POLICY BRIEF

Equitable Critical Mineral Value Chains: Developing Production and Technological Capabilities in the Global South Through South–South–North Cooperation

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Accelerating Climate Action and the Just Energy Transition

Abstract

The urgent need to accelerate the global energy transition, vital for achieving climate goals, will significantly increase demand for a range of 'critical' minerals. For example, by 2040, lithium demand is projected to grow nearly ninefold, driven by expanding EV battery production, while graphite demand – key for battery anodes – is expected to nearly quadruple. Copper consumption is also poised to nearly double, due to its critical role in electrical conductivity.

As demand rises, new economic opportunities emerge for resource–rich countries in the Global South. However, there is a risk of missing the window of opportunity to develop production and technological capabilities. The high global demand for minerals, within a context of asymmetric relationships between countries specialised in mining activities and those with consolidated positions in downstream segments of the value chain, as well as with end-user countries, pushes the former ones to export raw materials with low value–added processing.

Many Global South countries have sought to move beyond extractivism by developing production linkages with mining activity – whether backward, forward, or sidestream. While there have been some notable successes, most mineral–rich countries in the Global South continue to face significant obstacles. These include limited technological capabilities, the absence of close large–scale electromobility markets, high concentration in the more advanced segments of the value chain, restrictive trade barriers in key export destinations, and the predominance of foreign capital ownership.

This policy brief proposes measures to advance just transition–aligned critical mineral value chains through international cooperation oriented towards developing production and technological capabilities in resource-rich countries of the Global South. In particular, we suggest: (i) adopting shared principles and standards for mineral value chain governance; (ii) establishing a roadmap for technology collaboration and R&D cooperation; (iii) and calling for action to address trade barriers limiting value addition in Global South, supply–side countries. These recommendations prioritise supporting Global South efforts and global stability, benefitting both resource–rich and mineral–demanding countries. Fostering production and technological capabilities in resource–rich countries is in the interest of diverse G20 members as it contributes to the augmentation of global economic and political stability – core to the G20's original mandate.

Keywords: Critical Minerals Value Chains, Just Transition, South–South–North cooperation, Mineral Beneficiation, Production Linkages

Introduction

The urgent need to accelerate the global energy transition has been a key concern for recent G20 presidencies, driven by the Energy Sustainability Working Group since 2013. The previous three presidencies emphasised the need for international cooperation to achieve energy transition goals in line with the Paris Agreement.[1]

South Africa's presidency continued this approach by prioritising 'just, affordable, and inclusive energy transitions'[2]. Moreover, it has centred the role, significance, and potential of minerals deemed 'critical', 'strategic', or 'super-critical' for the transitioning global economy, and notably the energy transition within it.[3] Critical minerals are decisively framed within just transitions.[4]

'Justice' – encompassing equity, sustainability, and economic development – is not supplemental to the transition, but key to its implementability, particularly, but not only in Global South countries[5]. Relatedly, Brazil's (2024) presidency emphasised energy's connection to global supply chains, supporting diversified, sustainable, and responsible supply chains for energy transitions, including critical

[1] Indonesia's (2022) presidency focused on 'advancing renewable energy through international partnerships', India's (2023) presidency prioritized links to sustainable consumption and 'green innovation through South-South cooperation', and Brazil's (2024) presidency endorsed the New Compact for a Just and Inclusive Global Energy Transition. See G20 South Africa 2025, Energy Transitions Working Group, *Sherpa Track, Issue Note*, December 2024, https://g20.org/wp-content/uploads/2024/09/G20-ETWG-Issue-Note_30-January-2025.pdf (accessed March 28, 2025).

[2] G20 South Africa 2025, Energy Transitions Working Group, *Sherpa Track, Issue Note*, December 2024, https://g20.org/wp-content/uploads/2024/09/G20-ETWG-Issue-Note_30-January-2025.pdf (accessed March 28, 2025)

[3] South Africa's G20 presidency has set as expected outcomes for this Summit a 'G20 pact on beneficiation at the source of critical minerals required for energy transitions', as well as delineating 'beneficiation of critical minerals at source principles'. See G20 South Africa 2025, Energy Transitions Working Group, *Sherpa Track, Issue Note*, December 2024, https://g20.org/wp-content/uploads/2024/09/G20-ETWG-Issue-Note_30-January-2025.pdf (accessed March 28, 2025).

[4] G20 South Africa 2025, *Sherpa Track, Concept Note*, Energy Transitions Working Group (February 2025), https://g20.org/wp-content/uploads/2024/09/Annexure-C-Concept-Note-2025-South-African-ETWG_Final-Version-04.pdf (accessed April 3, 2025).

[5] G77 and China, *G77 and China Submission on Views towards Discussion Topic of the Second Dialogue under the UAE Just Transition Work Programme* (September 2024), https://www4.unfccc.int/sites/SubmissionsStaging/Documents/202410020924---G77%20and%20China%20Submission%20on%20Views%20on%20the%202nd%20Dialogue.pdf (accessed April 3, 2025).

minerals.[6] In this context, a just transition entails ensuring that mineral-rich countries in the Global South have a meaningful opportunity to create value locally through the processing and transformation of their resources. The G20 is a platform that convenes supplier and buyer countries together, reflective of a diversity of interests and market actors, and expanding the possibility for international cooperation beyond state actors, encompassing financial, business, knowledge, and civil society actors, through modalities such as frameworks, action plans, and technical outputs across several dimensions of economic cooperation.

Diagnostic

With the notable exception of China, the interests of countries on the supply and demand–sides of minerals markets and global value chains are often disconnected. This is reflected in geo–economic dynamics that relegate Global South, supply–side countries to positions of limited value addition and capture.

The need to scale up and accelerate the transition will significantly increase demand for critical minerals. Illustratively, the European Commission (2024) projects that lithium demand will increase nearly ninefold by 2040, driven by expanding EV battery production, while graphite demand – key for battery anodes – is expected to nearly quadruple.[7] Copper consumption is also poised to nearly double, due to its critical role in electrical conductivity.[8]

[6] G20 Brazil 2024, *G20 Rio de Janeiro Leaders' Declaration*, November 19, 2024, https://g20.gov.br/en/documents/g20-rio-de-janeiro-leaders-declaration (accessed March 29, 2025).

[7] European Commission, *Future Demand for Raw Materials in Emerging Technologies – A Global Perspective*, https://rmis.jrc.ec.europa.eu/futuredemand (accessed March 31, 2025).

[8] Copper is essential for the energy transition due to its high conductivity, durability, and efficiency in electrical applications. It is a key material in renewable energy systems (solar, wind, hydro), electric vehicles (EVs), and energy storage. EVs require 2–4 times more copper than conventional cars, while renewable power grids depend on extensive copper wiring. See International Copper Association, *The Electric Vehicle Market and Copper Demand* (June 2017), https://internationalcopper.org/wp-content/uploads/2017/06/2017.06-E-Mobility-Factsheet-1.pdf (accessed April 2, 2025).

As demand rises for these and several other minerals, new economic opportunities emerge for resource-rich countries of the Global South, which could leverage these resources for sustainable development. There is a risk, however, of missing the current window of opportunity to develop production and technological capabilities that enable value-addition at the domestic level. Juxtaposed with this potential, currently, the high global demand for minerals pushes these countries to export raw materials with low value-added processing, given the context of asymmetric relationships between countries specialised in mining activities and those with consolidated positions in downstream segments of the value chain, as well as with end–user countries.

Many Global South, supply–side countries have sought to move beyond extractivism by developing backward, forward, or sidestream linkages. Despite some notable successes, most of them still have faced major obstacles.[9] These include limited technological capabilities, the absence of close large–scale electromobility markets, high concentration in the more advanced segments of the value chain, restrictive trade barriers in key export destinations, and the predominance of foreign capital ownership.[10]

Downstream activities pose significant challenges, as the relative weight of the mineral resource within the final product is lower than in upstream and midstream

[9] South Africa has developed backward, forward, and sidestream linkages, ranging from capital equipment and machinery to manufacturing, services, and research and development. Similarly, Morocco has drawn substantial investment, both domestic and international, into the beneficiation of phosphate and the production of fertilizers. India is also a top mineral beneficiator. See Gaylor Montmasson-Clair, Lauren Hermanus, and Anthony Dane, *Navigating the African Opportunity Landscape for Value Chain Upgrading in the Global Scramble for Critical Minerals* (Southern Transitions, October 2024), https://static1.squarespace.com/static/66d875be45741e71e207c640/t/673221fd37f3ea6910235ef5/1731338763934/ST_2024_Paper_Critical_Minerals_Africa_Opportunty_Landscape.pdf (accessed April 5, 2025).

[10] Other domestic constraints – such as limited institutional capacity, lack of policy coherence, and coordination failures – can also significantly hinder the development of productive linkages and the strengthening of local capabilities. For an in-depth case study on Argentina, see Martín Obaya, Carlos Freytes, and Victor Delbuono, "Driving Regional Development through Critical Minerals: A Case Study of the Lithium Policy Mix in Argentina," *Mineral Economics*, published August 27, 2024, https://link.springer.com/article/10.1007/s13563-024-00458-7 (accessed March 27, 2025).

segments and the production processes are far more technologically complex.[11] Most supply–side countries have limited capabilities to manufacture these kinds of products at competitive costs.[12] Crucially, the existence and control of large–scale electromobility markets that drive demand for these products from close consumption centres is a necessary condition for the emergence of a competitive battery cell industry.

A viable option is to focus on the upstream and midstream segments.[13] In this case, the relative economic weight of the resource is much greater than in downstream activities, and some countries have successfully localised beneficiation processes.[14] However, this approach also faces relevant challenges, as most countries usually lack necessary technological capabilities.[15] A key constraint is the concentration of intellectual property, with most patents on climate technologies held by China and a few Global North countries.[16] This restricts access to critical technologies in the Global South.[17] Moreover,

[11] For instance, while lithium is a critical input for battery cell production, its relative economic weight within the battery – and even more so within the final product – is significantly lower than in upstream and midstream activities, where the mineral resource constitutes the primary input.

[12] Martín Obaya, Andrés López, and Paulo Pascuini, "Curb Your Enthusiasm: Challenges to the Development of Lithium-Based Linkages in Argentina," *Resources Policy*, March 2021, https://www.sciencedirect.com/science/article/abs/pii/S0301420720309430 (accessed March 26, 2025).

[13] In the case of the South American 'lithium triangle', for instance, there is considerable room for technological innovations that enhance mineral extraction efficiency, enabling greater rent capture. See Martín Obaya and Mauricio Céspedes, *Análisis de las redes globales de producción de baterías ion-Litio* (Santiago: CEPAL, 2021), https://repositorio.cepal.org/entities/publication/7270e26d-1d65-47e3-88f0-ca615f1d49b3 (accessed March 25, 2025).

[14] Chile and Argentina, for instance, already produce lithium compounds rather than exporting unprocessed raw material. These experiences demonstrate that local beneficiation is technically feasible and already happening in some contexts.

[15] Martín Obaya and Mauricio Céspedes, *Análisis de las redes globales de producción de baterías ion-Litio* (Santiago: CEPAL, 2021), https://repositorio.cepal.org/entities/publication/7270e26d-1d65-47e3-88f0-ca615f1d49b3 (accessed March 25, 2025).

[16] Japan, the EU, the USA, South Korea, and the UK accounted for 83% of these patents between 2010 and 2019. In recent years, China has emerged as a leading innovator, with over 15% of climate chang–related patents in 2020. See Gaylor Montmasson-Clair, Lauren Hermanus, and Anthony Dane, *Navigating the African Opportunity Landscape for Value Chain Upgrading in the Global Scramble for Critical Minerals* (Southern Transitions, October 2024), https://static1.squarespace.com/static/66d875be45741e71e207c640/t/673221fd37f3ea6910235ef5/1731338763934/ST_2024_Paper_Critical_Minerals_Africa_Opportunty_Landscape.pdf (accessed April 5, 2025).

[17] Although patents represent codified knowledge protected by intellectual property regimes, much of the expertise in mineral beneficiation remains tacit, experiential, or embedded in organizational routines. Consequently, patents do not constitute insurmountable barriers, but other domestic constraints, such as weak mechanisms for the participation of

technological advancement depends heavily on robust R&D investments and strong coordination between firms, governments, and the scientific community.[18]

Additionally, the development of backward, sidestream, and forward linkages is further constrained by market concentration, trade barriers, and the predominance of foreign capital ownership. Mining countries often face challenges from China's dominant refining capacity, limiting their ability to move up the value chain.[19] Furthermore, they also hit against Global North protectionist re–shoring and friend–shoring strategies. For instance, vehicles and batteries that come from outside the EU or the UK face a 10% tariff at either the EU or the UK border.[20] At the same time, the US government links green technology subsidies to the provenance of the minerals involved in their manufacture.[21] Moreover, Global North's sourcing initiatives often bypass resource rich countries' concerns on local industrialization[22], even going so far as to characterising these as a risk.[23]

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domestic stakeholders in knowledge creation and diffusion processes, can impede the development of production capabilities.

[18] Martín Obaya and Mauricio Céspedes, *Análisis de las redes globales de producción de baterías ion-Litio* (Santiago: CEPAL, 2021), https://repositorio.cepal.org/entities/publication/7270e26d-1d65-47e3-88f0-ca615f1d49b3 (accessed March 25, 2025).

[19] According to the International Energy Agency (2024), China accounts for 65% of refined lithium and over three-quarters of batteries sold globally. Besides, it controls 28% of refined nickel supply, 77% of refined cobalt supply, 77% for rare earth elements, and 92% for copper refining. International Energy Agency, *Critical Minerals Dataset*, last updated in May 2024, https://www.iea.org/data-and-statistics/data-product/critical-minerals-dataset (accessed April 3, 2025).

[20] European Parliament, *EU – UK Rules of Origin for Electric Vehicles and Batteries*, February 2024, https://www.europarl.europa.eu/RegData/etudes/ATAG/2024/757643/EPRS_ATA(2024)757643_EN.pdf (accessed March 23, 2025).

[21] To qualify for electric vehicle tax credits, at least 80% of the market value of the critical minerals in the battery must be sourced domestically or from US free-trade partners. See Jenna N. Trost and Jennifer B. Dunn, "Assessing the Feasibility of the Inflation Reduction Act's EV Critical Mineral Targets," *Nature Sustainability*, March 6, 2023, https://www.nature.com/articles/s41893-023-01079-8.pdf (accessed March 5, 2025).

[22] Obaya and Murguía (2024) points out that the European Batteries Regulation (2023) does not include provisions supporting local industrialization in lithium–mining countries. However, bilateral agreements, such as the Memorandums of Understanding (MoU) with Chile (2023) and Argentina (2023), does. See Diego Murguía and Martín Obaya, "Exploring Conditions for Just Lithium Mining in South America: The Case of the EU Responsible Sourcing Strategy," *Environmental Research Letters*, December 5, 2024, https://iopscience.iop.org/article/10.1088/1748-9326/ad948d/pdf (accessed March 25, 2025).

[23] Some policy initiatives aimed at mitigating such a perceived risk deliberately leverage geopolitical and market asymmetries, as is the case of the EU Clean Industrial Deal's Critical Raw Material Centre. The EU Critical Raw Material Centre's goal is to jointly purchase raw materials on behalf of interested companies, intending to negotiate 'better prices and conditions'. See European Commission, "The Clean Industrial Deal: A joint roadmap for competitiveness and decarbonisation", Communication from the Commision, February 26, 2025,

Finally, most of the mineral resources located in the Global South are under foreign control. For instance, while the Democratic Republic of Congo (DRC) mining facilities account for 66% of the world's cobalt extraction, European and Chinese companies each own a third of the supply.[24] DRC–owned companies account for less than 5% of production.[25] While the foreign ownership is not an insurmountable obstacle to the development of production capabilities,[26] it poses an additional challenge as mining companies usually locate their R&D activities abroad and tend to forge global contracts supplier networks rather than local ones.[27]

Recommendations

The challenges identified in the above diagnostic can only be addressed through cooperation that, first, connects the inadequately considered shared concerns, risks, and opportunities facing supply–side countries (generally, South–South), and second, addresses these within the same framework as those of demand–side

https://commission.europa.eu/document/download/9db1c5c8-9e82-467b-ab6a-905feeb4b6b0_en?filename=Communication%20-%20Clean%20Industrial%20Deal_en.pdf (accessed March 31, 2025).

[24] International Energy Agency, *Global Mineral Outlook 2024*, May 2024, https://iea.blob.core.windows.net/assets/ee01701d-1d5c-4ba8-9df6-abeeac9de99a/GlobalCriticalMineralsOutlook2024.pdf (accessed April 2, 2025).

[25] To give more examples, although the majority of copper production occurs in Chile, European companies are the leading copper producers with over 10% of production, with US companies controlling the second-largest amount of production. Additionally, although Indonesia is the leading location of nickel mining, local companies hold less than 10% of production: Chinese companies are the major nickel mine owners, accounting for around 40% of production, while European companies also have a sizeable share (over 20%). Source: International Energy Agency, *Global Mineral Outlook 2024*, May 2024, https://iea.blob.core.windows.net/assets/ee01701d-1d5c-4ba8-9df6-abeeac9de99a/GlobalCriticalMineralsOutlook2024.pdf (accessed April 2, 2025).

[26] It is worth noting that there are examples – such as Indonesia – that show progress in promoting downstream activities even with a large presence of foreign firms. Also, Chile has experimented with policy tools like the 25% lithium quota to incentivize local value addition. Similarly, both SQM (Chile) and YLB (Bolivia) are domestically owned or have significant domestic participation, yet this has not automatically translated into greater local value capture or technological upgrading. Ownership matters, but it is not the only factor, and proactive and well-designed policy frameworks can also play a critical role in shaping outcomes. Domestic industrial policies have a relevant role in fostering downstream linkages, regardless of the national origin of capital.

[27] Korinek (2020:1) points out that the main providers of services to mining firms – including R&D activities – 'are often not located in mineral-rich countries' and that mining firms 'rely to a greater extent on foreign inputs to produce and add value to their exports'. This effect is higher in lower-middle income countries than in higher income ones. See J. Korinek, *The Mining Global Value Chain* (Paris: OECD Publishing, January 14, 2020), https://www.oecd.org/en/publications/the-mining-global-value-chain_2827283e-en.html (accessed April 4, 2025).

countries (South–North). Such a framework should therefore reflect South–South–North interests and opportunities for a more equal distribution of benefits and burdens, in line with just transitions at international and domestic scales. Below, we identify governance, innovation, and trade as three intervention points for international cooperation.

1. Adopt shared principles and standards for mineral value chain governance

A globally-agreed governance framework can help tackle some of the aforementioned interconnected challenges by fostering international cooperation and coordination. It should establish common principles and standards on technology collaboration and R&D cooperation, ESG issues, fair benefit strategies, and fair trade practices. Importantly, it must place justice at its core, supporting upgrading and enabling value capture in resource-rich countries. Such an approach is not only vital for the development prospects of these countries, but also for building more resilient, sustainable, and secure global supply chains, and contributing to economic stability in a climate resilient world.

2. Establish a roadmap for innovation, technology, and skills exchange and cooperation

Beyond an overall governance framework, a specific roadmap for technology collaboration and R&D cooperation is needed.[28] While technology collaboration initiatives exist, they have been sporadic and mostly on a North-North or asymmetrical North-South basis.[29] International cooperation enabling more

[28] Findings from a Delphi survey on the lithium battery value chain suggest that technological collaboration between lithium-producing and importing countries is a key condition for promoting justice throughout the chain. See Martín Obaya, Diego Murguía, Carlos Freytes, and Tomás Allan, *A Just and Sustainable Lithium Battery Value Chain. Delphi Survey – Executive Report, Green Dealings Project* (Genève: Centre for International Studies, Geneva Graduate Institute (IHEID), June 2023), https://green-dealings.com/download/1119/?tmstv=1716795821 (accessed March 20, 2025).

[29] In the case of lithium, these cases include bilateral agreements such as Australia–United States Climate, Critical Minerals, and Clean Energy Transformation Compact and Australia–Canada agreements. See Eduarda Zoghbi, Lilly Lee, Pranati Kohli, Vicente Loyola, and William Tobin, *Creating Value for the Critical Minerals Supply Chain in Latin America* (T20 Brazil 2024, 2024), https://www.t20brasil.org/en/pbs (accessed March 23, 2025).

mutually beneficial partnerships are needed on this matter, connecting supplier countries to one another and to centres of demand through South–South–North configurations.[30]

Joint scientific projects could contribute to generating production and technological capabilities by enabling knowledge-based exchange and gaining investment scale[31]. Making mineral R&D a G20 goal, with guiding principles, could foster such cooperation. The success of such a framework hinges on the realistic and effective integration of public and private sector incentives and actions.

3. Call for action to address trade barriers limiting value addition in Global South, supply-side countries

Tariff and non-tariff trade barriers often restrict exports and limit the ability of mineral-endowed countries in the Global South to move into higher value-added activities. These barriers frequently reinforce structural asymmetries in global trade, preventing these countries from capturing a greater share of value. The G20 should issue a call to review, adjust, monitor, and prevent such trade barriers, with particular attention to high tariffs, tariff peaks, and tariff escalation. Addressing these obstacles is essential to support local industrial development, attract investment, and enable broader participation of the Global South in mineral-based value chains aligned with global sustainability goals.[32]

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[30] As a reference, Zambia and the Democratic Republic of Congo, two copper-producing countries, are exploring the establishment of a Transboundary Battery and Electric Vehicle industry Special Economic Zone, a joint initiative aiming to produce battery precursors and batteries for electric cars. See UN Economic Commission for Africa, *Zambia and DRC to Implement an Innovative Transboundary Battery and Electric Vehicle Special Economic Zone*, April 15, 2024, https://www.uneca.org/stories/zambia-and-drc-to-implement-an-innovative-transboundary-battery-and-electric-vehicle-special (accessed April 2, 2025).

[31] In the case of South America's 'lithium triangle', joint cooperation programs may include projects to increase efficiency and reduce processing times for lithium compounds or to study salt flats and identify new economically viable deposits.

[32] On the other hand, in their seeking to move away from extractivism and add value at the local level, some Global South countries have implemented export barriers. Indonesia, which accounts for 59,5% of the global nickel supply, has banned the export of unprocessed nickel ore, while Philippines, which accounts for 9% of the same mineral, plans to follow this path. Guinea, which supplies 32% of the world's bauxite, plans to prohibit the export of unprocessed bauxite. A meaningful dialogue on export restrictions from resource-rich countries must be preceded by a critical reassessment of existing import barriers, which often constrain their ability to pursue value addition and green industrial strategies.

The proposed measures prioritise creating global frameworks that are supportive of Global South efforts as well as global stability, benefitting both supply–side and demand–side countries. Aside from opening development opportunities for developing countries that have to deal with pressing socio-economic needs, they would enable more secure supply chains, scale up the supply of minerals and green technologies, and manage common risks across regions. Therefore, fostering production and technological capabilities in resource–rich countries is in the interest of diverse G20 members as it contributes to the augmentation of global economic and political stability – core to the G20's original mandate.

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