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THE INVISIBLE MATERIALITY OF AI: GOVERNING THE RESOURCES, PROCESSING CAPACITY, AND INFRASTRUCTURE BEHIND THE AI STACK

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ADVISORY COUNCIL

The Invisible Materiality of AI: Governing the Resources, Processing Capacity, and Infrastructure Behind the AI Stack

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1. The Material Foundations of AI

AI is often discussed as if it were weightless: algorithms, models, data, and applications operating in an increasingly digital economy. It is not. Every AI system rests on a physical stack of minerals, advanced semiconductors, energy, data centers, connectivity, and computing capacity. Yet, these material foundations remain peripheral to global AI governance.

This matters because vulnerability is not determined simply by where critical resources are found, but also by where they are processed, refined, and transformed into technologically useful inputs. Rare earth elements (REEs) illustrate the distinction. China possesses significant mineral resources, but its strategic position originates even more from its midstream capabilities. The U.S. Geological Survey estimates that China accounts for more than 70% of global rare-earth extraction and 87% of processing, including all processing of dysprosium and terbium.[2] For other critical minerals, China produces an estimated 98% of primary refined gallium and 77% of refined germanium; both minerals have strategic applications in semiconductor technologies, while germanium is also used in high-performance fiber optics and night vision systems.[3]

This asymmetry also raises the risk of a new form of technological extractivism, in which resource-rich countries remain concentrated at the extraction stage while processing capacity, technological know-how, infrastructure, and higher-value activities are located elsewhere.

These material dependencies are an integral part of the AI stack. Advanced semiconductor manufacturing, data-center capacity, reliable electricity, cloud infrastructure, and high-performance computing are unevenly distributed across countries and regions. The United States, for example, consumes roughly one quarter of the world's semiconductors, while fully manufacturing only about 10% of the chips it requires; the strategic importance of this dependence for AI infrastructure has already been recognized in U.S. policy.[4] This landscape creates vulnerabilities, but also an opportunity for the G20 to advance a whole-of-stack approach to AI governance, building resilient and competitive

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[2] "China," National Minerals Information Center, U.S. Geological Survey, accessed September 10, 2026, https://www.usgs.gov/centers/national-minerals-information-center/china.

[3] International Energy Agency (IEA), *Global Critical Minerals Outlook 2026* (IEA, 2026), https://www.iea.org/reports/global critical-minerals-outlook-2026.

[4] "Adjusting Imports of Semiconductors, Semiconductor Manufacturing Equipment, and Their Derivative Products into the United States," The White House, January 14, 2026, https://www.whitehouse.gov/presidential-actions/2026/01/adjusting imports-of-semiconductors-semiconductor-manufacturing-equipment -and-their-derivative-products-into-the-united-states/.

capabilities while respecting the rights and interests of local communities.

The invisible material AI stack

Layer	Key governance question
Critical minerals	Where are strategically important resources located, and how diversified is access to them?
Processing and refining	Where is the technological capacity to transform those resources concentrated?
Semiconductors	Where can advanced chips and their manufacturing equipment be produced?
Energy and data centers	Where can large-scale computing infrastructure be built and reliably powered?
Connectivity and compute	Who can access the infrastructure required to develop and deploy advanced AI?
Models and applications	Who can translate these capabilities into innovation and economic value?

2. The Current Governance Landscape

Governments have begun to recognize the material foundations of artificial intelligence, but policy responses remain fragmented across domains that are deeply interdependent. Critical-mineral strategies focus on extraction and supply security; semiconductor policies on fabrication capacity and technological leadership; energy policy on generation and grid capacity; and AI governance primarily on models, applications, safety, and data. Each addresses an important part of the problem, but rarely the stack as a whole.

Several G20 members are connecting AI development with its physical and industrial infrastructure. The United States links AI leadership to semiconductors, data centers, and energy,[5] while the European Union and UK prioritize compute and AI infrastructure.[6] [7] India and Brazil are expanding computing

[5] The White House, *America's AI Action Plan* (July 2025), https://www.whitehouse.gov/wp content/uploads/2025/07/Americas-AI-Action-Plan.pdf.
[6] "AI Continent Action Plan," European Commission, accessed September 10, 2026, https://digital strategy.ec.europa.eu/en/factpages/ai-continent-action-plan.
[7] UK Government, *UK Compute Roadmap* (July 2025), https://www.gov.uk/government/publications/uk-compute roadmap/uk-compute-roadmap; UK Government, *UK AI Hardware Plan*, https://www.gov.uk/government/publications/uk-ai hardware-plan.

capabilities,[8] [9] Argentina has incorporated AI into its strategic investment framework alongside energy and mining,[10] and China increasingly coordinates computing power, data, and electricity supply.[11] Yet, these initiatives address individual layers rather than the material AI stack as an interconnected system. Processing remains a critical blind spot: diversifying extraction does not diversify technological capacity when refining, specialized equipment, know-how, and manufacturing remain concentrated elsewhere. The IEA notes that diversification investment remains focused disproportionately on mining rather than refining and manufacturing.[12]

The G20 can help bridge this gap by mapping dependencies across the material AI stack and identifying opportunities for international cooperation. The U.S. G20 Presidency is well positioned to advance this agenda. Its priorities—reducing unnecessary regulatory burdens, unlocking affordable and secure energy supply chains, and pioneering new technologies and innovation—intersect precisely at the infrastructure underlying AI.

3. Global and Regional Governance Changes: A G20 Material AI Stack Initiative

The G20 should establish a Material AI Stack Governance Initiative built around two practical measures:

3.1. Develop a G20 Material AI Stack Resilience Map

G20 members should jointly develop a map to assess strategic dependencies and capabilities across the material AI stack. Existing datasets already track minerals, trade, semiconductor capacity, energy, and digital infrastructure. The missing element is an integrated diagnostic framework showing where vulnerabilities and bottlenecks lie and how dependencies across different layers interact.

The map should distinguish four dimensions that are too often conflated: where resources are located, extracted, processed, and refined, and ultimately transformed into technological capacity. Geological diversification alone cannot create supply-chain resilience when the technology, equipment, skills, and industrial capacity required for processing remain highly concentrated.

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[8] "IndiaAI Mission Expands AI Ecosystem with Affordable Compute and Startup Support," Ministry of Electronics & IT, Government of India, March 25, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2245069&reg=48&lang=2.

[9] "Plano Brasileiro de Inteligência Artificial," Ministério da Ciência, Tecnologia e Inovação, accessed September 10, 2026, https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/transformacaodigital/plano-brasileiro-de-inteligencia-artificial.

[10] Decreto 105/2026, "Decreto nº 749/2024. Modificación," Poder Ejecutivo Nacional, February 18, 2026, https://www.argentina.gob.ar/normativa/nacional/decreto-105-2026-423212/texto.

[11] Xinhua, "Chinese Premier Calls for Comprehensive Push in AI Innovation, Application," State Council of the People's Republic of China, February 11, 2026, https://english.www.gov.cn/news/202602/11/content_WS698c8c31c6d00ca5f9a090e0.html.

[12] International Energy Agency (IEA), *Global Critical Minerals Outlook 2026* (IEA, 2026), https://www.iea.org/reports/global critical-minerals-outlook-2026.

The exercise should identify high-concentration nodes, single points of failure, processing and manufacturing bottlenecks, infrastructure constraints, and opportunities for commercially viable diversification. It should also incorporate energy and data-center capacity and, where relevant, terrestrial and space-based connectivity as enabling infrastructure for compute.

The purpose would not be to prescribe where countries or firms must source inputs. Rather, it would provide governments and markets with a shared evidence base for investment, trade, infrastructure, and capacity-building decisions. Wherever possible, the initiative should build on existing data from national geological surveys, the IEA, OECD, international financial institutions, and industry rather than create duplicative reporting requirements.

3.2. Create G20 material AI Stack Partnerships

Mapping vulnerabilities is useful only if it changes investment and capacity. The G20 should therefore use the resilience map to facilitate voluntary Material AI Stack Partnerships among interested members, industry, development finance institutions, and technology partners.

These partnerships should focus particularly on the gap between resource ownership and processing capability. Resource-rich countries should have greater opportunities to move beyond extraction by developing commercially sustainable processing, refining, recycling, specialized workforce skills, and related infrastructure. At the same time, countries seeking more resilient supply chains would gain additional suppliers and reduce exposure to concentrated chokepoints.

This approach should not seek autarky or the wholesale relocation of supply chains. Both would be costly and unrealistic. The objective should instead be diversification with openness: maintaining trade and specialization while ensuring that strategically important layers of the AI stack are not dependent on a single geographic or technological bottleneck.

The partnerships could initially target a limited number of demonstrable chokepoints where G20 cooperation can produce measurable results. Rare-earth processing is an obvious candidate. Semiconductor-related minerals such as gallium and germanium offer another. Recycling and recovery technologies could provide a third area in which innovation can simultaneously strengthen resilience and reduce pressure on primary extraction.

Concrete next steps could begin with a joint G20 assessment of material AI stack dependencies, drawing on existing international and national datasets. A small number of voluntary pilot partnerships could then address priority processing or infrastructure gaps, assessed against clear commercial, resilience, and development criteria.

The policy challenge is not simply to secure greater access to resources while respecting the rights and interests of local communities where those resources are located. It is to build resilient and competitive capabilities across the chain that turn resources into computing power and computing power into innovation. AI governance must therefore look across the entire stack. Making its invisible materiality visible would give the G20 a stronger basis for governing the technologies that are shaping the global economy.