POLICY BRIEF

Sustainable Governance for Critical Raw Materials

I. Critical Raw Materials as a Challenge for Law and Policy

The great transitions – above all the "twin transitions" in the fields of climate and digitalisation – promise a better future, perhaps even the only viable future. In particular, they promise independence from fossil resources such as oil, gas and coal, and thus from all the problems that came with the fossil age. Awareness has grown in recent years that the great transitions require the use of enormous quantities of certain raw materials (for example lithium, nickel, cobalt, copper or rare earths).[1] Global demand for these materials is expected to rise exponentially over the coming decades, driven by the rapid expansion of renewable energy and electromobility.[2]

A secure supply of critical raw materials is a precondition for the success of the great transformations and for achieving far-reaching goals such as greenhouse-gas neutrality (or even negative emissions) – a link that deserves closer treatment given its centrality to current climate strategy.[3] Critical raw materials are an integral part of the great transformations and have aptly been described as "transition minerals."[4] As with those transformations, the question arises whether law is capable at all of organising comprehensive change over a period of decades.[5] Even more starkly than in the organisation of the climate transition as a whole, the immense economic, ecological and social challenges of producing, processing and trading critical raw materials are met by an extremely weak and fragmented legal framework at both the international and the national level.[6]

1. What is "critical" about "critical raw materials"?

There is growing recognition that these materials and minerals are an essential precondition for modern economies. Yet securing a reliable supply of them is fraught with substantial risk.[7] Can law guarantee security of supply? Even though critical raw materials are, in theory, sufficiently abundant to meet exponentially growing demand, supply on world markets is likely to remain tight for the foreseeable future. This is above all because opening new mines requires enormous amounts of capital and time (including permitting).[8] The problem is compounded by the geographic concentration of these resources, which leads to a concentration of power among supplier states (for example China in rare earths), fragility in global supply chains, and a risk of geopolitical conflict that has already begun to materialise.[9] Within the global comparison, supply risks in Europe must be regarded as particularly high.[10]

Alongside these economic challenges of resource procurement come massive ecological and social problems. Plans to mine manganese nodules on the seabed (deep-sea mining), for example, carry incalculable risks for marine ecosystems.[11] In many regions, moreover, mining conditions remain undignified. Reports repeatedly

1 For figures, see I.1.b) below.

2 For an overview, see Brückner/Marr, NuR 2024, 793 ff., with further references.

3 See Vesa et al. (2025), 6 f. on the significance of critical raw materials for climate targets.

4 Vesa et al. (2025), 99.

5 On the climate transition generally, see the literature on transformative climate law.

6 On the fragmented legal framework, see Vesa et al. (2025), 3.

7 On the economic analysis of import dependence in critical raw materials, see Jakob et al., *The Economic Logic of Policies to Address Import Dependence in Clean Energy Goods*, 2025.

8 European Court of Auditors, Special Report 04/2026, 2026, 70 ff., Figure 16: opening a mine in Sweden can take up to 30 years.

9 Reins/Zahar (eds.), *Climate Technology and Law in the Anthropocene*/Vesa et al. (2025), 114, with further references.

10 See Deberdt/DiCarlo, Energy Research & Social Science 133 (2026), 104601.

11 See the analysis by Pavel et al., Wirtschaftsdienst 104 (2024), 350 (353 ff.).

document serious human-rights violations, such as the use of child labour in cobalt mining in the Democratic Republic of the Congo.[12] This produces clear tension between policy goals – for instance where global climate protection conflicts with national security of supply, with security considerations increasingly taking precedence over environmental concerns.[13] Reconciling this security-driven logic with the broader sustainability agenda remains one of the central open questions addressed later in this article.

The concept of "criticality" is comparatively new in the social sciences and cannot be defined with precision.[14] "Critical raw materials" therefore refers to a dynamic concept that continues to evolve alongside scientific and technical development.[15] Beyond the natural sciences and medicine, the concept found its earliest use chiefly in defence policy: shortly before the outbreak of the Second World War, the United States enacted a "Strategic and Critical Minerals Stock Piling Act" to secure the raw materials needed for a war economy.[16] "Criticality" acquired a new dimension of meaning with the 1973 oil-price shock,[17] where the term referred to energy as an elementary precondition of modern economic life. A similar logic underlies the now firmly established concept of "critical infrastructure," which highlights systemic relevance for the economy, society and public security.

2. Overview of the most important critical raw materials and their geographic concentration

The following provides an overview of how critical raw materials are used in the energy and digital transformations.

Raw material	Main application	Why critical?
Lithium	Batteries for EVs & storage	Key input for the mobility transition
Cobalt	Lithium-ion batteries	High concentration in politically unstable regions
Rare earths	Permanent magnets (wind power, motors)	Near-total dependence at the refining stage
Silicon metal	Semiconductors, solar cells	Foundation of the entire digital transformation
Graphite	Anode material for batteries	Few technical alternatives available
Magnesium	Lightweight alloys (automotive/aerospace)	Massive EU import dependence on China

With respect to the geographic concentration of critical raw materials, three aspects must be distinguished:[18] (1) Who holds the underlying reserves, and to what extent? (2) In which countries, and to what extent, are these materials actually mined? (3) Which countries process (refine) critical raw materials, and to what extent?

(1) Reserves: In terms of global reserves, China, Brazil, Australia and Vietnam hold the most significant deposits of rare earths. For specific battery raw materials such as lithium, Chile and Australia dominate the global picture, while the Democratic Republic of the Congo holds the majority of the world's cobalt reserves.

(2) Mining: In lithium, Australia (approx. 47%) and Chile (approx. 29%) dominate the market, with Argentina currently showing the strongest growth. In cobalt, the Democratic Republic of the Congo supplies more than 70% of global output. Indonesia, through massive investment, has become the world's leading nickel producer, accounting for more than 50% of global production. Around 60% of rare earths are mined in China, which also holds a technological monopoly on extraction.

(3) Refining (the true bottleneck): far more critical than the place where the ore is taken out of the ground is the place where it is chemically processed. Here, concentration is even more extreme. China refines roughly 90%

12 See Cato/Evoy, Earth System Governance 24 (2025), 100249 (9 f.).

13 On the social and ethical dimensions of critical-raw-material extraction, see Herrington/Gordon, Geopolitics for the Future, 2024, 235 ff.

14 Leonelli, World Trade Review 24 (2025), 237 (240).

15 See Drengk/Hürlimann (eds.), *Rohstoffe und ihre Kritikalität*/Hürlimann, 2025, 7 ff.

16 Reins/Zahar (eds.), *Climate Technology and Law in the Anthropocene*/Vesa et al. (2025), 100.

17 Drengk/Hürlimann (eds.), *Rohstoffe und ihre Kritikalität/Hürlimann,* 2025, note 25, with further references.

18 See Kassem/Major, The Foundation Journal for Natural Resources & Energy Law 62 (2025), 329 (331).

of the world's rare earths and also controls the bulk of graphite and lithium refining.[19] Even lithium mined in Australia therefore typically travels to China for processing before it ends up in batteries.

3. Transformative law – the limits of law

These enormous challenges require political responses capable of creating an adequate legal framework for a law of critical raw materials – one that, as recent scholarship has emphasised, must be understood as fundamentally disruptive rather than merely incremental.[20]

Like climate law,[21] this body of law must orchestrate a transformation; it is necessarily transformative law. It must steer developments over a period spanning several decades while incentivising technical development and innovation, for instance in extraction technology or recycling.[22] Reality demands quantum leaps with disruptive dynamics.[23] At the same time, this law must reconcile the economic, ecological and social challenges described above – challenges that frequently involve significant trade-offs – within a coherent legal framework. The goal must be a sustainable law of critical raw materials. From today's perspective, that means nothing less than a transformation of law itself – a development that can fairly be called a legal quantum leap, or disruption. Alongside technological revolutions, a transformation of the socio-economic order must also take place.

There are many reasons for pessimism here, which will be listed below and examined more closely as the discussion proceeds. In each case, it should be borne in mind that the risk of failing to reach a consistent, comprehensive overall solution must not become a reason to abandon the pursuit of incremental solutions.

First, it must be recognised that the institutional framework of lawmaking tends to permit only incremental, system-immanent development.[24] At both the national level and the supranational level of the European Union, this is due to the discontinuity of parliaments and institutions, but also to the necessity of political compromise. This holds even more strongly for international law, which – when it comes to creating treaty law, for example – is subject to the constraints of treaty conferences (such as the unanimity principle) or to the weakness of international organisations such as the United Nations or the World Trade Organization.

As in other areas of transformative law, the emerging law of critical raw materials must also contend with the constraints of a multi-level legal order. The legal framework governing the extraction, processing, trade and (re-)use of critical raw materials must be pre-structured by international law but implemented through national, supranational or even local law.

Finally, building a coherent law of critical raw materials requires an ambitious integration of legal fields and principles. At the international level, this is reflected in the intersection of sustainable-development law and world trade law. At the national level, an often highly traditional and in places antiquated body of mining law meets the demands of transformation described above.

A look at the existing legal order reveals an extremely fragmented legal framework. A coherent law of critical raw materials is emerging neither at the international nor, generally, at the national level. Rather, the legal framework remains highly fragmented. Targeted reforms can be steps in the right direction, but they also carry the risk of undesirable side effects – for example, when trade barriers introduced in the name of security of supply create new de facto or legal "lock-ins."

The following sections first examine the international legal order. This begins with developments in world trade law, including new forms of trade-related cooperation. The discussion then turns to international sustainable-development law, which, absent more concrete legal implementation, typically offers only weak orientation. One possible avenue for greater specificity lies in standards that emerge bottom-up and are, in part, integrated into legal structures.

Developments in selected national legal orders are then examined by way of example.

Finally, the article turns to the European Union's Critical Raw Materials Act (CRMA). This displays genuinely transformative features and can currently be described as something of a "regulatory benchmark."[25]

19 Vesa et al. (2025), 9.

20 See Vesa et al. (2025), 22 ff. on legal disruption in this field.

21 On climate law generally, see the relevant transformative-law literature.

22 Vesa et al. (2025), 11 ff.

23 Vesa et al. (2025), 4 f.

24 See Vesa et al. (2025), 22.

25 Vesa (2025), 111.

II. Political Challenges and Regulatory Trends in International Law

a. World Economic Law

Overview - Hard law, in particular world trade law

1. A fragmented international legal framework

The claim that there is no international legal framework at all for the global challenges posed by critical raw materials[26] is not accurate. It is, however, highly fragmented.

The starting point of international law is the principle of territoriality: mineral resources may be disposed of only by the state on whose territory they are located.[27] Limitations on this principle can arise from customary international law and from treaty law. Rules of customary international law are, by their nature, very general.[28] One example is the rule of international environmental law that activities on the territory of one state must not cause harm on the territory of neighbouring states – a principle that obviously also applies to mining activities.[29]

As for treaty law, it must first be noted that there is no dedicated multilateral treaty addressing the negative effects of mining.[30] Only recently has a loose network of bilateral or plurilateral partnership agreements, along with dedicated chapters on critical raw materials in trade agreements, begun to take shape.[31] At present it is chiefly world trade law that is relevant to assessing the tension between free world trade and rising "resource nationalism."[32]

2. World trade law under pressure

a) The renaissance of export restrictions

One of the WTO's core principles (Art. XI GATT) is the prohibition of quantitative import and export restrictions. Yet an increasing number of states are using export tariffs, quotas or licensing requirements as strategic weapons: over the past decade, export restrictions on critical raw materials have roughly quintupled.[33] On one hand, this serves the protection of domestic economic interests – commonly labelled "resource nationalism." Countries such as Indonesia (nickel) or Zimbabwe (lithium) prohibit raw-material exports in order to force domestic processing (local-content requirements). On the other hand, states use their resource wealth as a "geopolitical lever" – an instrument for pursuing foreign-policy interests. China, for example, has repeatedly imposed export controls on gallium, germanium and graphite, officially justified on "national security" grounds. The result is a fragmentation of the market that runs counter to the spirit of free trade.

b) The stretching of "national security" (the essential-security exception)

WTO law permits exceptions for the protection of essential security interests under Art. XXI GATT. This was formerly a narrowly construed emergency clause. Today it is used by the major players – including the United States, China and, increasingly, the EU – as a blank cheque. Securing raw materials is simply defined as part of national security, for example for the defence industry or the stability of the electricity grid. Because WTO panels have traditionally been reluctant to second-guess a sovereign state's security determinations, world trade law is, in practice, becoming unenforceable in this field.

c) A subsidy race rather than fair competition

The WTO Agreement on Subsidies and Countervailing Measures (SCM) is meant to limit state aid that distorts trade. Yet competition for raw materials and green technologies has triggered a global subsidy race. The US Inflation Reduction Act (IRA) and the EU Green Deal Industrial Plan frequently tie support to strict conditions such as "Made in America" or "sourced from partner countries." These protectionist elements violate the WTO's most-fa-

26 This view, however, is rightly rejected; see Reins/Zahar (eds.), *Climate Technology and Law in the Anthropocene*/Vesa, 94 ff.

27 See Hailes, JIEL 25 (2022), 148 (155 f.).

28 eins/Zahar (eds.), *Climate Technology and Law in the Anthropocene*/Vesa, 108.

29 Reins/Zahar (eds.), *Climate Technology and Law in the Anthropocene*/Vesa, 108 f., with further references on the relevant international environmental law.

30 See section II.3 below.

31 See section II.2 below.

32 Kowalski/Legendre, *Raw Materials Critical for the Green Transition: Production, International Trade and Export Restrictions*, 2023, 11.

33 See Kassem/Major, The Foundation Journal for Natural Resources & Energy Law 62 (2025), 329 (357 f.).

voured-nation principle, since they favour certain trading partners while discriminating against others. The EU, meanwhile, is attempting to counter trade-distorting subsidies through its Foreign Subsidies Regulation.[34]

d) The end of rule-based predictability

The core promise of the WTO was predictability through bound tariffs and transparent rules. The current rivalry, however, is replacing this with erratic ad hoc politics. Trade relationships are becoming increasingly "transactional": access to raw materials is traded against security guarantees or technology transfer. Small and medium-sized states that depend on the world trading system are caught between the great powers and often must align themselves with one sphere of influence or another. In sum, it is fair to conclude that the economic efficiency of raw-material supply is currently being sacrificed to political resilience. World trade law is not being formally abolished, but it is being progressively hollowed out by the practice of "geopoliticising trade." In a world where raw materials are understood as instruments of power, the idea of a universal, rule-based market fades.

3. The outlines of a new international order

The progressive weakening of world trade law raises the question of what might take the place of a rule-based multilateral trading order in enabling continued trade in critical raw materials — an outcome in the interest of resource-rich and resource-poor states alike.

a) New forms of cooperation

It was China that first recognised the great importance of new forms of international cooperation in the field of critical raw materials.[35] Today, the significance of "resource diplomacy"[36] is widely acknowledged. Rather than relying on global rules, states are forming exclusive "raw-material clubs" or bilateral and plurilateral agreements (e.g., the Minerals Security Partnership). Alongside the political strategy of promoting domestic production of critical raw materials ("re-shoring"), the practice of directing trade flows not to where they are most efficient but to where they appear politically "safe" is spreading.[37] This is known as "friendshoring."[38]

Whereas it used to be common (for instance, in relation to fossil fuels) to conclude long-term supply agreements ("commodity agreements") focused mainly on offtake guarantees and price stability,[39] critical-raw-materials policy today increasingly relies on so-called "strategic partnerships." By 2026 the EU had concluded more than 14 bilateral partnerships (including with Chile, Namibia, Kazakhstan and Canada), trading technological cooperation for privileged market access.[40] Terminology varies — such instruments are also referred to as "memoranda of understanding," "joint action plans" or "joint statements of action."[41] The EU's Critical Raw Materials Regulation[42] defines a strategic partnership as "a commitment between the Union and a third country to intensify cooperation related to the raw-material value chain, established through a non-binding instrument setting out actions of mutual interest."[43]

Substantively, these instruments can, on the one hand, be seen as falling short of classic trade agreements, since they are largely vague and only weakly binding; on the other hand, they are substantively broader, also covering social and environmental aspects as well as questions of development aid and investment promotion.[44]

A problem with these agreements is that they are — necessarily — concluded predominantly with states that have relatively unstable systems of government.[45] Their effectiveness, too, remains doubtful.[46]

Because global rules are often too slow, "raw-material

34 Reins/Zahar (eds.), Climate Technology and Law in the Anthropocene/Vesa, 113 ff.

35 Sasmal, World Trade Review 2026, 1 (3, 5); Kassem/Major, The Foundation Journal for Natural Resources & Energy Law 62 (2025), 329 (349).

36 Jakob et al., *The Economic Logic of Policies to Address Import Dependence in Clean Energy Goods*, 2025.

37 Jakob et al., *The Economic Logic of Policies to Address Import Dependence in Clean Energy Goods*, 2025, 8.

38 Sasmal, World Trade Review 2026, 1 (5).

39 See Tröster/Papatheophilou/Küblböck, *Strategic Autonomy meets Global Dependency*, 2025, 10 ff.; for a comprehensive listing of EU, US and Japanese agreements, see Sasmal, World Trade Review 2026, 1 (6 ff.).

40 Sasmal, World Trade Review 2026, 1 (11).

41 Regulation (EU) 2024/1252.

42 Art. 2, Regulation (EU) 2024/1252.

43 On the systematisation of content, see Sasmal, World Trade Review 2026, 1 (13).

44 European Court of Auditors, Special Report 04/2026, 2026, para. 49 ff.

45 See the detailed overview in European Court of Auditors, Special Report 04/2026, 2026, Exhibit 12.

46 See Sasmal, World Trade Review 2026, 1 (19 ff.); Tröster/Papatheophilou/Küblböck, *Strategic Autonomy meets Global Dependency*, 2025, 10; on the EU–Latin America agreement, see Detsch/Olivera Villa/Mattheß, *The European Union's Critical Raw Materials Act*, 2024, 15 f.

clubs" have emerged, such as the transatlantic Minerals Security Partnership (MSP) led by the United States and the EU.[47] Here, like-minded Western industrialised states cooperate to build supply chains free of Chinese dominance. All of this is leading to a balkanisation of world trade: parallel supply-chain systems are emerging that are barely compatible with one another. The WTO, as a neutral arbiter, is losing relevance, as disputes are increasingly not even brought before its (already weakened) Appellate Body.

b) Changes in world trade law

Free trade agreements used to focus primarily on tariff reduction. Modern agreements (for example with Chile, New Zealand, or the agreement with Mercosur currently applied provisionally) contain specific chapters on energy and raw materials.[48] Their core elements include:

- Prohibition of export restrictions: partner countries commit not to impose export duties or quotas on critical raw materials that could impede the flow of supply to the EU.
- Non-discriminatory access: EU companies must be treated the same as local firms in accessing mineral deposits and in the award of mining licences in the partner country.
- Investment protection: legal certainty for EU companies investing abroad in mines or processing facilities.

b. Challenges from the Perspective of Sustainable Development

As already noted,[49] the rapidly growing global production of, and trade in, critical raw materials raises serious economic, ecological and social questions that stand in complex tension with one another. Resolving these tensions as sustainably as possible is the central aim of the principle of sustainability.[50]

a. Economic, ecological and social challenges

1. The economic perspective

The economic challenge forms, in a sense, the starting point for the overall problem. Critical raw materials are needed to achieve the intended great transformations – alongside the digital transformation, in particular the transformation of the economy and society towards greenhouse-gas neutrality (or even negative emissions). This presupposes that industry can be supplied with the necessary critical raw materials in sufficient quantities and at affordable prices (security of supply).

- Dealing with monopolistic or oligopolistic market structures (concentration risk, pricing power).
- Price volatility, planning certainty and investment risk (for example, the "pig cycle": high prices trigger investment in new mines that only begin producing years later; by the time the mine is operational, the market is often already oversupplied, prices fall, and the investment no longer pays off).
- Internalising external costs – competitive distortion caused by differing environmental and social standards.

2. The ecological perspective

Ecological challenges relating to critical raw materials arise in particular from extraction, which is often accompanied by significant local environmental damage.

- Land use and biodiversity: mining frequently takes place in ecologically sensitive areas, with negative effects on ecosystems, habitat loss for animals and plants, and the special problem of deep-sea mining.
- Water scarcity and contamination: extracting critical raw materials is extremely water-intensive.

  Example – lithium extraction: in the Atacama Desert (Chile), brine is pumped from the ground and evaporated, depleting groundwater in an already arid region. How does this affect local water cycles?

  Example – acid drainage: extracting metals from sulphidic ores can produce sulphuric acid, which dissolves heavy metals and poisons rivers. How is the safe storage of tailings guaranteed?
- Energy intensity and carbon footprint: a conflict between climate protection and environmental/nature conservation. Critical raw materials are needed

47 See also the new EU–India trade agreement, text available at https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/india/eu-india-agreements/text-agreements_en.

48 See section I above.

49 Sustainability is expressly addressed, for example, in Art. 1(1) CRMA.

50 Mangani et al., Peace and Sustainability 1 (2025) 100017, 2.

above all to build renewable-energy installations, yet their extraction causes serious damage to the environment and nature, along with substantial greenhouse-gas emissions. This can be described as a "sustainability paradox."[51]

Example – ore grades: as high-grade deposits are exhausted, ever more rock must be moved to obtain the same quantity of metal, driving up energy consumption per tonne of raw material extracted.

Example – refining: separating rare earths is chemically demanding and highly energy-intensive. If that electricity comes from coal-fired power stations, the ecological benefit of the end product (e.g., an electric motor) is diminished.

- Chemicals management and toxicity: processing ores often requires highly toxic substances (e.g., sulphuric acid, cyanide or solvents). Radioactive by-products: rare-earth extraction frequently produces radioactive thorium or uranium; the safe disposal of these by-products is one of the greatest ecological hurdles.

3. The social perspective

Finally, the extraction of critical raw materials in particular gives rise to dramatic social conflicts and human-rights violations.[52] This is due, among other things, to the fact that extraction often takes place in countries with weak state oversight (so-called fragile states). Mining frequently involves child labour and inadequate occupational safety. Large-scale mining projects require vast tracts of land, which often leads to conflict with local populations. Indigenous communities or smallholders are often displaced from their land without fair consultation processes, or expropriated without compensation. For many indigenous groups, land is not merely a resource but a spiritual inheritance, so that social uprooting and the destruction of cultural identity are real risks. In addition, the negative environmental effects described above burden the living conditions of local communities. The value created by resource extraction paradoxically often has negative economic consequences for local populations (the "resource curse"): high mining revenues frequently flow – often aided by corruption – into the pockets of a small elite, while the local population bears the ecological costs. Local economies are hollowed out as workers migrate into mining. When a mine closes or commodity prices fall, the social fabric risks collapsing.

b. The principle of sustainable development

It stands to reason that the principle of sustainable development could offer a viable path towards resolving the complex problems associated with the production of, and trade in, critical raw materials. This principle entered international law with the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (the "Earth Summit"). This applies, on the one hand, to the idea of intergenerational justice deriving from the 1987 Brundtland Report, which calls for development that meets present needs without compromising the ability of future generations to meet their own. Principle 3 of the Rio Declaration states that the right to development must be fulfilled so as to equitably meet the developmental and environmental needs of present and future generations. On the other hand, the Agenda for Sustainable Development for the twenty-first century ("Agenda 21"), adopted at the same conference by more than 170 states, enshrined the so-called three-pillar model, under which ecology (environment), economy and social affairs must be considered in an integrated manner. This was further elaborated in "Agenda 2030" ("Transforming our World: The 2030 Agenda for Sustainable Development"), a global programme of action adopted unanimously on 25 September 2015 by 193 UN member states.[53] It sets out Sustainable Development Goals (SDGs) for socially, ecologically and economically sustainable development through 2030.

The subsequent interdisciplinary literature has increasingly been shaped by the ecological pillar, in which the priority model ("strong sustainability") has gained growing support. On this view, ecology forms the absolute boundary ("planetary boundaries") within which social and economic systems must operate. This has, at times, made the model "blind" to the fact that environmental protection can itself exacerbate social inequality. This is precisely where the increasingly dominant discourse on "just transition" comes in, with its demand that the burdens of change be distributed fairly.[54]

c. Sustainability in relation to critical raw materials

With regard to the production of, and trade in, critical raw materials, the principle of sustainable development received relatively little concretisation in these instruments. Agenda 21 presupposes the principle more than it specifies it – for instance, in its call for better management of natural resources consistent with the require-

51 See, in overview, Mangani et al., Peace and Sustainability 1 (2025) 100017, 6 f.

52 It entered into force on 1 January 2016.

53 On just transition generally, see the relevant literature on distributive justice in the energy transition.

54 Pinenow/Pimenowa/Rembisz, Sustainability 18 (2026) 562, 2.

ments of sustainable development (Section I, Chapter 2.11). It otherwise remains at the level of calling for the liberalisation of trade in raw materials (Chapter 2.7), improved efficiency in production processes and in industry's overall resource and material consumption (Chapter 9.17), and, in Section II ("Conservation and Management of Resources"), for an integrated approach to planning and managing land resources, including mineral resources. Agenda 2030 brings no further clarification either. One can only observe that the production of, and trade in, critical raw materials touch on the Sustainable Development Goals relating to energy (SDG 7), industry (SDG 9), sustainable consumption and production (SDG 12), and climate action (SDG 13).[55]

In searching for possible concretisation, one encounters the Berlin Guidelines on Mining, adopted at an international symposium on "Environmental Management in Mining and Mineral Development" held in Berlin from 10 to 13 November 1991.[56] The aim was to establish environmental and social standards for mining. They were updated in 2002, with the involvement of UNCTAD (the United Nations Conference on Trade and Development), to strengthen their treatment of social and governance issues (the "Berlin II Guidelines for Mining and Sustainable Development").[57] Not least because of United Nations involvement, they can be regarded as international soft law.

The Berlin II Guidelines articulate fifteen fundamental principles for the mining sector and set out numerous facets of "good mining practice," covering all stages from extraction through processing to trade, and a life-cycle perspective spanning mine planning through to closure. Ultimately, however, they remain guidance for legislators rather than binding rules; as has rightly been observed, there is still "no benchmark for sustainable resource use."[58] Sustainable governance, in other words, still has to be given effect through law and regulatory instruments — a task that remains largely unaccomplished at the international level and only unevenly pursued at the national level, as the following sections show.

c. Standards for Critical Raw Materials

Beyond binding legal instruments, a range of voluntary standards has emerged to fill the gap left by weak hard law. These include industry codes and charters developed by mining associations, reporting frameworks such as the Global Reporting Initiative's sector-specific mining disclosures, and broader industrial sustainability guidelines that, while influential, are frequently drafted without specific reference to mining and therefore leave sector-specific risks inadequately addressed. Taken together, these standards illustrate both the potential and the limits of bottom-up governance: they can raise expectations and inform due-diligence practice, but — absent legal anchoring — they rarely bind the actors whose conduct poses the greatest risks.

III. Starting Points for Regulation from an Economic Perspective

An economic analysis of the production of, and trade in, critical raw materials[59] makes clear that this field is characterised by a variety of forms of "market failure"[60] and correspondingly by distinct challenges for state action.

With regard to domestic production, the market alone cannot capture the public-interest benefits of technological "spill-overs" or of scale economies. Nor can inadequate insurance markets and other transaction costs (for example, the retraining of workers) readily be compensated for through market mechanisms alone. It therefore makes sense to promote domestic production of critical raw materials through financial support mechanisms, funding for science and technology development, trade restrictions, or even direct state entrepreneurial activity.

With regard to the desired diversification and resilience of trade in critical raw materials, information asymmetries and associated information costs can first be identified: sustainability risks are frequently invisible within complex supply chains. There is also a risk of moral hazard, in that companies may concern themselves only with their own immediate supply chains. This justifies instruments such as state-mandated stockpiling, promotion of the circular economy, import quotas, or state information policy.

Finally, negative externalities arise because market prices do not reflect hidden social and ecological costs.

55 Jointly organised by the United Nations Department of Technical Co-operation for Development and the German Foundation for International Development (today GIZ).

56 See Bastida, MMSD No. 120, 2002, 6 ff.

57 Vesa (2025), 117: "no benchmark for sustainable resource use."

58 See Jakob et al., *The Economic Logic of Policies to Address Import Dependence in Clean Energy Goods*, 2025, 5 ff.

59 On the concept of market failure as applied to the instrumentation of state action generally, see Rodi, *Economic Analysis of Public Law,* 2022, 32 ff.

60 See on possible instruments Jakob et al., *The Economic Logic of Policies to Address Import Dependence in Clean Energy Goods*, 2025, 10 ff.

What instruments are available? Starting points for greater sustainability in the production of, and trade in, critical raw materials include:

- Improving production conditions.
- Increasing material efficiency.
- Building a circular economy — more recycling.

IV. Regulatory Trends in the Law of Critical Raw Materials at the National and Supranational Level

At the national level, there is, strictly speaking, no dedicated "law of critical raw materials"; rather, the legal framework is identical to the general law governing the extraction of mineral resources. These bodies of law are, for the most part, very old and are, for that reason alone, under considerable pressure for reform.

1. An illustrative overview of selected national legal orders

a. Germany

Ensuring a supply of critical raw materials such as lithium, cobalt and rare earths is essential for Germany as an industrialised nation, yet it remains only inadequately addressed by the classical, historically grown law of land and mining. Current raw-materials strategy requires a transformation away from mere resource availability towards a sustainable strategy resilient to crises, one that reconciles environmental protection with security of supply. Germany's Federal Mining Act (Bundesberggesetz, BBergG) dates in essence from an era in which resource security was understood in entirely different terms. Systematically, German mining law is built on a separation between land ownership and mineral resources not subject to that ownership ("bergfreie Bodenschätze"). Whoever holds an exploration permit ("Erlaubnis") may prospect; whoever holds a mining authorisation ("Bewilligung") may extract — independently of the will of the landowner, provided compensation is paid.

German mining law is, in many respects, regarded as outdated and in need of reform. This applies first to its strong focus on fossil fuels and construction materials. It lacks specific rules for the exploration and extraction of modern technology raw materials — for example, lithium extraction from deep geothermal brines. Permitting procedures are also criticised as excessively slow. The extraction of critical raw materials frequently comes into sharp conflict with environmental, nature-conservation and water-protection law. In practice, administrative procedures often take too long to allow a timely response to geopolitical shocks. Finally, German mining law does not sufficiently prioritise the extraction of strategic raw materials over other mineral resources. The BBergG is also often criticised as "pre-democratic," since public participation is only weakly developed compared with modern immission-control law. Ultimately, the idea of a circular economy is only inadequately reflected: classical mining law regulates the extraction of primary raw materials but barely addresses the use of secondary raw materials from recycling or legacy waste sites, which weakens the resilience of the domestic supply base.

German mining law — like that of other EU member states — has so far been only marginally affected by EU law. This is set to change considerably, as the CRMA now substantially overlays national mining law, above all with respect to procedural requirements and deadlines as well as substantive permitting standards.

Consequently, the approval of mining operational plans ("Betriebsplanzulassung") under the BBergG becomes, within the scope of the Regulation, a bound decision that in practice leaves virtually no room for planning discretion. The German legislature should, at the very least, clarify this point.[61] The approval decision will also now carry pre-emptive effect for expropriation purposes.[62] Even though the Regulation's impact on planning procedures has been softened compared with the Commission's original proposal, the German legislature should, in the context of the still-pending reform of mining law, at least consider whether to introduce dedicated raw-material demand planning.[63]

b. United States: the General Mining Act of 1872 — the gold-rush legacy

In the United States there is a sharp contrast between private and public land (federal lands), on which many critical raw materials are located. On public land, the principle of "free access" applies: whoever discovers a deposit (a "claim") may extract it without paying royalties to the state.[64]

American mining law is regarded as in need of reform in

61 So, correctly, Brückner/Marr, NuR 2024, 793 (800).

62 Brückner/Marr, NuR 2024, 793 (800 f.).

63 Gutmann, DVBl 2024, 1385 (1391).

64 See generally Meiners/Morriss, *Solving the Knowledge Problem in Natural Resources Law: Mining, Property Rights, and the Critical Minerals Challenge*, 2026.

several respects. Critics call for the introduction of royalties so that the state shares in the boom in critical raw materials. The 1872 Act also contains almost no provisions on land reclamation or environmental damage. Finally, many raw materials (for example lithium in Nevada) are located on indigenous land, where a modern legal framework for "free, prior and informed consent" (FPIC) is still lacking.

Under the current US administration (2025/26), the policy focus has shifted from climate protection towards a hard-edged national-security agenda. In February 2026, the administration launched "Project Vault," establishing a US Strategic Critical Minerals Reserve. The initiative is structured as a public-private partnership backed by a US $10 billion loan from the US Export-Import Bank (EXIM) together with roughly US $2 billion in private capital — an overall commitment of around US $12 billion — and is designed to protect US industry from price shocks and Chinese export restrictions by allowing participating companies to secure minerals at fixed prices. The reserve covers the 60 minerals on the US Geological Survey's critical-minerals list, with initial emphasis on rare earths. Alongside Project Vault, the administration launched the Forum on Resource Geostrategic Engagement (FORGE) at a Critical Minerals Ministerial in Washington in early February 2026, bringing together more than fifty countries and signing new bilateral critical-minerals frameworks with a number of partner states — underscoring a broader shift from multilateral rulemaking towards bilateral, security-driven arrangements.

c. China: technological protectionism

Like other areas of Chinese law and policy, Chinese mining law is shaped by the principle of central state planning.[65] The system is traditionally based on the principle of state ownership: all mineral resources belong to the state, irrespective of who owns the surface land. A two-tier system of rights strictly distinguishes between the right to prospect (exploration) and the right to extract. The allocation of exploration and mining rights is administered by the Ministry of Natural Resources (MNR).

Chinese mining law is currently undergoing a historic transformation. The recent reform responds directly to global geopolitical tensions and to China's goal of technological self-sufficiency. The foundational Mineral Resources Law, essentially unchanged since 1986, was comprehensively revised on 8 November 2024 and entered into force on 1 July 2025.[66] China is thereby regulating not merely the raw material itself but, increasingly, the associated know-how. Since late 2025, extraterritorial controls have applied: products manufactured abroad using Chinese technology or equipment are, in certain cases, subject to Chinese export restrictions. This forces Western companies to build entirely independent processing chains of their own. China now maintains lists of "strategic minerals" (currently 24 categories, including rare earths, lithium and cobalt) subject to particularly strict state quotas and controls. The reform aims at security of supply through strategic reserves, with the state able to steer both production and stockpiling. While the allocation of rights has been made more competitive, oversight of the supply chain has simultaneously been tightened. Environmental protection has become a statutory obligation under the banner of "green mining." Specific export licences were also introduced in 2025 to safeguard China's market power.

Update: implementation of the revised law has continued into 2026. The State Council approved an implementing Regulation on 9 May 2026 (State Council Order No. 839, signed by Premier Li Qiang on 15 May 2026), which entered into force on 15 June 2026. The Regulation operationalises Chapter V of the revised law on "Mineral Resource Reserves and Emergency Response," establishing a framework for a national strategic-mineral stockpiling system combining physical product reserves, production-capacity reserves and in-situ (origin) reserves, coordinated by the relevant authorities on the basis of periodically updated reserve plans and stockpiling targets. Existing exploration and mining licences issued before 1 July 2025 remain valid for their original term, while a number of older administrative rules are repealed as of the Regulation's entry into force.

d. Brazil

The legal basis remains the Mining Code of 1967, albeit substantially amended by recent legislation. Under the federal constitution, mineral resources belong to the Union (the state). Private companies are granted concessions for exploration and extraction. Mining rights are separate from land ownership; if a mining company cannot reach agreement with a landowner, it may apply to a court for a mining easement ("servidão mineral") to secure access. Royalty rates (CFEM) generally range between 1% and 3.5%, depending on the mineral. Landowners have a statutory claim to 50% of the royalties paid to the state.

Brazil's mining sector has undergone a significant shift since 2026. The traditional focus on bulk commodities (such as iron ore) has given way to a more sophisticated industrial policy centred on critical and strategic min-

65 See Wang et al., Sustainability 17 (2025), 1 (8): Implementation Plan for the Mineral Prospecting Action under the 14th Five-Year Plan, as of 2023.

66 See further Li et al., Mineral Economics (2025), doi.org/10.1007/s13563-025-00546-2.

erals for the global energy transition.[67] The legal landscape is shaped by the tension between state ownership of mineral resources and the drive to attract private investment, with primary responsibility resting with the National Mining Agency (ANM).

In late 2025 and early 2026, Brazil adopted several significant legislative and regulatory changes to accelerate the development of resources such as lithium, nickel, copper and rare earths:

- •Law No. 2,780/2024 (Critical Minerals Law): this landmark law, which entered into force in 2026, introduced the National Policy for Critical and Strategic Minerals (PNMCE). It explicitly shifts the focus from mere extraction towards "integrated industrial development," offering incentives to companies that refine and process minerals within Brazil.
- National Council for Mining Policy (CNPM): established in October 2025, this council serves as the sector's highest decision-making body, coordinating cooperation between the federal government and the states to reduce "regulatory overlap" and set national priorities.
- National Mining Plan 2025–2050: this new strategy replaces the outdated plan for 2030 and organises the sector around three pillars: sustainability, governance, and geological mapping.

2. The EU legal framework

a. The EU Critical Raw Materials Act (CRMA)

The EU Critical Raw Materials Act (CRMA) has been in force since May 2024[68] and is being substantially reinforced through new instruments in 2026. This forms part of a broader shift towards an EU industrial policy aimed at strengthening key sectors at the forefront of the green and digital transformations, as well as defence production, on the basis of "strategic autonomy." Industrial policy can be defined as state policy that "explicitly aims at reshaping the structure of the economy in order to achieve a particular public goal."[69] The EU's Critical Raw Materials Act focuses on five key areas.

First, it sets priorities and clear targets for strengthening EU policy on critical raw materials:

- Extraction: at least 10% of domestic consumption should come from EU sources.
- Processing: at least 40% of refining should take place within the EU.
- Recycling: at least 25% of demand should be met from secondary raw materials.
- Diversification: no more than 65% of any given raw material may come from a single third country.

The European Court of Auditors' criticism that these targets are not genuinely derived from a scientific methodology is well taken.[70] There is nonetheless broad agreement that the targets are ambitious.

The CRMA codifies the list of critical raw materials and introduces a new list of strategic raw materials. It aims to strengthen the EU's own extraction, processing and recycling capacity for strategic raw materials and to steer diversification efforts. These benchmarks set minimum shares for EU-based extraction, processing and recycling of strategic raw materials, as well as ceilings on dependence on any single third country for those materials. Under Art. 173(2) TFEU, industrial policy remains a shared competence between the EU and its member states. Unlike the EU Climate Law (Regulation (EU) 2021/1119), which legally binds the EU to net-zero by 2050, the CRMA's targets cannot be legally challenged if they are missed.[71] The EU can support, coordinate or supplement national efforts, but it cannot adopt legislation obliging member states to meet specific production or recycling quotas. Instead, the European Critical Raw Materials Board – a novel governance body established under Art. 35 CRMA – is tasked with monitoring progress, advising on project selection, and proposing further measures where progress lags. Its powers, however, are advisory rather than executive, which limits the EU's ability to intervene in member states that fall behind.

Second, the Act introduces measures to strengthen capacity for strategic raw materials. Chapter III of the Regulation, which – as its heading indicates – is devoted to strengthening the value chain for strategic raw materials, sets out in Section 2 the criteria for recognising strategic projects, the recognition procedure, and measures to accelerate implementation. Under Art. 10(1) CRMA, strategic projects are presumed to contribute to securing the Union's supply of critical raw materials – thereby codifying the particular weight such projects carry for the public interest in security of supply as a balancing

67 Mindreau, The Extractive Industries and Society 24 (2025), 101723, on the origins of Brazilian industrial policy in this field.

68 Kassem/Major, The Foundation Journal for Natural Resources & Energy Law 62 (2025), 329 (339 ff.); for an interdisciplinary assessment, see Hale et al., Global Sustainability 8 (2025), e25; see also Accompanying Communication COM(2023) 165 final.

69 Juhász/Lane/Rodrik, Annual Review of Economics 16 (2024), 213 (224 ff.).

70 European Court of Auditors, Special Report 04/2026, 2026, 31 ff.

71 Kassem/Major, The Foundation Journal for Natural Resources & Energy Law 62 (2025), 329 (340).

directive. Under Art. 9(1) CRMA, member states must designate one or more single points of contact; however, the Commission's original proposal for full procedural concentration (a genuine "one-stop shop") was abandoned. Art. 11 CRMA sets maximum permitting timeframes of 27 and 15 months respectively – genuinely ambitious targets[72] – though these, too, were softened relative to the Commission's original proposal.[73] In particular, the Regulation dispensed with a deemed-approval mechanism for cases where deadlines are missed (as had still been provided for in Art. 10(4) of the Commission's proposal). Also dropped was the Commission's proposal for a "comprehensive decision" by the national authority (Art. 9(7) of the Commission's proposal) – that is, a genuinely concentrated, single-decision authorisation.[74] The requirements concerning planning levels were particularly significantly diluted in the final Regulation. Under the Commission's proposal (Art. 12(1)), member states would still have had to ensure that national, regional and local authorities responsible for drawing up plans – including land-use, spatial-planning and zoning plans – included, where necessary, provisions for the development of critical-raw-materials projects in those plans. This was downgraded in Art. 13(1) CRMA to a mere obligation to review. It seems unlikely that this will lead to any significant legal strengthening of domestic extraction.[75]

Only the second half of the Regulation (from Art. 19 onward) contains provisions applicable to both strategic and critical raw materials. These concern, in particular, circular-economy rules and the efficient use of raw materials, by creating value chains for recycled materials and requiring operators and EU member states to improve the recovery of materials from products and waste placed on the EU market.

Finally, the Regulation establishes a joint administrative structure to monitor implementation and enforcement of its provisions. In early 2026, the Commission set out plans to establish a European Critical Raw Materials Centre as the "brain" of EU raw-materials policy, tasked with running stress tests, coordinating strategic stockpiling and steering investment. As of mid-2026, the Centre remained at the proposal and consultation stage – the Commission launched a call for evidence in the first half of 2026 and set out a legislative proposal in the RESourceEU Action Plan of 3 December 2025 (see immediately below) – rather than being fully operational; its establishment "from 2026" is intended, modelled in part on Japan's JOGMEC, to build systemic market intelligence, steer de-risking finance to priority projects, and support joint purchasing and stockpiling through the new Raw Materials Mechanism under the EU Energy and Raw Materials Platform.

b. The new architecture of European raw-materials sovereignty

The EU's raw-materials strategy reached a new level of maturity in 2026. While the CRMA forms the regulatory foundation, the strategy only becomes operational through a highly complex web of financing instruments, trade law and circular-economy measures.

A central pillar of this architecture is the RESourceEU Action Plan, adopted by the European Commission on 3 December 2025. This instrument serves as a financial catalyst intended to make the CRMA's ambitious extraction targets – in particular, the goal of covering at least 10% of annual strategic-raw-material consumption from domestic extraction by 2030 [76]– achievable in practice. With a budget of roughly €3 billion for 2026 (comprising around €2 billion from the European Investment Bank, €300 million from the Battery Booster programme and €600 million from Horizon Europe), the plan addresses the significant market risk associated with mining projects and aims to accelerate strategic projects with the potential to reduce dependency on any single country by up to 50% by 2029. A prominent example is the lithium mine at Zinnwald (Czech Republic), where EU funding supports not only technical development but also the deployment of state-of-the-art, low-water extraction methods intended to secure local acceptance and reduce dependence on Chilean or Australian imports.

In parallel, under the banner of "green trade," the EU is undertaking a paradigm shift in its external trade policy. By 2026, sustainability is no longer a mere rhetorical commitment but a hard criterion for market access. The EU is deliberately using environmental and social standards as a regulatory instrument to displace cheap imports from unsustainable sources – often produced in disregard of environmental requirements – from the internal market.[77] This is particularly evident in the now fully applicable EU Battery Regulation, under which companies are legally required to demonstrate the specific carbon footprint of batteries and full compliance with human-rights due diligence across the entire value chain – from the mine in the Democratic Republic of the Congo to the recycling facility in Europe.[78] The digital battery passport serves as the technical backbone of this system, ensuring that only batteries that withstand rigorous due-diligence checks are placed on the market.

72 Gutmann, DVBl 2024, 1385 (1386).

73 Brückner/Marr, NuR 2024, 793 (797).

74 Brückner/Marr, NuR 2024, 793 (796).

75 So, correctly, Brückner/Marr, NuR 2024, 793 (798).

76 Recital 11, Art. 5(1)(a), Regulation (EU) 2024/1252.

77 See, e.g., Recital 15, Regulation (EU) 2023/956; Recital 18, Regulation (EU) 2023/1115.

78 Regulation (EU) 2023/1542 on batteries and waste batteries, in particular Art. 7 (carbon footprint) and Art. 48 (due-diligence obligations).

This protective framework is complemented by the ongoing debate over a significant extension of the Carbon Border Adjustment Mechanism (CBAM). Originally designed for sectors such as steel and cement, member states are pressing in 2026 to extend CBAM to critical minerals such as lithium and nickel as well.[79] The logic is compelling: producers of raw materials with a high carbon footprint (for example, due to coal-fired refining) would have to pay a financial surcharge on import into the EU corresponding to the prevailing price under the EU Emissions Trading System. This is intended to prevent carbon leakage and to protect European producers that have already invested in climate-neutral processes.

The circle is closed by the EU's circular-economy strategy, which is increasingly taking on protectionist features aimed at safeguarding strategic resources. From the second quarter of 2026, strict export restrictions apply to waste containing permanent magnets. These magnets, which often contain neodymium and dysprosium, are indispensable for wind power and electromobility. By classifying such waste as a strategic secondary raw material, the EU aims to prevent valuable material from flowing to third countries, where recovery rates are often low.[80] This form of "urban mining" is intended to help Europe become the world's leading producer of recycled rare-earth magnets, structurally reducing its dependence on primary imports – predominantly from China.

V. Outlook

The trajectory outlined above raises more questions than it resolves. Whether the emerging patchwork of hard law, soft standards and industrial policy can converge into a coherent, genuinely sustainable law of critical raw materials – or whether fragmentation and geopoliticisation will instead deepen – remains, at this stage, an open question that will need to be revisited as the CRMA's implementation and the new instruments described above unfold in practice.

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