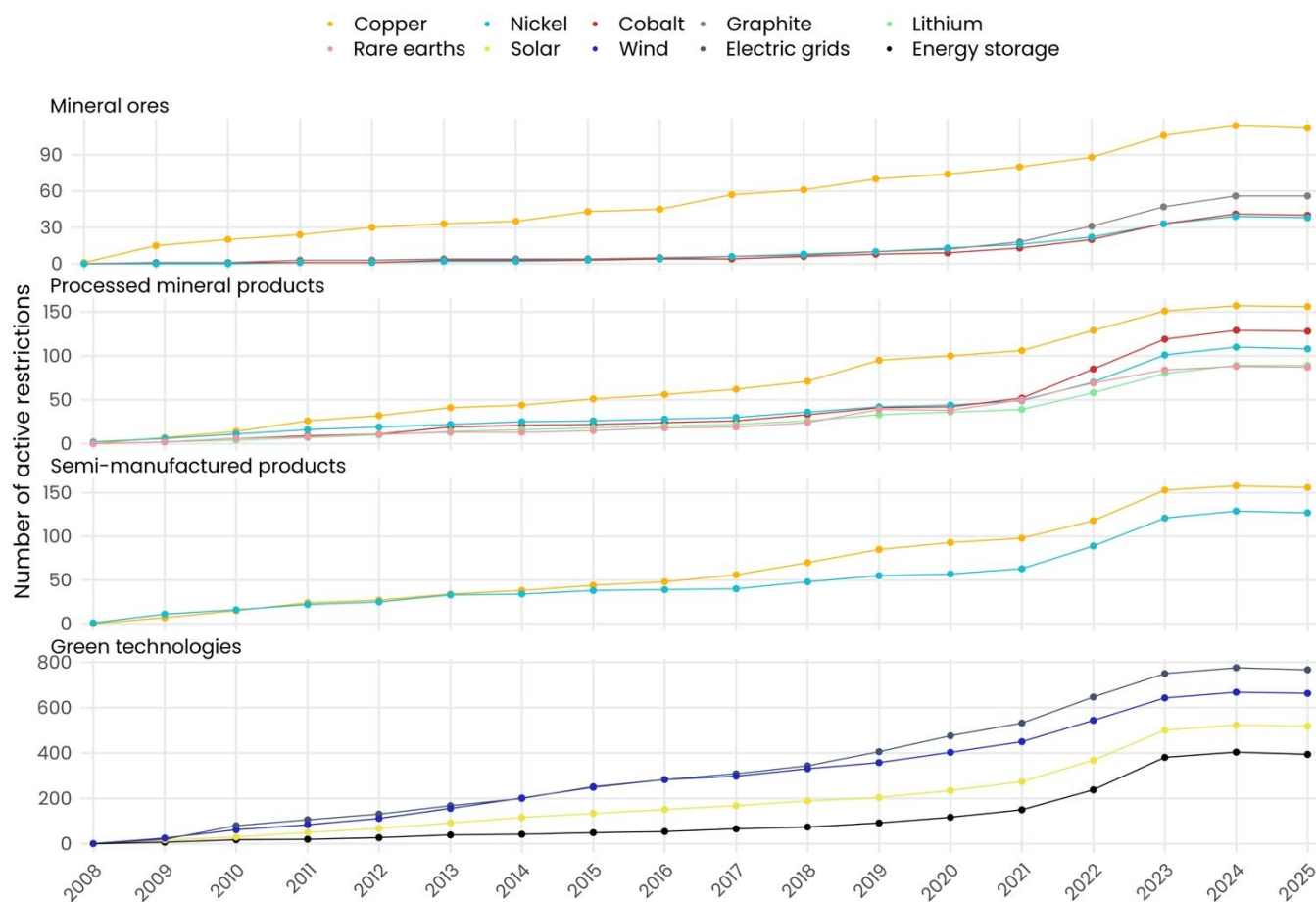
Additionally, geographical concentration measures based on production location alone may understate the true degree of supply chain vulnerability. Analysis of ownership structures reveals that China's effective control over critical mineral value chains extends well beyond its share of geographical output. Complex webs of indirect shareholding mean that apparently diversified supply sources may in practice remain under the influence of a single controlling actor (Leruth et al., 2022).

The practical implications of this concentration are illustrated by the IEA's N-1 analysis, which models the supply–demand balance following the removal of the largest single supplier. Under this scenario, shortfalls of 60–65% emerge for graphite and rare earth elements by 2035, with deficits of approximately 45% for nickel and 35% for both lithium and cobalt. Copper is the notable exception, where N-1 supply broadly covers N-1 demand, reflecting China's dual role as both the leading refiner and the largest consumer of refined copper (IEA, 2025a). These figures underscore that for most critical minerals, the global supply system has little redundancy; removing a single country's output, whether through export controls, geopolitical tension or natural disaster, would produce severe and rapid shortfalls with few alternative sources capable of compensating at scale.

### Critical mineral-related trade interventions are growing

Critical minerals are increasingly at the centre of geopolitical competition between major economies. China's 2025 imposition of export restrictions on rare earth elements represents the most acute example of supply concentration being weaponised as a trade policy instrument (IEA, 2025b). Figure 1.3 illustrates the rising trend in 'active' trade restrictions against critical minerals and green technologies.

**Figure 1.3. Trends in total active trade restrictions for critical minerals and green value chains**



Source: Global Trade Alert, 2026; authors' illustration.

Growing trade restrictions increase security of supply risks by making aggressive use of concentration across critical mineral supply chains. Products at all stages of the value chains have experienced an acceleration in trade restrictions post-2021. The acceleration in restrictions is most pronounced for processed and semi-manufactured products and for green technologies, suggesting that trade interventions are increasingly targeting downstream stages of the value chain rather than raw material extraction alone. This has direct implications for the design of stockpiling policy: if restrictions are concentrated at the refined or intermediate product stage, buffer stocks held at those stages may offer greater protection against supply disruption than raw ore reserves.

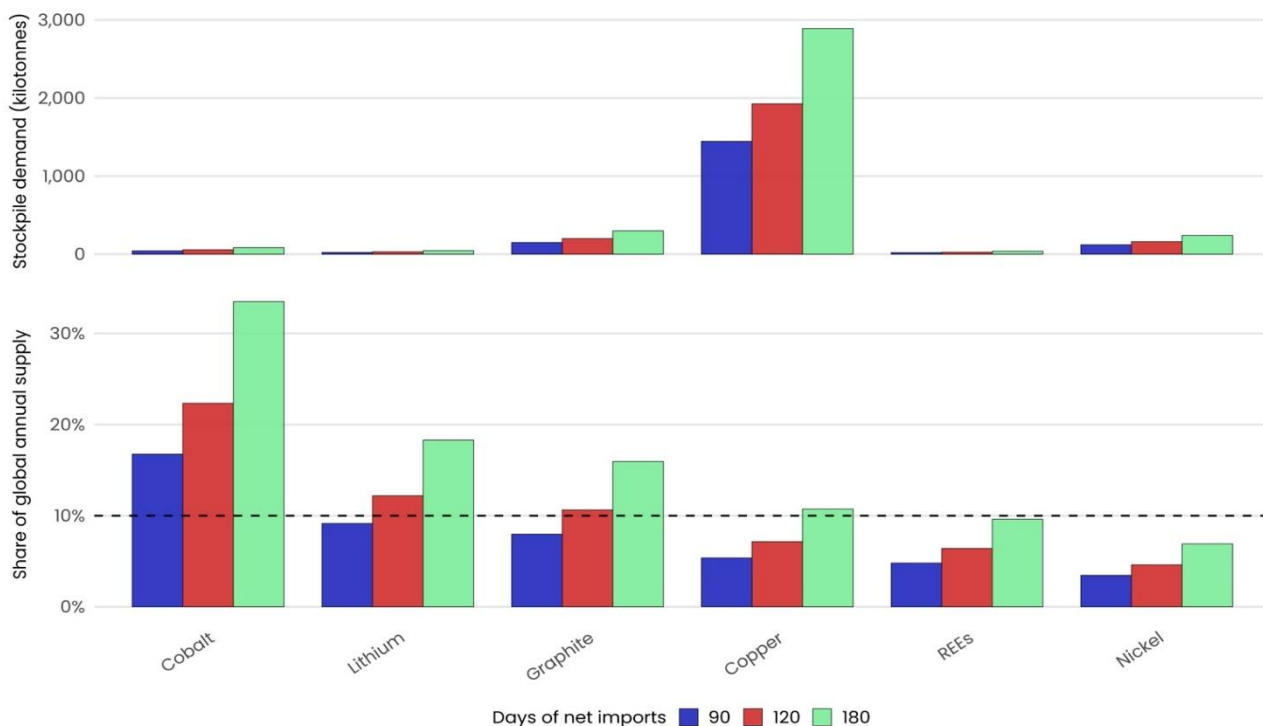
## Market impact and rationale for coordinated critical mineral stockpiling

An uncoordinated, national-level approach to critical mineral stockpiling creates material risks to global supply–demand balances. A simultaneous scramble to secure limited supplies could intensify competition between economies, restrict access for those with less fiscal capacity, distort markets and increase price volatility, while uncoordinated stock releases risk amplifying rather than dampening these effects.

### Market impact of national critical mineral stockpiling strategies

Figure 1.4 illustrates the potential market impact of currently implemented and announced national stockpiling programmes across six key minerals. The top panel shows aggregate stockpile demand in kilotonnes, and the bottom panel expresses this as a share of global annual supply based on the IEA Critical Mineral Database (IEA, 2026d). Three scenarios are presented, assuming that stockpiling countries hold 90, 120 and 180 days of net imports at the refined material stage.

**Figure 1.4. Estimated market impact of critical mineral stockpiling programmes**



Source: IEA, 2026d; Gaulier and Zignago, 2010; authors' analysis. Note: REEs are rare earth elements. These figures reflect the combined stockpiling demand of the seven economies that have implemented or announced strategic stockpiling programmes – Australia, China, the EU, India, Japan, South Korea and the US. Please see the import-dependence analysis in the appendix for detailed methodology.

The results highlight significant variation in market sensitivity across commodities. Cobalt is the most exposed, with aggregate stockpile demand equivalent to up to 34% of global annual supply under the most ambitious scenario, a level that would represent a severe demand shock if build-up were concentrated over a short period. Lithium, graphite and copper also face meaningful demand pressures, each exceeding 10% of global supply under the 180-day scenario. Moreover, while copper stockpile demand appears marginal on a relative basis, in absolute terms it equates to between 1.3 and 2.9 million tonnes, which would represent a significant demand shock in a market already experiencing tightness.

Rare earths and nickel are less affected, though the situation is still non-trivial. The findings presented here are conservative for certain minerals as only the refined product stage of the value chain is considered. For nickel and rare earth in particular, the import dependence occurs in greater volumes at the refined and semi-manufactured stages of the value chain (see Figure A.2). Stockpile demand as a share of global supply would be higher for these minerals if calibrated at those stages, underscoring the importance of the stage of the value chain at which stockpiling is targeted (see the import-dependence analysis in the appendix for further details).

There is no broadly accepted threshold over which a supply or demand shock will materially impact mineral markets. The 10% reference threshold reflects the level at which aggregate stockpile demand becomes a material fraction of annual global supply. Based on short-run supply elasticity estimates for energy transition metals, ranging from 0.32 for cobalt to 0.35 for copper (Boer et al., 2021), demand additions of this magnitude, if concentrated over a short accumulation period, would be consistent with price increases in the range of 29–31% for the most inelastic minerals before any supply response.<sup>1</sup> This threshold is conservative. For the most concentrated markets, including cobalt and rare earth elements, where supply elasticity is lower and HHI<sup>2</sup> exceeds 4,000 (Vertier et al., 2025; Bucciarelli et al.,

<sup>1</sup> These estimates should be interpreted as indicative. They are derived by inverting the Boer et al. elasticity estimates rather than directly reported in that literature, and do not account for inventory buffers or demand-side adjustment.

<sup>2</sup> HHI refers to the Herfindahl-Hirschman index which is a measure of market concentration.

2025), material price effects are likely to emerge at lower demand additions. Moreover, Shojaeddini et al. (2024) demonstrate that demand elasticity for battery minerals is very low and, for cobalt, nickel and manganese, has fallen further following structural breaks tied to the growth of EV demand. This means price increases from a demand shock will not be significantly dampened by demand-side adjustment, reinforcing the upper-end of price impacts. The analysis does not consider the role of inventories, which play an important role in dampening shocks (Roache and Erbil, 2010), or the possibility that existing private inventories may reduce the volume of mineral demand required for stockpiling initiatives. Beyond the market impacts, the competitive fast-tracking of mining operations being seen at present has contributed to the weakening of socio-environmental safeguards (Westenberg, et al., 2026). The current pursuit of stockpiling may accelerate the erosion of these safeguards.

These findings establish the quantitative case for coordinated stockpiling. Agreement on staggered build-up schedules, shared calibration methodologies and pre-agreed release conditions would reduce the risk of simultaneous demand shocks while preserving the supply security benefits that stockpiling is designed to provide. (Further analysis on cross-country comparisons on import dependencies and potential stockpiling demand is included in the import-dependence analysis in the appendix.)

### **Critical mineral stockpiling: considerations and scope**

The design of any coordinated mechanism must be shaped by two analytical considerations bearing directly on the institutional architecture assessed in Section 2. First, stockpiling is effective as a short-term insurance buffer against acute supply disruptions, but it is not a response to structural energy security risks. This limitation is most acute for disruptions originating from Chinese trade policy. Unlike production outages or natural disasters, which temporarily reduce global supply, a sustained export restriction would remove the dominant refining capacity from global markets entirely. The IEA's N-1 analysis illustrates this limitation, as shortfalls of 60–65% for graphite and rare earths following the removal of the largest supplier exceed what any plausible stockpile could cover beyond a brief bridging period. Moreover, unlike fossil fuel shocks, critical mineral disruptions slow the deployment of clean energy infrastructure rather than curtailing existing output, meaning buffer stocks cannot offset near-term energy shortfalls (Miller and Martínez, 2025). A credible mechanism must therefore be embedded within a broader strategy encompassing supply chain diversification, investment in refining capacity and R&D for material substitution, functions that require institutional capabilities beyond those of a stockpiling body alone.

Second, the historical record of internationally coordinated commodity agreements, particularly those with explicit price management mandates, provides important design lessons. Several collapsed entirely due to unrealistic price floors, inadequate financing and the inability to control non-member production, with only limited impact success in reducing price volatility (Gilbert, 2011). The International Tin Agreement is the most prominent example, defaulting on almost £900 million in debt in 1985 after exhausting its resources defending an unsustainable price floor (Prest, 1986). The institutional design of any coordinated mechanism must be robust to these failures.

Both considerations point toward the same design conclusion: the proposed mechanism should carry a clear security of supply mandate rather than an explicit price management function, with an institutional architecture capable of supporting both emergency response and longer-term supply diversification.

## **Structure of the report**

The report is structured as follows. Section 2 provides an institutional assessment of existing international organisations against the requirements for coordinated stockpiling. Section 3 sets out the operational mechanics of the proposed mechanism, covering mineral scope, procurement and release design, and governance arrangements. Section 4 identifies the enabling conditions necessary for the mechanism to function effectively in practice and Section 5 concludes with policy recommendations.

## 2. Institutional assessment

A platform to coordinate an international critical mineral stockpiling programme will need to support coordinated stockpiling and release, limit market distortions and ensure credibility during supply disruptions. This section assesses existing institutions' capabilities in these areas based on five core criteria: mandate and policy levers; technical expertise; membership and governance; financing capacity and private-sector engagement; and transparency and accountability. Our analysis focuses on the BRICS grouping, the Forum on Resource Geostrategic Engagement (FORGE), the International Energy Agency (IEA), the International Monetary Fund (IMF), the International Renewable Energy Agency (IRENA), the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF), the Organisation for Economic Co-operation and Development (OECD), the United Nations Conference on Trade and Development (UNCTAD), and the World Bank Group (WBG).

The historical record of commodity agreements suggests that institutional design, particularly with respect to mandate, enforcement capacity and financing resilience, is a determinant of whether coordinated stockpiling succeeds or fails under stress. The selection of criteria is grounded in Koremenos et al.'s (2001) rational design framework, which identifies membership, scope, centralisation, control and flexibility as the core dimensions along which international institutions vary. Building on this, a credible international critical minerals stockpiling programme depends on inclusive institutions with strong technical capacity, transparency and accountability, and an appropriate mandate. Governance arrangements must balance the needs of import-dependent economies with producer-country development priorities, while avoiding excessive bureaucratic burdens and ensuring operational efficiency. Together, these features are essential to ensure that stockpiling mitigates short-term supply disruptions and supports longer-term supply security, without triggering unilateral action.

**Table 2.1. Overview of assessment criteria for institutional assessment**

Assessment criterion	Relevance of criterion for international stockpiling mechanism
<b>Mandate and policy levers</b>	Determines whether an institution has the scope and binding authority to coordinate collective action and avoid uncoordinated national stockpiling
<b>Energy and critical mineral expertise</b>	Evaluates the institutional capacity to monitor markets in real time, assess supply and refining risks, and provide the shared analytical basis needed to identify when coordinated action is required
<b>Membership and governance</b>	Assesses who participates and how decisions are taken, balancing operational effectiveness with legitimacy, and whether membership is sufficiently inclusive of both import-dependent economies and emerging producer countries to support coordinated emergency response and long-term diversification
<b>Budget, financing capacity and private sector engagement</b>	Examines whether the institution can sustain core operational functions through predictable financing and engage credibly with private actors across mineral value chains
<b>Transparency and accountability</b>	Assesses whether stockpiling levels, release decisions and financial flows can be independently verified and disclosed in a way that deters free riding, prevents market manipulation and sustains member confidence under stress

Source: Authors' illustration adapted from Koremenos et al. (2001).

## Mandate and policy levers

### Does the institution have a mandate that covers security of supply and the authority to coordinate collective action, including during crises?

Mandate and policy levers refer to the relevance of an institution's objectives, scope of authority and capacity to coordinate collective action. Following Koremenos et al.'s (2001) rational design framework, an effective mandate must balance a sufficiently broad scope and the centralisation of core functions such as monitoring, data provision and emergency response. Applied to stockpiling of critical minerals, this implies a sufficiently broad mandate to cover energy security, long-term supply and refining diversification, and ESG-aligned extraction with sufficient authority to prevent uncoordinated stockpiling, ensure credible release protocols and avoid market distortions.

**Table 2.2. Summary of international organisations' mandates**

Organisation	Mandate
<b>International Energy Agency (IEA)</b>	Energy security and clean energy transition, with binding authority for emergency stockholding and collective action
<b>Forum on Resource Geostrategic Engagement (FORGE)</b>	Critical mineral supply chain security, with plurilateral policy and project coordination, and voluntary trade and investment alignment
<b>BRICS</b>	Political alignment and economic cooperation, with voluntary coordination on trade and development
<b>International Monetary Fund (IMF)</b>	Monetary cooperation, exchange rate stability and balance of payments
<b>World Bank Group (WBG)</b>	Poverty reduction, development finance and private sector investment mobilisation
<b>Organisation for Economic Cooperation and Development (OECD)</b>	Sustainable economic growth, trade expansion and policy standards
<b>United Nations Conference on Trade and Development</b>	Development-friendly trade and investment integration, with commodity market assessment
<b>Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF)</b>	Mining governance, sustainable development and responsible extraction standards
<b>International Renewable Energy Agency (IRENA)</b>	Renewable energy development, policy advice and technological transfer

Source: Authors' illustration.

The institutions assessed differ markedly in this respect. The IEA's mandate, established under the International Energy Program, assigns binding authority to require member states to hold emergency stocks and coordinates releases during supply disruptions by giving it the only existing precedent for centralised, rules-based stockpiling coordination (IEA, 1974). BRICS, encompassing a growing coalition of major emerging economies, focuses on political alignment and economic cooperation, with voluntary coordination on trade and development, but lacks binding enforcement mechanisms or a specific critical minerals mandate (BRICS, 2025). FORGE, by contrast, was launched in February 2026 as the successor to the Minerals Security Partnership (MSP) with a specific critical minerals mandate, aiming to establish a preferential trade-and-investment zone with coordinated price floors but, like BRICS, operates through voluntary coordination and its operational details remain to be defined (US Department of State, 2026). The IMF's mandate, as set out in its Articles of Agreement, focuses on monetary cooperation, exchange rate stability and balance of payments support, not physical supply

security (IMF, 2021). Similarly, the World Bank's mandate under its Articles of Agreement centres on poverty reduction and development finance rather than commodity coordination (World Bank, 2012). The OECD's founding Convention defines its objectives around sustainable economic growth and trade expansion, with no authority over physical supply chains (OECD, 1960). UNCTAD, established by the UN General Assembly in 1964, focuses on development-friendly trade and investment integration, providing analytical and capacity-building functions but lacking centralised authority for market intervention (UN General Assembly, 1964). IRENA's founding Statute assigns it a mandate around renewable energy deployment, policy advice and technology transfer, but not supply security or stockpiling (IRENA, 2009). The IGF, established in 2005, focuses on mining governance and sustainable development in resource-rich economies, without operational authority over mineral markets (IGF, 2023).

## Energy and critical minerals expertise

### Can the institution monitor supply, refining, inventories and risks in real time and support evidence-based release decisions?

Energy and critical mineral expertise refers to an institution's capacity to analyse markets, forecast demand, assess supply and refining risks, manage stockpile-relevant data and support evidence-based decision-making. Institutions with robust analytical capacity and technical authority are best placed to underpin coordinated stockpiling with timely, credible release decisions.

The IEA combines system-wide energy market surveillance with dedicated critical minerals analysis through its Critical Minerals and Clean Energy Transitions Programme, producing annual Critical Minerals Market Reviews covering mining and refining capacity, processing bottlenecks, demand projections and supply risks, and integrating these into real-time monitoring and long-term energy transition scenarios (IEA, 2023; IEA, 2025). This analytical capacity has been formally recognised and expanded by member governments through the 2026 Ministerial Declaration, which explicitly directed the IEA Secretariat to reinforce its role in secure data collection and market monitoring across a broad suite of energy-related strategic minerals (IEA, 2026).

By contrast, most other institutions provide partial or sector-specific analytical functions that fall short of the real-time, stockpile-focused monitoring required. BRICS facilitates information exchange through the BRICS Energy Research Cooperation Platform but lacks permanent analytical units or centralised data systems for critical minerals (BRICS, 2025). The MSP coordinated project-level assessments among members but did not produce independent supply risk assessments or mineral demand forecasts (US Department of State, 2022). As MSP's successor, FORGE is likely to inherit this coordination role; however, whether it will develop independent analytical capacity remains unclear, as its working structures and mandate details have yet to be made public (US Department of State, 2026). The IMF's analytical work on commodities is distributed across its Research, Strategy and Fiscal Affairs departments, covering macro-financial surveillance and extractive sector fiscal regimes, but without real-time mineral market monitoring or stockpile-focused tracking (IMF, 2012, 2023). The WBG's relevant expertise sits within its Energy and Extractives Global Practice, including dedicated analysis on transition minerals through its Minerals for Climate Action reports, but does not extend to operational stockpile management (World Bank, 2023). IRENA's Knowledge, Policy and Finance Centre provides detailed demand-side analysis of mineral requirements for clean-energy technologies, but does not maintain real-time supply chain surveillance systems (IRENA, 2023). The IGF and OECD provide technical guidance on mining governance, ESG standards and responsible supply chains through their respective thematic programmes and the joint BEPS in Mining initiative, but neither produces market forecasts or supply risk assessments (IGF, 2023; OECD, 2023). UNCTAD occupies a distinct position – its Division on International Trade and Commodities contributes in-depth analysis of commodity markets, value chain concentration and development impacts, including through its annual Commodities and Development Report, offering perspectives that are particularly relevant for producer-country participation (UNCTAD, 2023).

## Membership and governance

### Does the institution's membership structure balance operational effectiveness with legitimacy, including producer-country participation, and does governance allow timely decisions?

Membership and governance determine who participates in an institution, how decisions are taken and how compliance is supported. In the context of critical minerals stockpiling, effective design must balance inclusiveness with enforceability, given that countries are often simultaneously producers and importers and that legitimacy depends on recognising producer-country development priorities while maintaining credible decision-making and operational efficiency. As the rational design literature suggests (Koremenos et al., 2001), governance arrangements that combine inclusive membership with centralised decision-making and binding enforcement mechanisms are more stable and credible. Historical experience with commodity agreements reinforces this in the sense that producer-only or consumer-only arrangements have proven structurally fragile, while shared governance frameworks have proven more durable and less distortionary (Chandrasekhar, 1989).

Membership varies across institutions. There is near-universal participation in UNCTAD (195 members), the IMF (190 members) and WBG (189 members), highly inclusive technical forums such as IRENA (168 members) and the IGF (80 member governments). Finally, the more selective, invitation-based groupings include the IEA (32 full members), the OECD (38 members), BRICS (9 members) and FORGE (15 founding members, retaining the MSP's membership base, with an explicit ambition to expand participation through new bilateral agreements).

The governance models vary correspondingly: UNCTAD, IRENA, IGF, BRICS and the MSP operate through consensus-based, non-binding arrangements relying on voluntary cooperation and reputational incentives, without formal enforcement mechanisms. FORGE, which replaced the MSP in February 2026, is expected to operate similarly, though its formal governance structures and decision-making procedures have yet to be made public. The IMF and WBG occupy an intermediate position, combining near-universal membership with weighted voting and enforcement capacity through lending conditionality and legal covenants in project agreements.

The IEA stands out for its centralised governance, binding rules and delegated technical authority, enabling coordinated action during supply disruptions. Even though only full members are bound by the Agency's decision-making procedures and emergency mechanisms, its membership structure includes accession candidates that are in the process of meeting membership criteria, and association countries that participate in selected activities and data sharing through formal cooperation agreements, creating a broader and more inclusive structure. Institutions with universal or broad membership, such as UNCTAD, IRENA and the IGF, provide legitimacy and producer-country representation but lack enforcement capacity. As such, they are likely to play complementary roles in coordinating stockpiling rather than providing an operational framework.

## Budget, financing capacity and private sector engagement

### Can the institution finance the coordination architecture and engage credibly with firms that control mining, refining, storage and logistics?

Budget, financing capacity and private sector engagement determine whether an institution can support the operational requirements of a stockpiling mechanism and, where relevant, contribute to supply-side capacity. Under the proposed framework, no institution is expected to finance physical stockpiles directly; instead, stockholding obligations rest at the national level, deliberately avoiding the centralised buffer stock financing that proved fatal to historical commodity agreements such as the International Tin Council.

Financing capacity has two relevant dimensions. First, there is the ability to mobilise predictable resources for core operational functions, such as coordination architecture, market monitoring, analytical work, data and reporting systems, verification of stock levels and implementation of release

protocols, and access to development finance to support producer-country and private sector capacity, including ESG standards. Second, there is the need to function without imposing excessive administrative or operational costs. While no institution finances physical stockpiles directly, differences are significant.

The IEA and WBG are the strongest performers on this criterion – though for different reasons. The IEA operates with a stable, member-funded budget that supports market surveillance, data verification and coordinated emergency response, and maintains structured dialogue with private firms through advisory platforms and its critical minerals work. It has proven capacity to operate a rules-based stockpiling system. This has been formally recognised and expanded by IEA member governments; the 2026 Ministerial Declaration explicitly directed the IEA Secretariat to provide support to members establishing and expanding critical minerals stockpiling systems, and to strengthen secure data collection and market monitoring across a broad suite of strategic minerals (IEA, 2026).

The WBG cannot operate stockpiles directly, but has the strongest capacity to mobilise long-term public and private finance for upstream and midstream investments through lending, guarantees and risk-mitigation instruments, including via the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA), as well as through the Extractives Global Programmatic Support trust fund, which finances advisory services on responsible extractive-sector development. Notably, the IFC engages directly with private mining and refining firms through loans, equity and investment funds, while MIGA provides political risk insurance to investors in the extractives sector, making the WBG the institution best placed to connect public coordination frameworks with private sector supply chain investment.

Other institutions are more limited in this respect. The IMF can mobilise substantial financial resources through lending arrangements and emergency financing facilities, but these are designed for balance of payments support rather than supply chain coordination or stockpile financing. Its private sector engagement does not extend to operational mineral supply chains (IMF, 2021).

The OECD and IGF occupy a distinct position on private sector engagement. The OECD's Due Diligence Guidance for Responsible Supply Chains of Minerals and its Responsible Business Conduct framework are applied directly by mining and refining firms, creating a meaningful channel of industry engagement, while the IGF's membership structure explicitly includes industry participants alongside governments, giving it direct access to mining companies, though neither institution commands financing capacity beyond its secretariat budget (OECD, 2023; IGF, 2023).

UNCTAD and IRENA possess stable but comparatively modest secretariat budgets, primarily relevant for analytical work and policy guidance. IRENA maintains some industry partnerships through its renewable energy work, but neither institution has operational financing capacity or structured private sector engagement mechanisms relevant to minerals supply chains (UNCTAD, 2023; IRENA, 2023).

BRICS has developed permanent financial capacity through the New Development Bank (NDB), established to finance infrastructure and sustainable development in member states and emerging economies, but this does not have a specific critical minerals mandate or structured private sector engagement mechanism for supply chains.

FORGE, while lacking permanent multilateral financial instruments, represents a more integrated approach than its predecessor, the MSP. It operates alongside Project Vault, a US-backed US\$12bn strategic minerals reserve launched concurrently in February 2026, and has signalled structured private sector engagement through its association with Pax Silica and the government–industry dialogue held at its launch. However, Project Vault remains a unilateral US instrument, and the operational details of FORGE's private sector engagement remain to be defined (US Department of State, 2026; Export–Import Bank of the United States, 2026; Kine, 2025).

## Transparency and accountability

### Can the institution support harmonised reporting, independent verification and credible disclosure during market stress?

Credibility depends on harmonised reporting of stock levels, release triggers, financial flows and ESG standards, combined with independent verification and crisis-ready disclosure. The normative foundation for these requirements is well established; the Extractive Industries Transparency Initiative (EITI) Standard, adopted by over 50 countries, already defines disclosure obligations along the extractive industry value chain, from extraction rights through to revenue flows and public benefit (EITI, 2023). The IEA again stands out as the only institution with an operational transparency framework directly relevant to stockpiling. Its Emergency Oil Response System is the only existing precedent, balancing public disclosure with confidentiality to deter market manipulation. This system also encompasses reserve adequacy assessments, scenario exercises and post-release evaluations, developed and institutionalised through decades of operational practice under the International Energy Program (IEA, 1974; IEA, 2022). This transparency function was formally reinforced in the 2026 Ministerial Declaration, which directed the IEA Secretariat to expand its data collection and market monitoring role across a wider range of strategic minerals, strengthening its standing as the central international platform for credible mineral market information (IEA, 2026).

Several other institutions contribute partial but meaningful transparency functions. The IMF contributes transparency through its Article IV consultations and multilateral surveillance frameworks, which provide harmonised macroeconomic reporting across member countries (IMF, 2021). However, these do not extend to physical commodity stocks or supply chain disclosure. The WBG promotes transparency through environmental and social safeguard frameworks, fiduciary standards, audits and grievance mechanisms, but these apply to project-level investment rather than coordinated stockpiling operations (World Bank, 2023). The OECD contributes the most developed supply chain transparency tools through its Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, providing a five-step risk-based framework for identifying, managing and disclosing ESG risks across mineral value chains (OECD, 2016). The IGF complements this through its Mining Policy Framework and peer review mechanisms on mining governance (IGF, 2023).

IRENA, UNCTAD and BRICS contribute partial transparency tools, including sustainability disclosures, trade monitoring and ESG reporting standards, but do not integrate these into a single harmonised framework capable of supporting accountable stockpiling decisions under market stress. FORGE, as a newly launched initiative, has yet to define its transparency and accountability architecture.

## Summary

This assessment reveals a consistent pattern across all five criteria: no single institution combines the mandate, enforcement capacity, technical expertise and governance architecture required to anchor an international critical mineral stockpiling mechanism (see Table 2.3 for a summary). The IEA comes closest, performing strongly across mandate, expertise, financing and transparency, the four criteria most directly linked to operational credibility. Its central limitation is membership. As an OECD-centric body, it lacks the producer-country participation that legitimacy in mineral markets requires.














































The IMF, WBG and UNCTAD, while lacking operational stockpiling capacity, contribute complementary functions, such as macroeconomic surveillance, development finance and commodity market analysis, respectively. These are all relevant to the broader architecture of supply security.

BRICS, while geopolitically significant, is structurally oriented around the interests of major commodity-exporting economies and operates without a specific critical minerals mandate or the governance architecture required for rules-based supply security coordination.

IRENA, the IGF and the OECD contribute important but partial functions – respectively, demand-side analysis, mining governance standards and supply chain due diligence – that are relevant to the enabling conditions for stockpiling but insufficient as operational anchors.

Finally, FORGE represents the most significant recent development in critical minerals governance, combining a specific supply chain security mandate, a growing membership base and an integrated financing approach through Project Vault. However, its transparency architecture, enforcement mechanisms and operational structures remain to be defined, making it a framework of considerable ambition but uncertain operational shape.

**Table 2.3 Overview of institutional assessment to coordinate international critical minerals stockpiling**

Institution	Mandate and policy levers	Energy and mineral expertise	Membership and governance	Budget and financing	Transparency and accountability
IEA					
WBG					
IMF					
OECD					
UNCTAD					
IGF					
IRENA					
FORGE					
BRICS					

Source: Authors' illustration.

Note:  strong  partial  weak

This points to a hybrid model in which the IEA anchors the operational and governance backbone, while complementary institutions address its membership gap. WBG is best placed to mobilise development finance and private sector engagement on the producer side; the IMF to provide macroeconomic surveillance and policy support around supply shocks; and UNCTAD to supply the trade, commodity market and development perspectives needed to sustain producer-country participation and legitimacy. Together, this division of labour addresses the dual mandate of the proposed mechanism: short-term resilience to supply disruptions, anchored in the IEA's proven emergency response architecture, and longer-term supply diversification, supported by the development finance and inclusive governance of its complementary partners.

### 3. Stockpiling mechanics

Any international critical minerals stockpiling mechanism housed by the IEA would need to be engineered to reflect the unique breadth of the commodities within its scope and their idiosyncrasies, as well as the competing perspectives of importers and exporters and the complex geopolitical situation. The operational components and design choices are critical. Decisions about the scope for minerals – which ones should be included – the principles of procurement and release, and membership and governance structures must be informed, inclusive and practical.

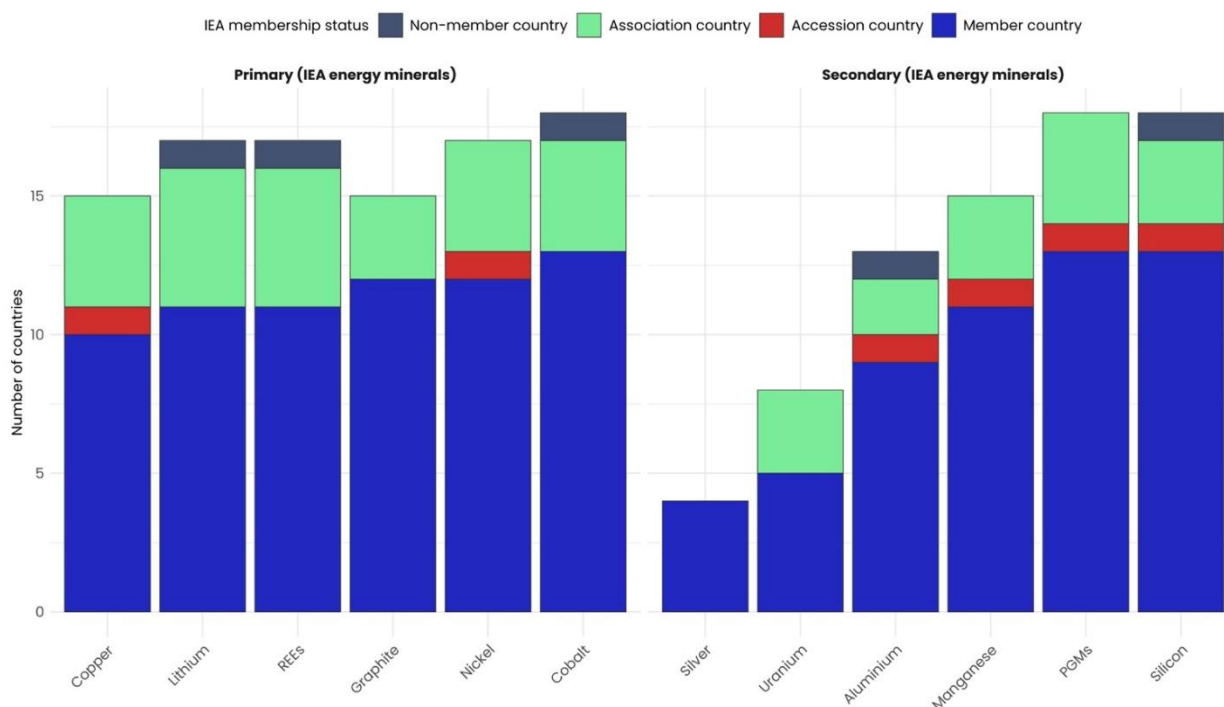
#### Mineral scope and monitoring

##### Mineral scope: inclusion criteria and participation agreements

An international critical minerals stockpiling mechanism differs from earlier commodity arrangements in the breadth of the commodities potentially within scope. A universal mandatory list would risk being too narrow to capture commodity-specific risks or too broad to sustain political agreement across members. Clear inclusion criteria are therefore required to define eligible minerals and participation obligations. Given the high refining concentration (see Figure 1.1), stockpiling would occur at the post-refining stage. National criticality assessments and the IEA’s analysis of energy-related minerals provide the primary basis for defining scope.

Minerals consistently identified as critical across member assessments and relevant for the energy transition should be prioritised for inclusion (see Figure 2.1). Minerals with more targeted use cases or more heterogeneous criticality could be addressed through bilateral or multilateral arrangements among subsets of interested members. This implies a two-tier operational model: (i) mandatory member-wide coordination for priority minerals and (ii) optional plurilateral arrangements for non-priority minerals.

**Figure 3.1. Energy-related minerals within countries’ criticality assessments by IEA membership**



*Source: IEA, 2026d; authors' analysis. Note: REEs are rare earth elements; PGMs are platinum group metals. The chart depicts countries' inclusion of different minerals within their respective lists of critical minerals, disaggregated by IEA membership status. The primary and secondary energy minerals refer to the IEA's focus on a set of primary and secondary minerals within their annual Critical Mineral Outlooks, based on their importance for the energy transition (IEA, 2025).*

Based on overlap across IEA energy-related minerals and national criticality lists, priority minerals would include aluminium, cobalt, copper, graphite, lithium, manganese, nickel, platinum group metals (PGMs), rare earth elements (REEs) and silicon. Uranium would be excluded as it is already covered under the IAEA's Low-Enriched Uranium Bank (IAEA, 2017). Silver would also be excluded given its relatively low criticality across IEA and associated countries. All members would be obliged to participate in stockpiling efforts for these priority minerals.

Three established international precedents inform the design of participation thresholds: minimum national stockholding requirements analogous to the IEA's 90-day oil obligation; collective targets with burden-sharing, as under the EU Gas Storage Regulation; and earmarking of national stocks for regional use, as in the South Asian Association for Regional Cooperation (SAARC) Food Bank and the Economic Community of West African States (ECOWAS) Regional Food Security Reserve (IEA, 2008; European Parliament, 2024; SAARC, 2016; ECOWAS, 2021).

A hybrid approach is recommended, combining a minimum commodity-specific stockholding threshold, expressed as a required number of days of net imports, with a commitment to allocate a share of national stocks to an international reserve. The minimum threshold reduces free-riding risks and ensures that countries with larger import dependencies carry a proportionate share of the stockpiling burden, while the partial allocation to an international reserve preserves national autonomy over remaining stocks. Member states would benefit from coordinated releases and collective crisis responses while retaining domestic reserves for their own strategic and industrial needs.

Non-priority minerals, characterised by lower or more heterogeneous criticality, could be incorporated through flexible bilateral or plurilateral arrangements among subsets of members, and potentially non-members. Candidate non-priority minerals include, but are not limited to, antimony, chromium, germanium, gallium, magnesium, niobium, silver, tantalum, titanium, tungsten and vanadium. These minerals tend to have more targeted applications whose criticality is closely tied to country context and expected energy supply mix.

Such arrangements would operate under the umbrella of the broader framework, with participation thresholds negotiated on a case-by-case basis to reflect market structure and economic relevance. This more flexible framework for non-priority minerals would enable countries to tailor their stockpiling approaches to reflect their national strategic priorities. The IEA could play a limited coordinating role in facilitating these arrangements, conceptually similar to, though more restrained than, UNCTAD's role under historical Integrated Commodity Agreements, helping to establish participation rules and identify potential supply sources for non-priority mineral stockpiles (UNCTAD, n.d.).

Critical minerals present a more complex stockpiling challenge than oil or food reserves, given the breadth of commodities, the heterogeneity of market structures and the multiple stages at which import dependencies can arise. Moreover, the shelf life and cost of warehouse storage differs substantially based on the specific compound; for example, lithium hydroxide is more difficult and more costly to store than lithium carbonate (IEA, 2026c).

As shown in the appendix (Figure A.3), however, while import dependencies across members are concentrated predominantly at the refined and compound stages, several members hold net export positions at upstream stages. These complementarities suggest that coordinated stockpiling need not replicate each member's full import exposure. Where possible, net exporters at particular value chain stages could partially offset the stockpiling burden of net importers at those same stages, reducing the collective acquisition cost of the mechanism and creating natural supply relationships within the membership. This would strengthen rather than strain collective action. Even with this complementarity, however, constraints remain; for example, each mineral comes in different forms, and there is the risk of obsolescence in stockpiled materials, especially given rapid innovation in clean energy technologies.

## Structural shifts in global supply–demand dynamics

The economic importance and supply risk of critical minerals are evolving over time as global economic structures, technologies and market conditions change. Accordingly, the case for stockpiling individual minerals changes with shifts in supply and demand dynamics, affecting both disruption risk and economic relevance. Supply risks may diminish as new producers enter the market and supplier concentration declines, while demand pressures may ease through technological substitution, structural economic change and efficiency gains. The structural decline in tin's economic importance, which contributed to the eventual collapse of the International Tin Agreement, illustrates this dynamic (Chandrasekhar, 1989). To limit fiscal costs and reduce the risk of stockpile obsolescence while maintaining effective risk mitigation, the mechanism would require two additional monitoring functions:

- **Periodic reassessment of mineral inclusion.** As technologies evolve, substitutes emerge, market concentration shifts, recycling expands and import dependencies varies, the relevance of individual minerals will change. Regular reviews will ensure that the stockpiling regime remains aligned with current economic importance and supply risk, preventing obsolete commodities from remaining within scope.
- **Commodity-specific minimum stockholding thresholds.** Critical minerals exhibit heterogeneous risk profiles reflecting differences in market structure and end use. Copper, a broad-based input with sustained demand growth, differs radically from graphite, with its more targeted applications and highly concentrated supply chain. And so on. Hence, stockholding thresholds should be commodity-specific and updated periodically to remain proportionate to risk. For example, Japan's standard target for critical mineral stockpiling is 60 days of domestic consumption but can be set higher for high-risk minerals (METI, 2020).

## Procurement and release mechanisms

There are trade-offs between financial feasibility, efficiency and control in the methods used to procure critical mineral stockpiles. The degree of centrality for an international critical mineral stockpiling mechanism ought to reflect these, as well as the desire for flexibility and certainty of cooperation among interested countries.

### Procurement mechanism

Centralised coordination of procurement would allow members to negotiate collectively, lowering costs through demand aggregation and potentially conferring monopsony-style negotiating power that could reduce acquisition costs for all of them. It would also mitigate the risk of uncoordinated national stockpiling, which could distort supply–demand dynamics and generate market stress through sudden demand surges.

Two models illustrate the range of design options. Under a fully centralised approach, analogous to the ECOWAS Regional Food Security Reserve, a designated agency acts as buyer on behalf of all members, issuing international bids that are financed collectively (ECOWAS, 2012). This offers standardisation and equitable cost sharing but requires countries to relinquish control over procurement decisions and commit finance beyond their own immediate needs. A more flexible model, exemplified by AggregateEU under the EU Gas Storage Regulation, provides a platform to pool demand and match it with competitive supply offers, while leaving procurement decisions and financing at the member level (EC, n.d.). Countries retain control over how and where they hold their reserves, either nationally, through private companies, or through a hybrid arrangement.

For critical minerals, the flexible, market-facilitating model is the more appropriate design. It provides a market-making function that facilitates procurement without forcing countries to relinquish control over stock acquisition or commit finance beyond their own immediate needs. In decentralised arrangements, transparent shared guidelines will be required to prevent competitive bidding and price escalation.

Irrespective of the procurement model, stockpiling should align with international standards on sustainability and responsible sourcing. Existing frameworks, including the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas and related initiatives under the IGF, should be integrated into procurement processes to ensure that stockpiling supports equitable and sustainable supply chains (see Section 4 for further details).

## Storage and burden-sharing agreements

Critical minerals stockpiles may be held through either centralised or decentralised arrangements. Centralised storage can enhance release effectiveness by aggregating volumes and enabling coordinated deployment, but reduces national control, requires collective financing mechanisms that have historically proven difficult to sustain, and can create tensions between members where objectives and risk profiles differ. The histories of the International Tin Council and the International Cocoa Agreement illustrate the risks of underfunding and weakened credibility in centrally managed systems (Chandrasekhar, 1989). Decentralised storage allows countries to tailor arrangements to national risk profiles and institutional capacity (Miller and Martinez, 2025), whether through government-owned reserves, mandated private stockholding or hybrid models such as the Japan Organization for Metals and Energy Security (JOGMEC) (JOGMEC, 2005). While this flexibility enhances national autonomy, it may impose higher costs on countries with limited storage capacity or for minerals requiring specialised handling.

Several mechanisms can ease these constraints. One is cross-border storage arrangements, which can reduce the fiscal and operational burden of decentralised stockpiling. Notable examples of these are the EU Gas Storage Regulation, which allows storage-constrained Member States to contract capacity equivalent to 15% of annual consumption in other Member States (Oxford Energy Institute, 2025), and Australia's proposed offtake arrangements on behalf of partner countries (Albanese Government, 2025).

Market-based commitment mechanisms offer a complementary approach. The IEA's ticketing system allows members to purchase the right to draw on stocks held by others, at a cost limited to a reservation fee plus market value if exercised. However, availability may decline in tight market conditions, particularly during a global shock, potentially undermining the security of supply precisely when reserves are most needed (Department of Energy of Australia, 2018).

Similarly, the US Project Vault reserve extends this logic to the private sector, with manufacturers paying upfront for guaranteed access to specified materials at specified processing stages (EXIM, 2026). Its commercial structure, underpinned by binding arrangements with commodity trading firms rather than intergovernmental obligations, makes it more resilient to the political collective action problem that affects intergovernmental ticketing arrangements. However, it remains subject to commercial counterparty risk if trading firms cannot source or deliver agreed volumes under severe market stress. This demand-led structure distributes fiscal exposure across public and private balance sheets and ensures that stockpiles reflect actual industrial requirements rather than government assumptions about end use.

To maximise flexibility and limit fiscal exposure, storage decisions should remain primarily at the national level, with the international framework setting minimum commodity-specific thresholds while allowing members to meet obligations through direct ownership, cross-border contracts, offtake agreements or ticketing arrangements. Hybrid public-private models deserve particular consideration, both for their fiscal advantages and because they are better suited to serving multinational enterprises whose operations span multiple jurisdictions. The corollary is that nationally held stockpiles are of limited use if stocks are held in a different country from where they are operationally needed.

## Release conditions

A central design feature of an international critical mineral stockpiling agreement is the definition of clear and credible conditions for the international release of stocks. To avoid uncoordinated releases, which may generate unintended market effects, release decisions should be governed by an agreed, principles-based mechanism. A supranational trigger at the IEA member level would provide a transparent and timely basis for coordinated action. By contrast, bilateral negotiation mechanisms,

such as those under the SAARC Food Bank, have proven lengthy and subject to politicisation, reducing the speed and effectiveness of emergency releases (Rahman et al., 2018; SAARC, 2016). However, bilateral release arrangements could be appropriate for non-priority minerals, where only a subset of members engage in coordinated stockpiling efforts.

Clearly defined release triggers are essential to support compliance with, and enforcement of, coordinated stock releases. The IEA emergency response system and related agreements provide the most developed precedents for specifying objective release conditions. Comparable triggers could be adapted for critical mineral stockpiles. Indicative release conditions may include:

- **Severe supply disruptions**, defined as a shortfall exceeding 7% of global or market-relevant supply.
- **Major geopolitical events**, including armed conflict, trade restrictions or other exogenous shocks materially affecting supply.
- **Acute price dislocations**, defined as single-session price movements significantly exceeding exchange-level circuit breaker thresholds,<sup>3</sup> calibrated on a per-commodity basis.

The third condition recognises that extreme price dislocations can threaten the orderly functioning of metal exchanges themselves, as illustrated by the 2022 London Metal Exchange (LME) nickel crisis in which prices more than doubled within hours before trading was suspended entirely (Oliver Wyman, 2023). Coordinated stockpile releases in such circumstances could provide a stabilising supply injection to restore market confidence and avoid disruption to market functioning.

Pre-agreeing such conditions would reduce reliance on discretionary or case-by-case decision-making and limit the need for formal majority approval under clearly defined market circumstances. This would support faster and more predictable responses to market stress, particularly in the event of abrupt and unanticipated price spikes. More complex situations, including prolonged geopolitical disruptions or coordinated supply restrictions, would continue to require collective deliberation and approval. Members would retain the right to deploy national stocks unilaterally in line with domestic objectives, provided that such actions were not inconsistent with the overarching principles of the international stockpiling framework.

### Early warning system and market monitoring framework

Continuous market monitoring is essential to assess evolving supply risks, provide early warning of potential disruptions and identify when release conditions have been met. The IEA already performs this function for energy commodities through its oil emergency response mechanism, including reserve adequacy assessments, bi-annual scenario exercises and post-release evaluations (IEA, 2008). A comparable, though expanded, monitoring function would be required for critical minerals.

Given the opacity and complexity of critical mineral markets, this function should combine systematic horizon scanning with integrated bottom-up and top-down analysis. An early warning system, analogous to the Cadre Harmonisé under the ECOWAS framework, could provide a structured and harmonised approach to identifying supply-side stress that may warrant coordinated stock releases (CILSS, 2020). The Cadre Harmonisé's effectiveness derives from its combination of quantitative market data with qualitative country-level intelligence, triangulated across multiple indicators to distinguish temporary stress from structural deterioration.

While it operates in the context of sovereign food security, where physical stocks are relatively transparent and largely publicly held, critical minerals inventories are predominantly private and commercially sensitive. Nonetheless, the underlying analytical logic applies directly to critical minerals markets: quantitative signals and qualitative country intelligence must be combined to identify supply stress before it becomes visible in market prices. In critical minerals markets, the opacity of bilateral

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<sup>3</sup> The CME Group and LME have applied 10–15% dynamic circuit breakers to metal markets, respectively (LME, 2022; CME Group, 2023). The exact threshold for intervention may be calibrated by the IEA based on historical volatility for each commodity.

trade flows, the prevalence of long-term offtake contracts and the absence of centralised price discovery for non-exchange-traded minerals make such triangulation especially important.

Bottom-up monitoring would be conducted at the national level, drawing on existing critical mineral institutions with detailed knowledge of domestic production, consumption and market conditions. Institutions such as Canada's Critical Minerals Centre of Excellence (CMCE), Japan's JOGMEC, the UK's Critical Minerals Intelligence Centre (CMIC) and the US's National Minerals Information Center (NMIC) already perform related analytical functions and could serve as focal points for country-level monitoring. Similarly, private companies and commodity exchanges would contribute to the national monitoring framework, providing real-time data on prices, spot market liquidity and procurement conditions that public institutions alone could not supply. Formalised data sharing arrangements with major exchanges – such as the London Metal Exchange – and with vertically integrated producers and trading firms would be essential to capture commercially sensitive market intelligence on inventory levels and offtake agreements.

Formalised information sharing arrangements with the IEA would enable these bodies to disseminate timely insights into national and regional trends, technological developments and substitution patterns throughout the international framework (see Figure 2.2). Such arrangements would have to address three practical requirements: standardised reporting formats to ensure comparability across national submissions; agreed confidentiality protocols to protect commercially sensitive data on procurement arrangements and inventory levels; and defined reporting frequencies, with baseline submissions on a quarterly basis and expedited reporting obligations during periods of market stress. Participation would be incentivised through reciprocal access to the IEA's consolidated global supply risk assessments, providing national institutions with analytical intelligence they could not generate independently. Sharing of commercial data is likely to be among the most sensitive issues, but aggregating this at the national level prior to submission to the IEA might help to overcome concerns. Additionally, all three practical requirements are already addressed under the IEA's existing oil emergency response framework, requiring only an extension of those arrangements to critical minerals (Wilson, 2016; IEA, 2008).

National-level monitoring would focus on five core elements:

1. **Technological change and substitution**, capturing both short-term input substitution and longer-term technological shifts between commodities, drawing on patent data, R&D spending trends and published technological roadmaps
2. **Country-level consumption**, including monthly use of critical minerals, distinguishing final and intermediate demand, domestic versus imported supply and sectoral end-use, compiled from trade statistics, customs data and industry surveys
3. **Available inventories**, covering public and private stocks, distinguishing accessible from committed inventories and tracking both levels and turnover rates, drawing on government stock reports and exchange warehouse data
4. **Market access conditions**, including prices, procurement channels and purchasing power, with attention paid to the share of supply under long-term offtake agreements, spot market liquidity and vertically integrated or take-or-pay arrangements, informed by exchange prices and offtake contract data
5. **Forward-looking demand projections**, aligned with announced policies and investment plans and disaggregated by sector, drawing on national energy plans, sector decarbonisation pathways and industry investment pipelines

These bottom-up analyses would be complemented by IEA-led global monitoring, focusing on three areas of global mineral commodity markets:

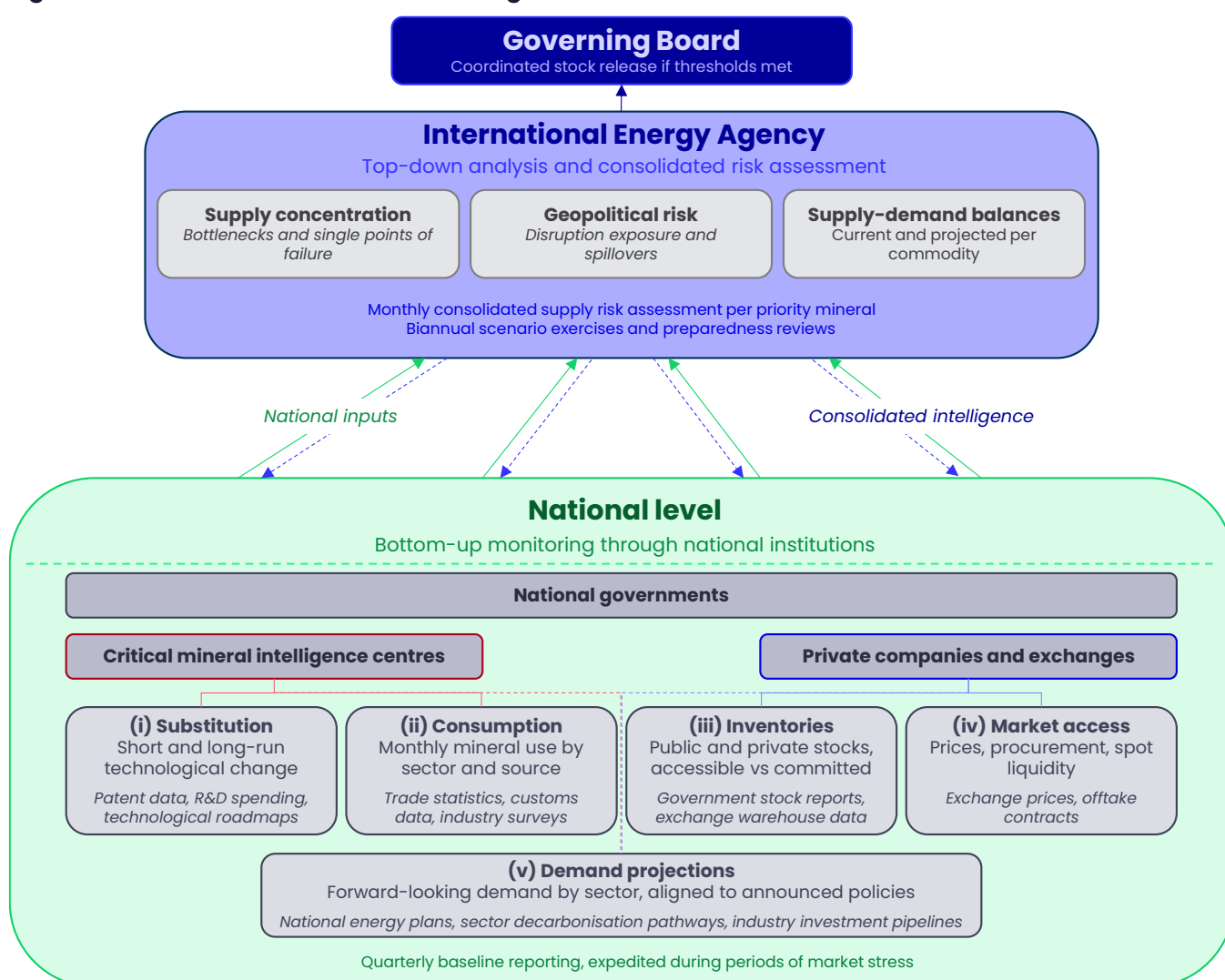
1. **Supply-side concentration and bottlenecks** across extraction, refining and manufacturing, including capacity utilisation, ramp-up times and single-point-of-failure risks
2. **Exposure to geopolitical and production shocks** with potential global spillovers
3. **Current and projected global supply-demand balances** for each critical mineral

The IMF and UNCTAD would support this top-down analysis in their respective areas of expertise, namely financial market surveillance and trade monitoring (see Section 4 for further details).

Together, this integrated bottom-up and top-down framework would provide a robust analytical basis for early warning, feeding directly into the stock calibration and release condition mechanisms discussed above, and strengthening both the credibility of release decisions and the responsiveness of the international stockpiling mechanism (see Figure 2.2). Drawing on the IEA’s existing oil emergency response framework, baseline supply risk assessments for each priority mineral would be produced on a quarterly basis, with bi-annual scenario exercises to test release procedures and assess member preparedness (IEA, 2008). Country-level assessments should include demand-side reduction measures to reduce import dependencies and security of supply risks (see Section 5).

During periods of heightened market stress (for example, when early warning indicators approach predefined thresholds), the assessment frequency would increase to provide the Governing Board with a continuously updated basis for release decisions.

**Figure 3.2. Overview of market monitoring framework**



Source: Authors’ illustration.

## Release mechanism

An effective release mechanism within a coordinated stockpiling regime must account for market structure, deployment modalities, stock accessibility and operational credibility. Given the multi-commodity nature of a critical minerals agreement, release mechanisms should be tailored to the

characteristics of individual markets. In all cases, released volumes must be sufficiently large to influence market conditions and provide credible insurance against supply disruptions.

For exchange-traded minerals with liquid markets, such as aluminium, copper and nickel, releases should be conducted through open market operations or competitive auctions. Under both approaches, the coordinating institution would determine timing, volumes and signalling, while national authorities would execute releases via exchanges, bilateral transactions or time-limited auctions. Competitive auctions, based on sealed bids, allow greater control over allocation while preserving price discovery, whereas open market operations enable rapid deployment and efficient market pricing (Meidan, 2021). The choice between these mechanisms should reflect the ownership structure of the stockpile; open market operations are more appropriate for privately held stocks, where speed of deployment is paramount, while competitive auctions are better suited to public stockpiles, where controlled allocation and transparency of distribution are primary objectives.

For non-exchange-traded minerals, where markets are thin and opaque, more managed release mechanisms are required. These include targeted auctions restricted to pre-certified participants, with volume caps structured either as a maximum quantity per participant or as a fixed share of total auction volume, or conditional direct sales at reference prices to buyers identified in advance of any disruption event (IEA, 2008). Direct sales may impose conditions on end use, resale and reporting, enabling closer alignment with energy security objectives and limiting speculative behaviour, as observed in regional food reserve mechanisms (World Bank, 2025). Targeted auctions preserve some price discovery while ensuring broader physical distribution, with allocation determined through eligibility criteria rather than price alone. Direct sales offer greater control over allocation and end use, imposing direct price constraints that reduce the risk of speculative trading and heightened volatility. The calibration of eligibility for targeted auctions could be based on the disclosed information from private companies as part of countries' bottom-up analyses.

For idiosyncratic or firm-specific disruptions, stock leasing arrangements may provide a complementary tool. This mechanism is particularly relevant for firms at a single point of supply failure, where the objective is operational continuity rather than broader market stabilisation. Under such arrangements, affected firms could temporarily borrow stocks from public or private reserves to address short-term supply gaps, paying a leasing fee and returning the material, or its cash equivalent, at maturity. This prioritises operational continuity over price intervention, analogous to the draw-and-return provisions of the US Strategic Petroleum Reserves (US Department of Energy, n.d.).

Ensuring operational readiness requires that release channels are functional and regularly tested. The IEA's emergency oil response programme provides a useful blueprint, including stress testing through simulated disruption scenarios, peer reviews of national preparedness and assessments of intergovernmental coordination (IEA, 2008). A critical minerals regime could go further by adopting a 'live' stockpile approach, whereby stocks are periodically deployed and replenished under normal market conditions, akin to the Ethiopia Emergency Food Reserve (Weber, 2024; Mulugeta, 2015). This continuous market engagement would serve three functions: (i) it would test release mechanisms under realistic conditions; (ii) it would reduce operational risk by ensuring that logistics, counterparty arrangements and reporting systems remain active; and (iii) it would lower the risk of stock obsolescence by embedding regular turnover into the management of reserves, rather than relying on periodic emergency drawdowns of potentially degraded or technologically superseded material.

## **Membership and governance structure**

### **Membership and governance**

An internationally coordinated critical mineral stockpiling mechanism, designed primarily for emergency response, should be anchored in a single-tier governance structure among countries with broadly aligned interests in mitigating supply disruptions. Historical experience shows that security-oriented stockpiling regimes are most effective when participation and decision-making are concentrated among members with shared operational incentives. By contrast, commodity agreements with an explicit price stabilisation mandate and combined producer-consumer governance have proven structurally fragile. Two historical cases illustrate this. The International Tin Agreement's dual-tier structure, combining consumer and producer members with divergent price

interests, contributed to its collapse when buffer stock financing was exhausted (Chandrasekhar, 1989). Similarly, during the 2007–2008 food price shock, major producing members of the Association of Southeast Asian Nations (ASEAN) Plus Three Emergency Rice Reserve (APTERR) imposed export restrictions to protect domestic supply, effectively neutralising the stabilising role of a reserve that was already limited to less than two days of regional consumption (Trethewie, 2013). Both cases demonstrate how producer incentives can directly undermine collective emergency response when governance structures do not separate these functions.

This design choice is particularly relevant for critical minerals. Unlike oil markets, critical mineral supply chains are heterogeneous, with no cartel-like producer bloc and substantial variation in geographical concentration across commodities. However, this does not mean that critical mineral markets lack a dominant actor with structural leverage over supply.

China simultaneously occupies the position of leading miner, refiner and manufacturer across many critical mineral value chains, a degree of vertical integration with no direct parallel in oil markets, where the Organization of the Petroleum Exporting Countries' (OPEC's) influence is confined to the extraction stage. (See Figure A.3 for an analysis of China's dominant role across critical mineral value chains.) Critically, China exercises this leverage primarily through trade and export policy rather than production quotas. The export controls imposed on the rare earth elements, gallium, germanium and graphite, between 2023 and 2025 demonstrate that supply disruption in critical mineral markets can be near-total and near-instantaneous, without any reduction in domestic output (IEA, 2025b; IISS, 2025). The security of supply implications are, therefore, more acute than in oil markets, and the IEA's emergency response architecture, designed around physical supply shortfalls and coordinated stockholding, is less well suited to disruptions delivered through trade weaponisation rather than production cuts.

This means there is a fundamental design choice to be made concerning the mechanism's membership architecture. Full Chinese participation in the binding emergency response core would require China to accept transparent reporting of stock levels, pre-agreed release obligations and shared calibration methodologies; in effect, constraining the primary instrument of its mineral market power. There is no strategic incentive for China to accept these constraints voluntarily. The mechanism should therefore be designed as a managed exclusion framework: a binding coalition of import-dependent economies and like-minded producer countries, with China invited to participate in the data sharing and market monitoring functions of the IEA's open-door architecture, but outside the core release and calibration obligations. This approach follows the logic of the IEA's own design as a consumer-country counterweight to OPEC. Its effectiveness depends on the clarity of that boundary, not on attempts to include the dominant supplier in the emergency response core. While China's exclusion from the mechanism is a challenge for its effectiveness, managed exclusion with the open-door policy of the IEA offers the most pragmatic solution.

The absence of a cartel-like producer structure nonetheless provides greater institutional flexibility than in oil markets, meaning a critical mineral agreement need not replicate the import-centric design of the IEA's emergency oil stockholding regime but can instead combine a clearly defined emergency response core with structured engagement of key producing economies. An effective regime would require adaptation through an IEA membership+ framework built around two core elements.

First, membership would be expanded to include systemically important import-dependent economies not currently members of the IEA, most notably India, reflecting its rapidly growing demand for refined critical minerals. Given the blurred distinction between producers and import-dependent countries in mineral markets, a flexible participation architecture is essential. While core emergency response functions would be anchored within the membership+ group, the IEA's open-door policy would allow non-members to participate in specific components of the framework, including data sharing, market monitoring, and – under an expanded framework – agreed release protocols (IEA, 2024a).

Second, the framework would incorporate an operationally separate, structured participation forum for major producing economies, focusing on the secondary objective of long-term supply diversification through investment, particularly in refining and processing capacity (see Section 4 for further details). Consistent with the golden rule of supply security (Birol, 2026), engagement should focus on achieving

N-1 resilience of critical mineral supplies across extraction and refining. This resilience objective aligns with existing diversification benchmarks among IEA members, including the EU's Critical Raw Materials Act and the UK's Critical Minerals Strategy, which set supply concentration thresholds of 65% and 60%, respectively, for reliance on any single source country (European Parliament, 2024; Department for Business and Trade, 2026). This group would include, among others, Argentina, Bolivia, Brazil, Chile, the Democratic Republic of Congo, Indonesia, Peru, South Africa and Zambia. Several of these countries are already IEA association countries or in the accession process, a factor that meaningfully reduces the institutional barriers to their structured engagement within an expanded framework (IEA, 2024b).

To support this objective, the investment and market-related functions of FORGE should be integrated into a reformed IGF with an expanded mandate covering investment, as a complementary dialogue forum institutionally distinct from the emergency stockpiling regime. This forum would serve as the primary platform for medium- to long-term supply security through supply chain diversification, investment in refining and processing capacity and offtake agreements or contracts for difference arrangements designed to stabilise prices. Equal producer country representation would ensure that investment in supply chains supports sustainable development and aligns with emerging international environmental and social standards related to mining activities.

## 4. Enabling conditions

Key enabling conditions for coordinated stockholding and release must be in place for an international critical mineral stockpiling regime to function effectively. These conditions are not a substitute for the operational design of stockpiling but determine whether it can operate credibly in practice and contribute to longer-term supply resilience rather than reinforcing existing vulnerabilities.

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### Enabling conditions for an effective critical mineral stockpiling regime

#### Investment in refining and processing capacity outside current concentration hubs

Diversifying critical mineral supply chains requires sustained, long-term investment across the value chain, particularly in processing, refining and associated infrastructure. These segments are characterised by high upfront capital costs, long payback periods, technological risk and significant exposure to regulatory and political uncertainty, especially in resource-rich developing economies. As a result, purely market-driven investment tends to focus on established jurisdictions and lower-risk regions, reinforcing existing patterns of geographical and technological concentration rather than supporting diversification (OECD, 2023).

In this context, finance constitutes an enabling condition insofar as it addresses three interrelated constraints:

1. **Scale and horizon:** diversification requires patient capital capable of financing long-lived assets whose returns materialise over extended periods.
2. **Risk-sharing and coordination:** cross-border investments in higher-risk jurisdictions require instruments that mitigate political, regulatory and market risks and reduce reliance on fragmented national strategies.
3. **Institutional intermediation:** effective diversification depends on platforms that can blend public and private finance, apply common standards, support project preparation and coordinate investment pipelines across jurisdictions and actors (OECD, 2023).

Multilateral development banks (MDBs) are well-positioned to address these constraints and play a critical enabling role by shaping the upstream and midstream investment environment within which stockpiling becomes feasible and credible. Through long-term lending, guarantees, selective equity participation and technical assistance, they can support the development of processing and refining capacity, strengthen regulatory and institutional frameworks, and crowd in private capital where commercial incentives alone are insufficient (World Bank, 2023).

Recent MDB strategies increasingly reflect this enabling role by linking critical minerals to downstream value chain development, industrial upgrading and regional integration, rather than treating extraction as an isolated activity. These approaches typically combine analytical work, policy dialogue and investment facilitation to improve investment climates and reduce coordination failures. Within the WBG, for example, initiatives that integrate analytics, technical assistance and finance facilitation aim to help countries establish enabling conditions for diversified and resilient supply chains, while the International Finance Corporation (IFC), its private sector arm, supports investment through direct financing and by anchoring vehicles that mobilise additional private capital (World Bank, 2023). Similarly, the African Development Bank Group is conducting extensive analytical work to identify potential investment projects, country readiness, and develop recommendations around strengthening governance (AfDB, 2025).

Moreover, a reformed IGF, with an expanded mandate covering investment coordination and long-term supply chain diversification, should serve as the primary forum for aligning MDB instruments, bilateral finance and private investment around shared priorities, standards and risk-management approaches. The OECD DAC Blended Finance Guidance could be used as standards to scale up and deploy blended finance effectively (OECD, 2025b). This would strengthen finance as an enabling condition for a credible international stockpiling regime. The IEA and OECD would facilitate coordination between the reformed IGF and the core emergency response mechanism, ensuring coherence across the dual mandate.

When deciding which regions and supply chains to prioritise for investment, three factors should guide decision-making.

First, there is the question of which stage of the value chain requires increased capacity. Figure A.3 illustrates where dependencies are most acute for IEA member countries. For instance, there are significant import dependencies for graphite at the ore, compound and refined stages, but not at the semi-manufactured stage. This indicates that investment in diversification is needed across the value chain rather than being concentrated at a single stage.

Second, there is the question of which minerals experience the most extreme concentration at the refining stage. As Figure 1.2 shows, cobalt, graphite and rare earth elements face the most severe refining concentration, making them the highest-priority candidates for investment in diversified processing capacity.

Third, there is the question of the relative time horizons for different investment types. Establishing new refining capacity typically requires 18–36 months, compared averages of 16.7, 17 and 18.6 years for new lithium, copper and nickel mines, respectively (Manalo, 2025). Investment in refining can reduce supply chain concentration in the medium term, unlike mine development alone. However, diversifying refining faces structural obstacles. State-supported facilities operate at costs that unsubsidised competitors cannot match, and access to processing technology and skilled labour remains constrained outside existing hubs (IEA, 2023; IEA, 2026b). Addressing these barriers requires not only upfront capital support but also instruments that underwrite operational viability, including guaranteed offtake.

This is where the stockpiling mechanism itself becomes an enabling condition for supply diversification. Coordinated stockpile build-up, structured around offtake agreements with producers in diversification-priority jurisdictions, provides the guaranteed revenue stream that makes new refining investments bankable. Stockpiling and supply diversification are therefore not sequential but mutually reinforcing – the mechanism creates demand that supports the investments that reduce the concentration it is designed to insure against.

## Macroeconomic surveillance and systemic risk management

A second enabling condition relates to macroeconomic surveillance and systemic risk management, particularly for economies that are highly exposed to critical mineral price volatility and trade disruptions. While stockpiling can mitigate short-term physical supply shocks, it does not eliminate the broader macroeconomic spillovers associated with concentrated and volatile critical mineral markets. Effective international coordination, therefore, requires complementary analytical surveillance to monitor inflationary pressures, external balances, fiscal risks and financial stability implications arising from critical mineral shocks.

The IMF is well placed to play this role by integrating critical minerals more systematically into its existing macroeconomic surveillance framework. It already assesses how commodity price movements and supply disruptions affect inflation dynamics, fiscal revenues and expenditures, current account balances, exchange rates and debt sustainability through Article IV consultations and multilateral surveillance. This enabling condition does not require new mandates, but rather a more systematic and explicit integration of critical minerals into existing surveillance and analytical frameworks, strengthening early identification of macroeconomic vulnerabilities and supporting policy advice on buffers, fiscal frameworks and macro-prudential responses (IMF, 2021, 2023).

UNCTAD plays a complementary role through its long-standing expertise in commodity market analysis, trade monitoring and assessment of development impacts. Its analysis of global commodity market trends, value chain concentration and trade policy developments provides essential context for understanding how critical mineral shocks propagate across countries and regions, while its capacity-building role is particularly relevant for producer countries, supporting analysis of trade resilience, industrial upgrading and development strategies in the context of volatile and strategic mineral markets (UNCTAD, 2023). Further, the OECD could perform a complementary role with its tracking of export restrictions and export finance related to critical minerals, through the OECD Inventory of Export Restrictions on Critical Raw Materials (OECD, 2026).

Together, IMF and UNCTAD surveillance help ensure that international critical mineral stockpiling is embedded within a broader framework for managing macroeconomic adjustment and systemic risk. By improving transparency around shock transmission, supporting policy coordination and strengthening analytical capacity in exposed economies, these institutions strengthen the credibility and stability of a coordinated stockpiling regime, particularly during periods of acute market stress.

### Domestic regulatory and institutional capacity in producer countries

A third enabling condition relates to the regulatory and institutional capacity of producer countries to meet the responsible sourcing, fiscal governance and compliance requirements that participation in an international stockpiling regime implies. Without this capacity, the mechanism risks becoming exclusionary, setting standards that only well-resourced jurisdictions can meet, or, alternatively, accumulating stockpiles from sources whose ESG performance cannot be verified credibly. Either outcome would undermine the legitimacy and political durability of the regime.

At the regulatory level, effective oversight of mining and processing operations requires functioning public institutions responsible for environmental permitting, monitoring, labour inspections and social safeguards. Where these institutions are weak or under-resourced, private voluntary standards, however well designed, cannot substitute for binding public regulation. As the IGF notes, strengthening domestic regulatory capacity is a precondition for socially and environmentally responsible mineral development, and international standards risk acting as de facto barriers to participation if they are not accompanied by targeted support to build the institutional infrastructure needed to meet them (IGF, 2021; Fundar, 2024). Market-based initiatives, such as the Taskforce for Nature-related Financial Disclosures (TNFD), may offer additional information to policymakers concerning the adverse environmental impacts associated with mining operations (TNFD, 2026).

Fiscal governance constitutes an equally important dimension of this enabling condition. Transparent and robust mineral pricing and transfer pricing rules shape the distributional social contract around extraction, influencing public acceptance of mining activity and the willingness of producer-country governments to sustain participation in international arrangements. Where revenue leakage is significant and producing countries do not capture a fair share of mineral rents, the political legitimacy of supply diversification and, by extension, that of the stockpiling regime it underpins, is weakened. The IGF and the OECD have begun to address these issues through guidance on mineral pricing, base erosion and profit shifting, including the OECD's recent transfer pricing framework for copper. Expanding this guidance to additional critical minerals would strengthen fiscal transparency, reduce revenue leakage and reinforce the legitimacy of stockpiled supply (OECD, 2025a).

Several institutions are well placed to support producer-country capacity building in both dimensions. The IGF, through its Mining Policy Framework and peer review mechanisms, provides technical assistance on mining governance to member governments. WBG supports regulatory strengthening and institutional development through its Extractives Global Programmatic Support trust fund and broader country engagement, as other regional MDBs do. The OECD contributes normative guidance on due diligence, fiscal governance and responsible supply chains. A critical minerals stockpiling regime anchored in the IEA should actively coordinate with these bodies to ensure that participation requirements are accompanied by commensurate support, rather than creating a two-tier system in which only producers with relatively strong institutions can credibly participate.

## A note on the asymmetric costs of extraction and demand-side responsibility

Any international stockpiling regime must be designed with explicit recognition of the demand-side risks that shape its long-term operational credibility. There is a risk that security of supply strategies focused primarily on expanding extraction, refining and stockholding will direct guaranteed stockpile demand toward established processing hubs rather than alternative jurisdictions, reinforcing existing supply concentration rather than diversifying it. The energy transition does not automatically break this pattern. Demand for critical minerals is driven largely by deployment pathways in advanced consuming economies, such as electrification of transport, defence modernisation and digital infrastructure, while supply expansion faces physical, environmental and social constraints concentrated in a smaller set of producing countries (IEA, 2024a), many of which are simultaneously being asked to phase out fossil fuel revenues and attract new forms of extractive investment (UNCTAD, 2023).

This creates two material risks that any credible stockpiling proposal must confront. First, if the mechanism accelerates extraction pressures without parallel commitments to responsible sourcing, equitable revenue sharing and producer-country development priorities, it risks undermining the political agreement with producing countries on which coordinated stockpiling depends. Producer countries that perceive the mechanism as extracting supply security benefits without commensurate economic returns may withdraw cooperation or impose the export restrictions that stockpiling is designed to mitigate, eroding the mechanism's credibility precisely when it is most needed (OECD, 2023; UNCTAD, 2023).

Second, higher mineral demand intensity directly magnifies supply risk exposure. The larger the volume of critical minerals required to sustain consuming economies, the greater the potential impact of any supply disruption and the more acute the concentration risks documented in Section 1. Demand-side measures, material efficiency improvements, substitution R&D and circular economy investment therefore constitute an additional and underutilised risk mitigation strategy that reduces the scale of the supply shock the mechanism must be designed to absorb (UNEP IRP, 2019). The IEA's emergency oil response framework has long recognised that demand-side measures are an integral complement to stockholding rather than an afterthought (IEA, 2008), and a critical mineral mechanism that omits this dimension will face both greater political fragility and greater exposure to the supply risks it is designed to hedge against.

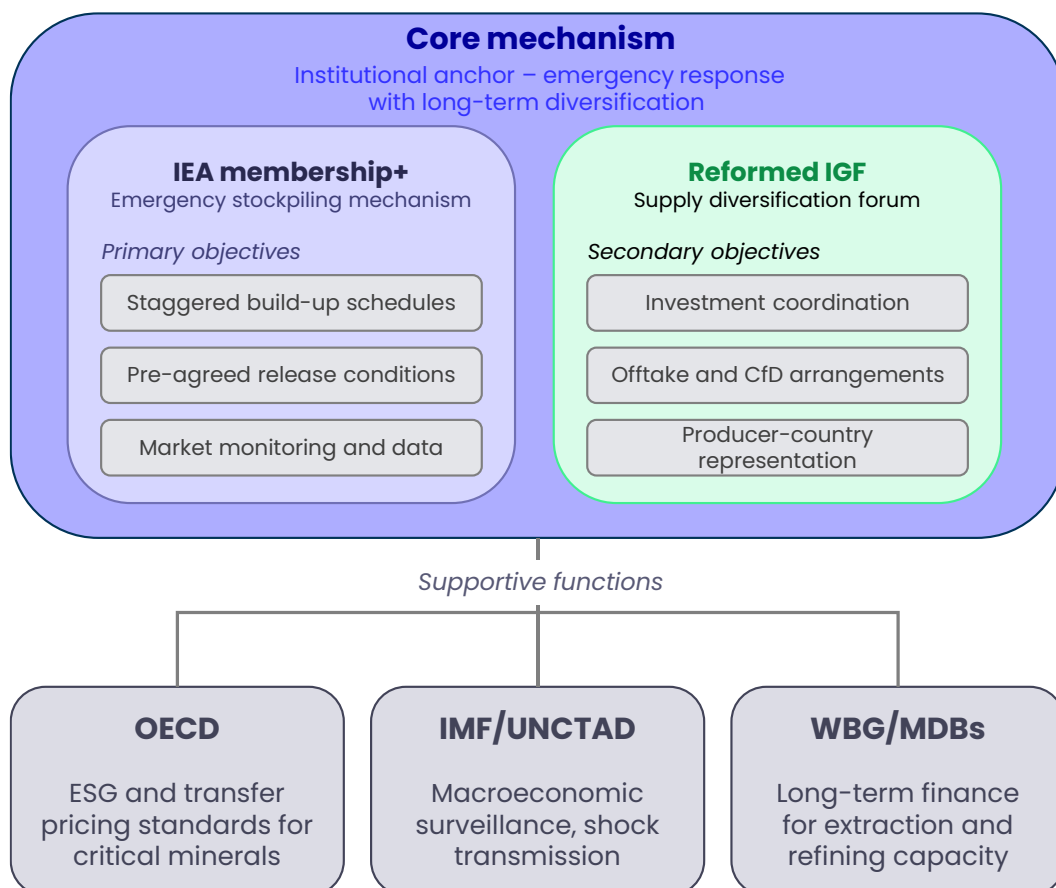
# 5. Conclusion

Unilateral stockpiling is likely to be self-defeating, risking the very problems it seeks to avoid. In this report, we have assessed how a mechanism for coordinating stockpiling might be engineered using existing multinational institutions. We conclude with six core recommendations and two considerations for policymakers.

The energy, digital and rearmament transitions are generating unprecedented concurrent demand for critical minerals, while supply chains remain highly geographically concentrated and increasingly subject to trade weaponisation. We argue that the growing wave of unilateral stockpiling responses may exacerbate the disruptions they seek to prevent. Aggregate stockpile demand from seven economies alone could represent up to 34% of global annual cobalt supply and over 10% of the global lithium, graphite and copper supply, risking a scramble that will amplify precisely the price volatility that stockpiling is designed to hedge against.

Coordination offers three advantages that no national programme can replicate. First, staggered build-up schedules reduce simultaneous demand shocks. Second, pre-agreed release conditions improve market predictability. And third, an integrated framework connects short-term stockpiling to longer-term supply diversification. No single existing institution combines the mandate, enforcement capacity and governance architecture required to anchor such a mechanism, but the IEA comes closest. An effective regime would require an IEA membership+ framework, with a reformed IGF handling long-term supply diversification as an institutionally distinct but complementary forum. Figure 5.1 offers an overview of the institutional set-up to host such a mechanism.

**Figure 5.1 Institutional architecture for an internationally coordinated stockpiling mechanism**



Source: Authors' illustration.

Operationally, we recommend a hybrid design combining public, private and market-based stockpiling, with a 'live stockpile' approach to maintain operational readiness and limit obsolescence. Stockpiling is most effective as insurance against acute supply disruptions and is not a substitute for structural supply resilience.

## Policy recommendations and considerations

Our analysis here points to six core recommendations and two considerations for policymakers. The first four recommendations are for immediate implementation; the final two address longer-term priorities.

The four short-term recommendations are:

**1. Anchor the mechanism within the IEA, with an expanded participation model.** No single institution combines the mandate, enforcement capacity, technical expertise and governance architecture required to host a coordinated critical mineral stockpiling mechanism. The IEA comes closest, with binding authority over emergency stocks, operational experience with petroleum reserves, dedicated critical minerals analytical capacity and a formal direction from its 2026 Ministerial Declaration to expand its critical minerals role. An effective regime would require adaptation through an IEA membership+ framework – expanding full participation to include systemically important import-dependent economies not currently in the IEA, most notably India, while allowing non-members to participate in data sharing, market monitoring and agreed release protocols through the IEA's existing open-door architecture. The IEA should additionally serve as the institutional interface between the emergency stockpiling mechanism and the diversification forum established under Recommendation 5, ensuring operational coherence across the dual mandate without conflating its two objectives.

**2. Separate emergency response from supply diversification objectives by design.** The primary objective should be emergency response – a credible buffer against acute supply disruptions and geopolitical shocks. A secondary, operationally distinct objective is to support long-term supply diversification through investment coordination and offtake arrangements. Keeping these objectives institutionally separate is essential. Historical commodity agreements that blurred emergency response with price management, most notably the International Tin Agreement, which collapsed in 1985 after exhausting its resources defending an unsustainable price floor, demonstrate the dangers of mandate overreach. Release conditions, calibration methodologies and governance arrangements should be designed explicitly around the primary mandate, with diversification objectives pursued through a separate institutional forum rather than being embedded within the emergency response mechanism.

**3. Coordinate stockpile build-up schedules to avoid simultaneous demand shocks.** Our market impact analysis demonstrates that uncoordinated build-up of national stockpiles could represent up to 34% of global annual cobalt supply and over 10% of global lithium, graphite and copper supply under plausible calibration scenarios, amplifying precisely the market volatility that stockpiling is designed to mitigate. An internationally agreed framework should establish staggered build-up schedules, shared calibration methodologies expressing minimum stockholding requirements as commodity-specific days of net imports, and burden-sharing arrangements that ensure countries with larger import dependencies carry a proportionate share of the stockpiling obligation. Coordination of build-up schedules would be supported by the IEA-led market monitoring framework, enabling real-time adjustment of accumulation rates in response to evolving supply and demand conditions.

**4. Establish pre-agreed, transparent release conditions calibrated to individual commodity markets.** The efficient and timely release of buffer stocks is the mechanism's most operationally critical function and the one most vulnerable to political delay. Release conditions should be pre-agreed, transparent and tied to objective triggers rather than discretionary deliberation. Indicative conditions should include severe supply disruptions exceeding 7% of global or market-relevant supply, major geopolitical events materially affecting supply and acute price dislocations significantly exceeding exchange-level circuit breaker thresholds, calibrated on a per-commodity basis. Release mechanisms should be differentiated by market structure: open market operations or competitive auctions for exchange-

traded minerals, and targeted auctions or conditional direct sales for non-exchange-traded minerals with thin and opaque markets.

The two longer-term recommendations are:

**5. Establish a secondary forum for long-term supply diversification, with equal producer-country representation.** The investment-related functions of the Mineral Security Partnership should be integrated into a reformed IGF, with an expanded mandate covering investment coordination, offtake agreements and contracts for difference arrangements. This forum should be institutionally distinct from the emergency stockpiling mechanism, reflecting the dual mandate separation recommended above. Equal producer-country representation is essential to ensure that diversification supports sustainable development and aligns with emerging environmental and social standards, rather than reproducing the extractive asymmetries of the fossil fuel era. Engagement should focus explicitly on achieving N-1 resilience across extraction and refining, consistent with the supply concentration thresholds set out in national-level critical mineral strategies, and with the diversification benchmarks identified in our report's N-1 analysis. The reformed IGF would additionally serve as the primary forum for engagement with MDBs on investment coordination, drawing on its expanded mandate and producer-country membership to align financing priorities with supply diversification objectives, as elaborated in Recommendation 6.

**6. Mobilise complementary institutional roles to support the core mechanism and long-term diversification objectives.** No stockpiling mechanism can function effectively without the enabling conditions that support its operational credibility and long-term sustainability. Existing international institutions should be mobilised in their respective areas of comparative advantage, engaging with the emergency stockpiling mechanism through the IEA and with long-term diversification objectives through the reformed IGF. WBG and regional MDBs should finance extraction and refining capacity in diversification-priority jurisdictions, with investment coordination channelled through the reformed IGF to ensure alignment with producer-country development priorities and MDB financing standards. The IMF should integrate critical minerals into its macroeconomic surveillance frameworks, including Article IV consultations, improving early identification of shock transmission risks for import-dependent and mineral-dependent economies alike. The OECD and IGF should expand transfer pricing and ESG guidance across critical minerals beyond the existing copper framework, strengthening fiscal transparency and reducing revenue leakage in producer countries. UNCTAD should contribute trade resilience analysis and capacity-building support for mineral-dependent economies, ensuring that producer-country perspectives are integrated into the analytical foundations of the mechanism. Together, this institutional division of labour addresses both dimensions of the dual mandate without creating redundant coordination structures or conflating the mechanism's two distinct objectives.

Beyond these key recommendations, there are two key considerations to ensure the durability and political feasibility of an internationally coordinated stockpiling mechanism:

**1. Embed demand-side responsibility within the governance architecture.** Any coordinated stockpiling mechanism must incorporate explicit commitments to material efficiency, demand moderation and responsible sourcing from import-dependent countries. Without these commitments, the mechanism faces two operational risks. If it accelerates extraction pressures without equitable returns to producer countries, they may withdraw cooperation or impose the export restrictions that stockpiling is designed to mitigate, eroding the mechanism's credibility precisely when it is most needed. If it locks in demand at current mineral intensity levels without incentivising efficiency gains or substitution, it magnifies the supply shock exposure it is designed to hedge against, since higher demand intensity means greater vulnerability to any given disruption. Consuming-country commitments on material efficiency, responsible sourcing and demand moderation should therefore be treated as conditions of participation, not voluntary complements to it.

**2. Stockpiling is not a substitute for structural supply resilience.** Buffer stocks provide insurance against acute supply disruptions but cannot resolve longer-term structural supply constraints. This limitation is most consequential for disruptions delivered through trade and export policy, which represents the most plausible and most severe supply shock scenario for most priority minerals. Our report's N-1 analysis demonstrates that, for most critical minerals, the global supply system has little redundancy, and no volume of emergency stocks can compensate for the removal of the largest supplier from

global markets. Stockpiling must therefore be embedded within a broader strategy encompassing supply chain diversification, investment in refining capacity, R&D for material substitution and demand-side efficiency measures. Policymakers should be explicit that the credibility of a stockpiling mechanism depends on parallel progress on structural supply resilience. Without it, buffer stocks risk creating a false sense of security that delays rather than supports the longer-term policy responses the energy transition requires.

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# Appendix

## Mining and processing operational costs

### Additional analysis and charts

As Figure A.1 illustrates, production costs vary substantially across countries, with major producing economies – most notably China for copper and REEs, the Democratic Republic of the Congo for cobalt and Indonesia for nickel – operating at or near the bottom of the global cost distribution. Diversification into higher-cost jurisdictions, including IEA member countries, therefore requires either sustained public subsidy, guaranteed offtake at above-market prices, or both, to achieve commercial viability against incumbents whose cost advantage reflects decades of accumulated infrastructure, skills and scale.

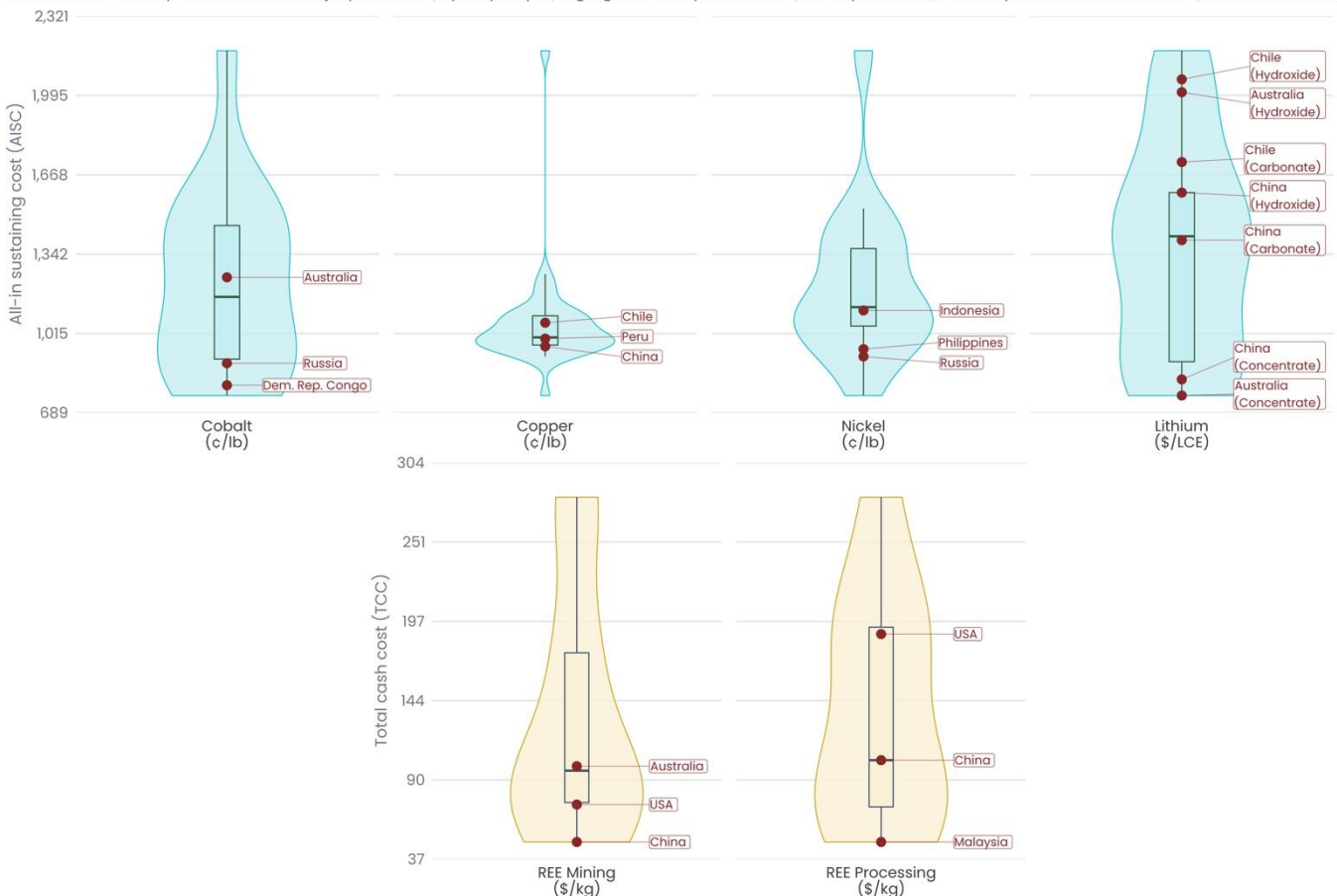
The top panel of Figure A.1 shows all-in sustaining costs (AISC) for cobalt, copper, nickel and lithium. The cost differentials are most consequential for cobalt, where the Democratic Republic of the Congo operates well below Western alternatives. For lithium, the cost disadvantage for diversified supply is most acute at the hydroxide and carbonate processing stage rather than at the concentrate stage, precisely where battery-grade material is produced.

The bottom panel shows total cash costs for rare earth mining and processing, where the cost differential is most stark. China anchors the bottom of both distributions, while the USA operates near the top of the processing cost range. This gap illustrates why competitive REE processing outside China remains the central obstacle to policy efforts focused on supply chain diversification.

**Figure A.1. Relative operational cross-country comparison for mining and processing**

**Mineral production costs by country (2024 weighted average estimates)**

Distribution of country-level costs with major producers (top 3 by output) highlighted. Teal panels: AISC (\$/lb S&P Capital IQ Pro). Amber panels: Total Cash Costs (Benchmark Mineral Intelligence)



Source: S&P Capital IQ Pro (2026); Benchmark Mineral Intelligence (2026); authors' calculations.

Note: Major producers defined by IEA production output shares. AISC and total cash costs are not directly comparable across commodity groups but reflect the data availability for different commodities. Lithium major producer labels show country and processing form. The mining and processing figures for REEs include both operational and expected costs of developing mines due to the small sample size. REEs: rare earth elements.

## Import-dependence analysis

### Additional analysis and charts

Figure A.2 shows the potential market impact of a 90-day critical mineral stockpile scenario across 33 countries, comprising Australia, China, India, Japan, South Korea, the US, and all 27 EU member states. Each panel corresponds to one of six critical minerals; within each panel, bars are broken out by value chain stage, from ores and concentrates through to semi-manufactured goods.

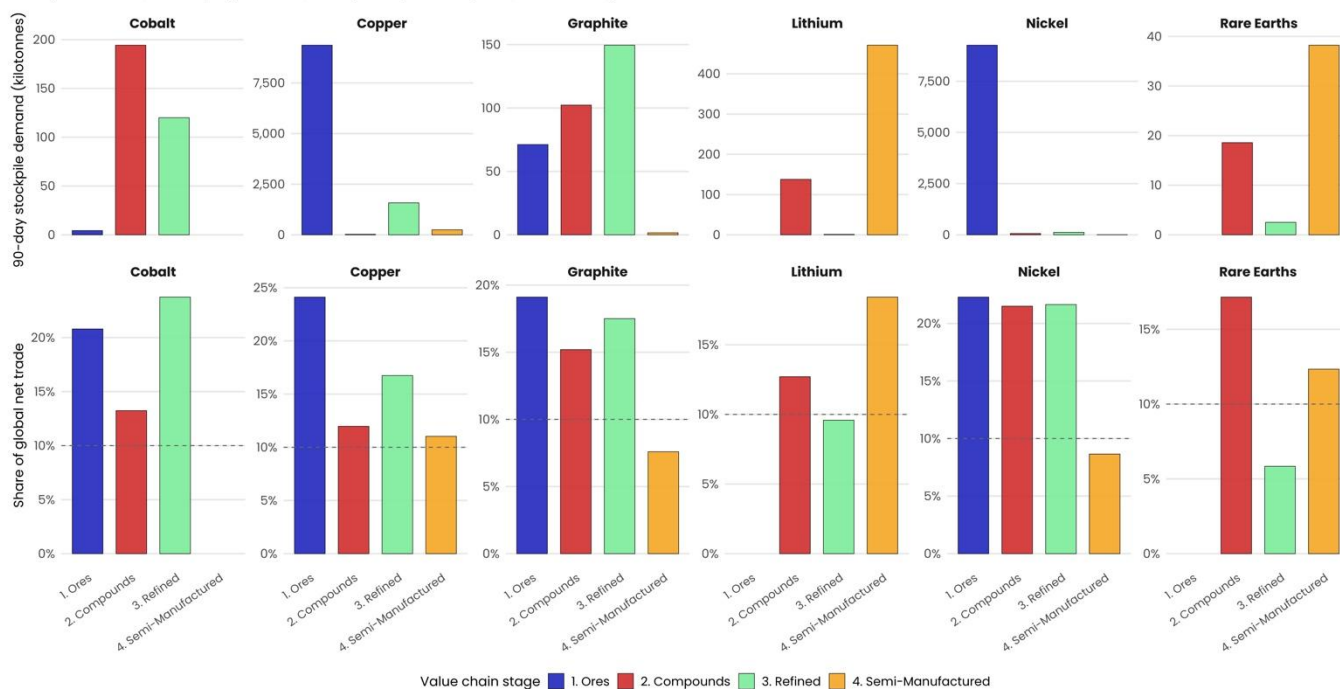
The upper panels show the absolute volume of material (in kilotonnes) that the 33 countries would need to acquire to cover 90 days of their combined net imports at each stage. The lower panels express the same demand as a share of total global net trade flows at that stage, providing a measure of how large the stockpile build-up would be relative to the market. The dashed line at 10% is shown as a reference threshold, above which stockpile accumulation would represent a material fraction of annual traded supply and could plausibly generate upward price pressure during build-up.

Only countries within the group that are net importers of a given commodity contribute to the aggregate figure; net exporters within the 33 are excluded, consistent with the policy rationale that stockpile requirements are calibrated on the basis of import dependence. Both the stockpile demand and the denominator are derived from the BACI trade database (2022–2024 average), meaning that the share metric reflects each stage’s position within globally traded markets rather than against total production.

**Figure A.2. Stockpiling impact across critical minerals value chains under a ‘90 days of net imports’ scenario**

**Stockpiling countries’ market impact by value chain stage (90-day stockpile)**

Average 2022–2024 | 33 stockpiling countries | 90-day net import assumption | Denominator: global net trade flows from BACI



Source: Gaulier and Zignago, 2010; authors’ calculations.

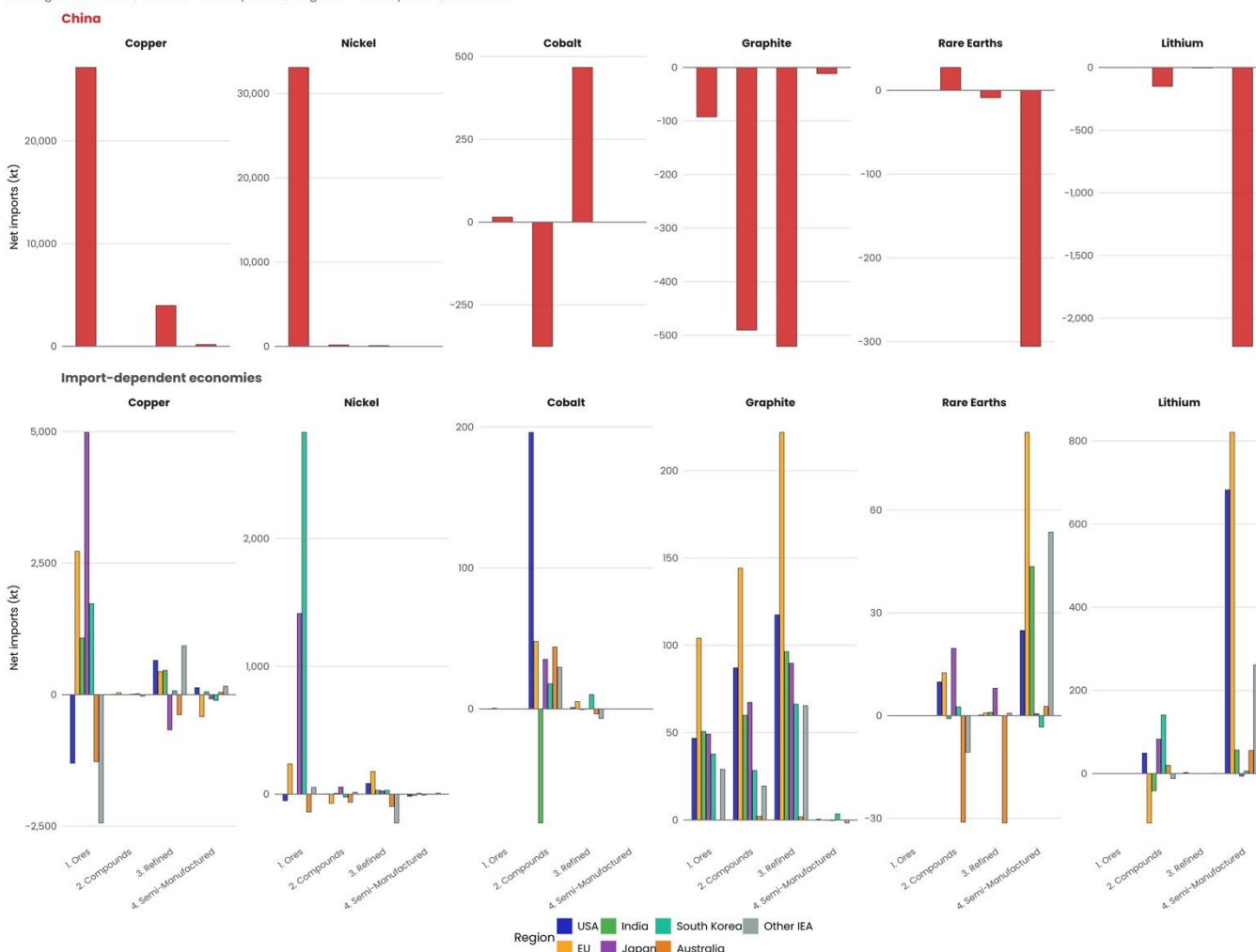
Note: Stockpile demand is calculated as 90 days of mean net imports (2022–2024) across the 33 stockpiling countries. The denominator is the sum of all positive net import positions across all BACI-reporting countries at each value chain stage – a proxy for total globally traded supply at that stage. REE ore stage (HS 260110) and lithium ore stage (HS 260190) capture broader

categories than REEs and lithium ores alone and should be interpreted cautiously. Natural graphite (HS 250410/250490) is merged into the Refined stage. REE refined metals (HS 280530) are subject to known underreporting in BACI. Semi-manufactured stage volumes reflect manufactured goods and are not directly comparable to upstream mineral-content stages.

**Figure A.3. Comparative overview of import dependencies across critical mineral value chains**

**Net import dependency across critical mineral value chains**

Average 2022–2024 | Positive = net importer | Negative = net exporter | Kilotonnes



Source: Gaulier and Zignago, 2010; authors' calculations.

Note: Net imports are calculated as the three-year average (2022–2024) of total imports received minus total exports dispatched, aggregated to the regional level. REE ore stage (HS 260110) and lithium ore stage (HS 260190) capture broader categories than REE and lithium ores alone and should be interpreted cautiously. Natural graphite (HS 250410/250490) is merged into the Refined stage. REE refined metals (HS 280530) are subject to known underreporting in BACI. Semi-manufactured stage volumes reflect manufactured goods – including permanent magnets (REEs) and lithium-ion batteries (lithium) – and are not directly comparable to upstream mineral-content stages.

## Methodology

### Overview

This note sets out the methodology underlying three analytical outputs: (1) the stockpile demand and market impact chart (Figure 1.4); (2) the value chain net import dependence chart (Figure A.1); and (3) the value chain share of global trade chart (Figure A.2). All three outputs draw on the BACI bilateral trade database, averaging data across 2022, 2023 and 2024 to smooth year-on-year volatility and reduce the influence of outlier trade flows.

## Data and commodity coverage

Trade flows are extracted from BACI at the six-digit Harmonised System (HS) level for six critical minerals: copper, nickel, cobalt, graphite, rare earth elements (REEs) and lithium. The HS codes selected for each commodity are detailed below. Several methodological considerations apply to specific commodities.

- **Cobalt.** Cobalt sulfate (HS 283329) dominates cobalt trade flows in BACI and is included alongside cobalt oxide (HS 282200). Both compounds carry elemental content conversion factors (0.21 and 0.73, respectively) to express traded volumes in terms of contained cobalt metal equivalent.
- **Lithium.** Four lithium compounds are included: lithium carbonate (HS 283691), lithium hydroxide (HS 282520), lithium chloride (HS 282739) and lithium sulfate (HS 283322), with lithium content factors of 0.188, 0.165, 0.163 and 0.100, respectively. Lithium metal (HS 280519) is included without adjustment. Conversion factors are applied to express all traded volumes in lithium metal equivalent tonnes.
- **REEs.** Trade data for REE oxides (HS 284610 and 284690) are used as the central estimate. REE metals (HS 280530) are subject to known underreporting in BACI and are noted as a limitation. The production denominator used (388,276 tonnes, sourced from BMI) is expressed in rare earth oxide (REO) weight, which is directly comparable to the oxide-based trade flows without requiring further conversion.
- **Graphite.** Natural graphite (HS 250410 and 250490) and processed battery-grade graphite (HS 380110) are included in the primary stockpile demand calculation. An additional battery-grade coated spherical graphite code (HS 380190) is included in the value chain analysis.

## HS codes and product classification

**Figure 1.4 – stockpiling demand.** This plot uses a single-stage classification for each commodity, implicitly treating all codes as representing the refined product stage. No value chain disaggregation is applied. These products are chosen to align with the IEA’s inclusion of supply figures within their critical minerals database to ensure coherence between the numerator and denominator.

- **Copper:** HS 7403 (refined copper, unwrought) – four-digit heading, captures all sub-headings including cathodes, wire bars and billets
- **Nickel:** HS 7502 (unwrought nickel) – four-digit heading, captures nickel not alloyed and nickel alloys
- **Cobalt:** HS 282200 (cobalt oxides and hydroxides) and 283329 (cobalt sulfate) – with cobalt content conversion factors of 0.73 and 0.21, respectively
- **Graphite:** HS 250410 (natural graphite in powder or flakes), 250490 (other natural graphite) and 380110 (artificial graphite) – mixture of ore-stage and processed-stage codes treated as a single category
- **Rare earths:** HS 284610 (cerium compounds) and 284690 (other rare earth compounds) – compounds stage only, refined metals excluded
- **Lithium:** HS 283691 (lithium carbonate), 282520 (lithium oxide and hydroxide), 282739 (lithium chloride), 283322 (lithium sulfate) and 280519 (alkali metals including lithium metal)

**Figures A.1 and A.2 – share of global trade and value chain net imports charts.** Both plots use the same HS basket classification across four explicit value chain stages.

Stage 1: ores and concentrates:

- **Copper:** HS 260300 (copper ores and concentrates)
- **Nickel:** HS 260400 (nickel ores and concentrates)
- **Cobalt:** HS 260500 (cobalt ores and concentrates)
- **Graphite:** HS 250410 (natural graphite in powder or flakes) and 250490 (other natural graphite); note that these same codes are also used at the refined stage for graphite, reflecting that natural graphite is the primary traded form prior to further processing
- **Rare earths:** HS 260110 (iron ores and concentrates including roasted iron pyrites); this is a broad residual category that includes REE-bearing ores but is not exclusive to them; trade volumes should be interpreted cautiously
- **Lithium:** HS 260190 (other ores and concentrates) – a residual category that includes spodumene (the primary lithium ore) but captures other minerals as well; trade volumes should be interpreted cautiously

Stage 2: compounds and intermediates:

- **Copper:** HS 282741 (copper chlorides), 282550 (copper oxides and hydroxides) and 283325 (copper sulfates)
- **Nickel:** HS 282735 (nickel chlorides), 282540 (nickel oxides and hydroxides) and 283324 (nickel sulfates)
- **Cobalt:** HS 282200 (cobalt oxides and hydroxides) and 283329 (cobalt sulfate heptahydrate); the same codes as Figure 1.4, with cobalt content conversion factors of 0.73 and 0.21, respectively; cobalt sulfate (283329) dominates trade flows at this stage
- **Graphite:** HS 380110 (artificial graphite) and 380190 (other forms of graphite and carbon); battery-grade processed graphite; note overlap with stage 1 for natural graphite codes
- **Rare earths:** HS 284610 (cerium compounds), 284690 (other rare earth metal compounds) and 280530 (rare earth metals, scandium and yttrium); same as Figure 1.4 plus the refined metals code; REE metals (280530) are subject to known underreporting in BACI
- **Lithium:** HS 283691 (lithium carbonate), 282520 (lithium oxide and hydroxide), 282739 (lithium chloride) and 283322 (lithium sulfate); with lithium content conversion factors of 0.188, 0.165, 0.163 and 0.100, respectively; same as Figure 1.4, excluding the refined metal code

Stage 3: refined metals:

- **Copper:** HS 740200 (unrefined copper, copper anodes), 740311 (copper cathodes) and 740312 (copper wire bars)
- **Nickel:** HS 750210 (unwrought nickel, not alloyed) and 750220 (unwrought nickel alloys)
- **Cobalt:** HS 810510 (cobalt mattes and other intermediate products), 810520 (unwrought cobalt), 810530 (cobalt waste and scrap) and 810590 (other cobalt and articles)
- **Graphite:** HS 250410, 250490 (natural graphite, merged from Stage 1) and 380110 (artificial graphite); natural graphite is merged into the refined stage to reflect its role as the primary traded form of graphite prior to advanced processing; note this creates overlap with stage 1 and 2 graphite codes
- **Rare earths:** HS 280530 (rare earth metals, scandium and yttrium)
- **Lithium:** HS 280519 (alkali metals, including lithium metal)

Stage 4: semi-manufactured products:

- **Copper:** HS 740321, 740329 (copper alloys unwrought), 740710, 740721, 740729 (copper bars, rods and profiles), 740811, 740819, 740829 (copper wire) and 740911, 740919, 740929 (copper plate, sheet and strip)
- **Nickel:** HS 750511, 750512 (nickel bars, rods, profiles and wire), 750610 (nickel plates, sheets, strip and foil), 750711, 750712 (nickel tubes and pipes) and 750810, 750890 (other nickel tube or pipe fittings and other nickel articles)
- **Cobalt:** HS 810595 (other cobalt articles); thin trade data at this stage; volumes are low relative to upstream stages

- **Graphite:** HS 680410 and 680490 (millstones, grindstones and grinding wheels, including those of graphite); captures abrasive and electrode applications of processed graphite
- **Rare earths:** HS 850511 (permanent magnets of metal) and 850519 (other permanent magnets and articles); key downstream REE application; trade volumes at this stage reflect manufactured goods rather than raw mineral content and are not directly comparable to upstream stages
- **Lithium:** HS 850760 (lithium-ion accumulators) and 850780 (other accumulators and parts); captures battery-stage lithium dependence; as with REE magnets, volumes reflect manufactured goods and are not directly comparable to upstream mineral-content stages; China's dominant net exporter position at this stage (-2,225 kt) reflects its role as the world's leading battery manufacturer rather than primary lithium producer

## Net import calculation

For each commodity and country, annual net imports are calculated as:

**Net imports = total imports received - total exports dispatched**

where imports are identified by the destination country code (*j* in BACI notation) and exports by the origin country code (*i*). Trade quantities are summed across all trading partners and all relevant HS codes for a given country and year.

This is computed separately for each of the three years (2022, 2023, 2024), and the three annual net import values are then averaged to produce a single mean net import figure per country. This three-year averaging reduces the distorting effect of any single year's anomalous trade patterns.

Where a country has no recorded imports or exports for a given commodity, quantities are treated as zero rather than missing, ensuring that the net import calculation is not inflated or deflated by data gaps.

## Figure 1.4. Estimated market impact of critical mineral stockpiling programmes

The analysis covers 33 stockpiling countries: Australia, China, India, Japan, South Korea, and the US, as well as all 27 EU member states. For each commodity, the mean annual net import position is calculated for each of the 33 countries. Only countries with a **positive** net import position (i.e. net importers) are summed to produce the aggregate net import figure. Countries that are net exporters of a given commodity are excluded from this aggregation, consistent with the policy rationale that stockpile calibration is relevant only for import-dependent economies.

**Aggregate net imports =  $\Sigma$  (mean net imports) for all countries where mean net imports > 0**

Three stockpile duration scenarios are modelled: 90, 120 and 180 days. For each scenario, stockpile demand is calculated as:

**Stockpile demand = (aggregate net imports / 365) × days**

This expresses stockpile demand as the quantity of material required to cover the specified number of days of net imports, analogous to the IEA's 90-day net import calibration methodology for strategic petroleum reserves.

Stockpile demand is expressed as a share of global annual production to contextualise the market impact:

**Share of global production = stockpile demand / total world production**

Production denominators are sourced from the IEA (for copper, nickel, cobalt, graphite and lithium) and BMI (for REEs), as detailed in Section 2. The 10% reference line shown on the chart represents a threshold above which stockpile accumulation would constitute a material fraction of annual global supply, potentially generating price pressure during build-up.

## Figure A.1. Comparative overview of import dependencies across critical mineral value chains

For each HS basket, the aggregate net import position of the 33 stockpiling countries is calculated as in Section 4.1, summing only positive net import positions, three-year average. This is then converted to a 90-day stockpile demand figure:

$$\text{90-day stockpile demand (kt)} = (\text{aggregate net imports} / 365) \times 90 / 1,000$$

Rather than using production data as the denominator (as in Chart 1), this chart employs a BACI-derived global net trade denominator. For each HS basket, the net import position is calculated for every country appearing in BACI. The global denominator is then defined as the sum of all **positive** net import positions across all countries:

$$\text{Global net trade (kt)} = \Sigma (\text{mean net imports}) \text{ for all BACI countries where mean net imports} > 0$$

This denominator represents a proxy for total globally traded supply at each value chain stage – i.e. the aggregate volume of that material flowing from net exporting to net importing countries – and is directly comparable to the numerator (the 33-country stockpile demand), since both are derived from the same BACI dataset and use the same net import methodology.

$$\text{Share of global net trade} = \text{90-day stockpile demand} / \text{global net trade denominator}$$

This metric captures the proportion of total globally traded supply at each value chain stage that would be required to meet the 33-country stockpile equivalent of 90 days of net imports. A higher share indicates a greater potential market impact during stockpile build-up. The 10% reference line is retained from Figure 1.4 as a comparator threshold.

## Figure A.2. Stockpiling impact across critical minerals value chains under a '90 days of net imports' scenario

Trade flows are disaggregated into four value chain stages, each defined by a distinct set of HS codes:

**Stage 1 – Ores and Concentrates:** primary mined material prior to processing

**Stage 2 – Compounds and Intermediates:** chemically processed forms, including battery precursor materials

**Stage 3 – Refined Metals:** pure or near-pure metal forms, including natural graphite merged at this stage given its role as the primary traded form prior to further processing

**Stage 4 – Semi-Manufactured Goods:** downstream fabricated products such as wire, sheet and permanent magnets

Several caveats apply to specific stages. REE-bearing ores are captured within the broader iron ore code (HS 260110) and spodumene (the primary lithium ore) falls within the residual 'other ores' category (HS 260190); both codes are broader than REE and lithium ores alone, and volumes should be interpreted cautiously. Stage 4 REE and lithium entries (permanent magnets and lithium batteries, respectively) reflect manufactured goods whose volumes are not directly comparable to upstream mineral-content stages.

Countries are assigned to one of eight regions: Australia, China, the EU (27 member states aggregated), India, Japan, South Korea, the USA, and other IEA members (Canada, Mexico, New Zealand, Norway, Switzerland, Türkiye, the UK). This is based on countries or regions with announced/implemented critical mineral stockpiling programmes, and IEA membership.

For each basket of HS codes, net imports are calculated at the individual country level as described in Section 3, then aggregated to the regional level by summing net import positions across all countries within each region. The result is expressed as a three-year average in kilotonnes.

A positive regional net import value indicates that the region is a net importer of that material at that value chain stage; a negative value indicates net export. The split visualisation – with China shown separately from all other regions – reflects China's unique role as a simultaneous net exporter at upstream stages and net importer at downstream stages for several commodities, which would obscure the dynamics for other regions if plotted on a common axis.