UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Columbia Center on Sustainable Investment
A JOINT CENTER OF COLUMBIA LAW SCHOOL AND COLUMBIA CLIMATE SCHOOL

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The Fu Foundation School of Engineering and Applied Science

Market Assessment on Critical Minerals Innovation in Developing Countries

Tuesday, 26 November 2024, 14:10–14:40 (CET)

Objectives

- **Understand the nexus** of key stakeholders, policies, initiatives, financial mechanisms, technologies, and SDG impacts in critical minerals value chains in developing countries.
- **Identify potential lighthouse pilot projects** for technological innovation in developing countries.
- **Support UNIDO's A2D Facility and other key activities and organizations** focused on accelerating innovation in critical minerals in developing countries.

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Scope

Critical Minerals

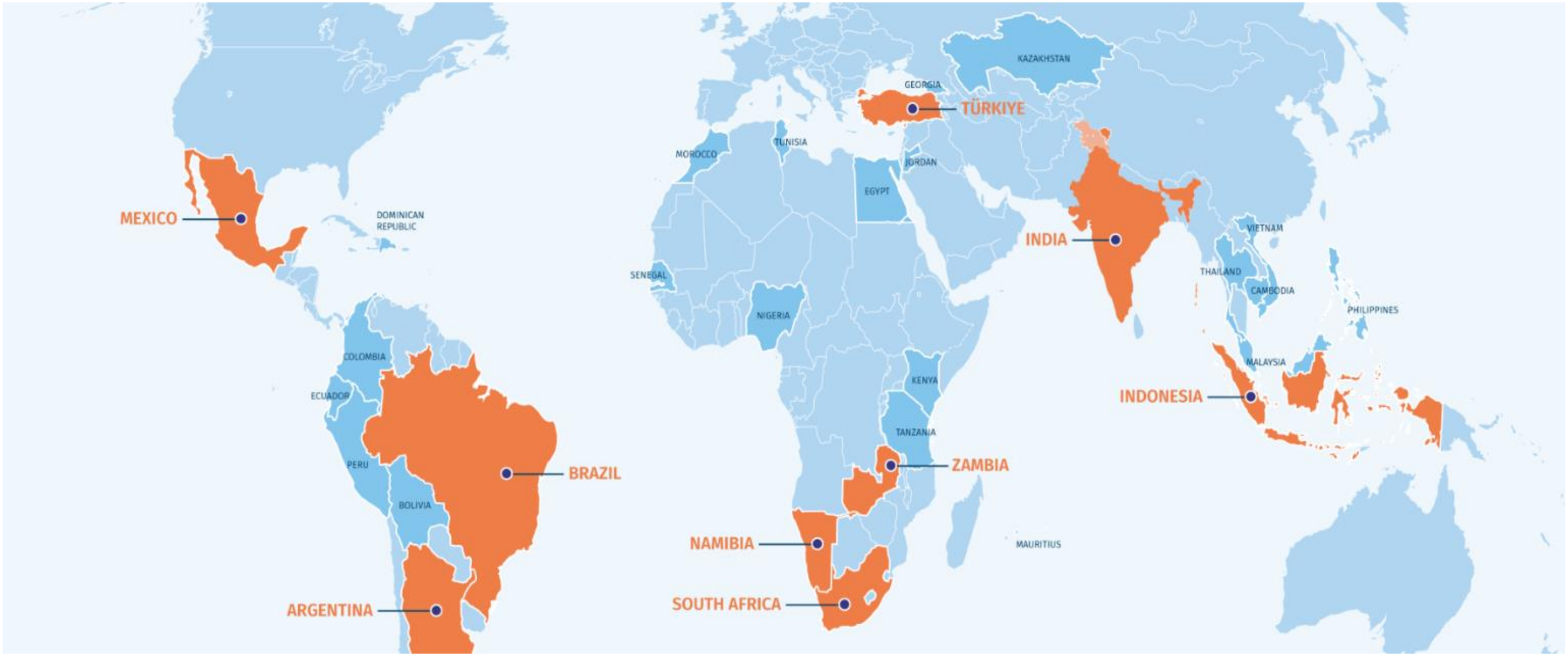
- Minerals that play a key role in the global clean **energy transition**:
  - Lithium
  - Nickel
  - Manganese
  - Cobalt
  - Graphite
  - Rare Earth Elements (REEs)
  - Copper
  - Platinum Group Metals (PGMs)

Geography

- **Phase 1: 30 countries** selected out of 131 OECD official development assistance (ODA) recipients in Africa, Asia and South Pacific (ASP), and Latin America and the Caribbean (LAC)
- **Phase 2: 9 countries** selected from 30 Phase 1 countries, divided evenly between the 3 regions

Technology

- **Midstream**: processing, refining, and recovery
- **Downstream**: manufacturing of end-use goods, recycling
- **Technology Readiness Levels (TRLs)**: target of 6–7 for developing countries, 8–9 for transfer from developed countries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THAILAND
CAMBODIA
PHILIPPINES
SENEGAL
NIGERIA
MALAYSIA
COLOMBIA
KENYA
ECUADOR
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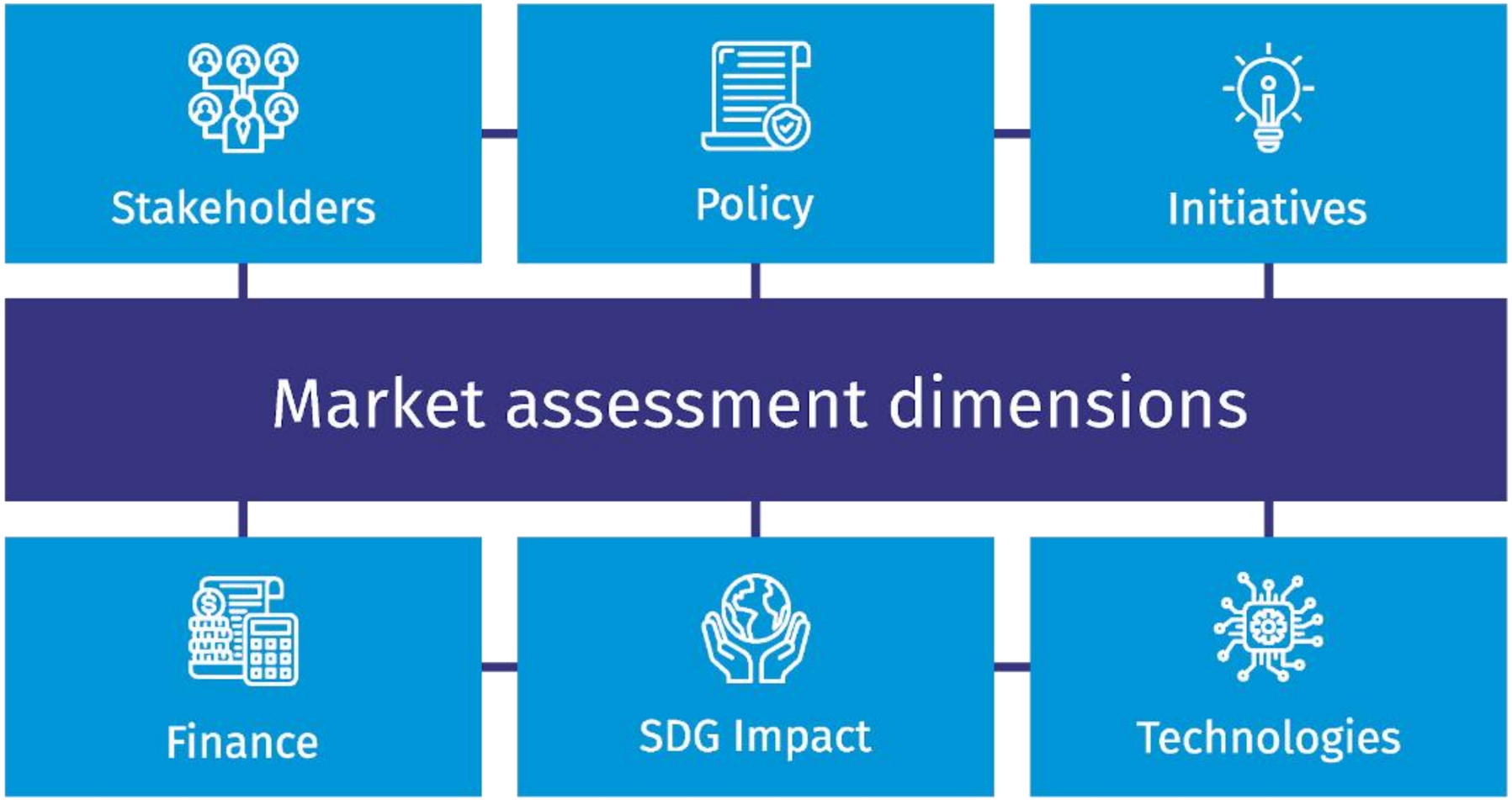
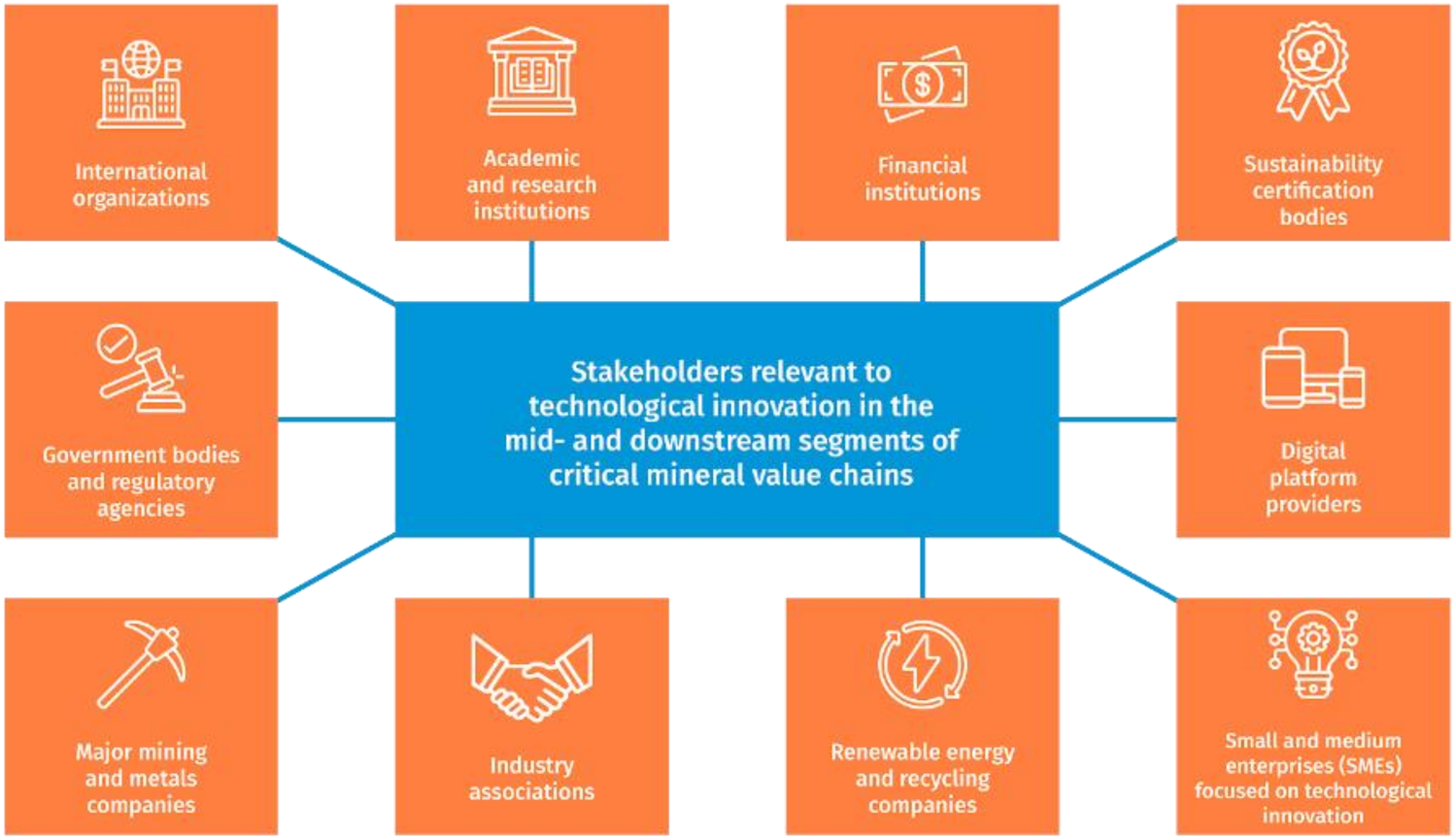

Stakeholders
Policy
Initiatives
Market assessment dimensions
Finance
SDG Impact
Technologies

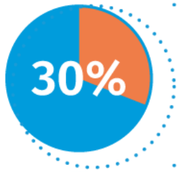
Stakeholder Mapping

The assessment achieved a macro-level understanding of the **relevant stakeholder groups** and their **actual and potential roles in technological innovation** in the mid- and downstream segments of critical minerals value chains.



Policy, Legal, and Regulatory Frameworks

rated **high** in renewable energy targets and policies for technological innovation, research and development (R&D), and critical minerals processing and refining



rated **high** in policies for assembly and manufacturing

rated **high** in policies for circular economy, recycling, and waste management

Table. High-level analysis of policy, legal, and regulatory environments in the 30 Phase 1 developing countries

	Africa	ASP	LAC
High	Morocco Namibia South Africa Zambia	India Indonesia Türkiye	Argentina Brazil Mexico
Medium	Egypt Tanzania Tunisia	Georgia Malaysia Kazakhstan Philippines Thailand	Bolivia Colombia Peru
Low	Kenya Mauritius Nigeria Senegal	Cambodia Jordan Viet Nam	Dominican Republic Ecuador

Initiatives and Financial Mechanisms

Initiatives by international organizations, governments, industry, and other stakeholders support technological innovation in critical minerals in developing countries. A total of **100** global, regional, and national initiatives were analysed, including financing mechanisms **(53%)** and other initiatives **(47%)**; they seek to either finance innovation projects or build up the enabling environment for mid- and downstream activities.

Gaps in these initiatives include the need for greater scale; finer coordination among them as to policy interventions, minerals, and segments to be prioritised in different markets; and increased sharing of knowledge and data on technologies and their drivers and barriers.

Noteworthy global financial mechanisms

UNIDO's A2D Facility	GBP 65 million
World Bank	
• Resilient and Inclusive Supply-Chain Enhancement (RISE) Partnership	USD 75 million
• Climate-Smart Mining Initiative	USD 50 million
• Energy Sector Management Assistance Program (ESMAP)'s Energy Storage Partnership (ESP)	Broader USD 1 billion battery storage programme
European Union (EU)'s Horizon Europe	Broader EUR 95.5 billion innovation programme

AFRICA

Namibia
South Africa
Zambia

STRENGTHS

- Mineral beneficiation strategies
- Bilateral cooperation with developed countries (e.g. EU-Namibia Strategic Partnership on Raw Materials Value Chains and Renewable Hydrogen [USD 1.1 billion]; South Africa-UK Minerals for Future Clean Energy Technologies Partnership; partnership between Zambia and the Japan Organization for Metals and Energy Security)
- Regional initiatives (e.g. African Green Minerals Strategy and DRC-Zambia Battery Council)
- Industrial development agencies
- Policies advancing SDGs

AREAS FOR IMPROVEMENT

- Circular economy, recycling, and waste management policies
- Power and logistics infrastructure constraints to industrial development
- Government institutional capacity to build up and enforce regulatory frameworks
- Policies advancing SDGs

ASP

India
Indonesia
Türkiye

STRENGTHS

- Circular economy, recycling, and waste management policies
- Tax incentives for technology development
- Special Economic Zones (SEZs) for industrialisation and downstream activities
- Cooperation with developed countries: Minerals Security Partnership
- National financial mechanisms (e.g. Make in India; Indonesia Battery Corporation; Turkish Growth and Innovation Fund [USD 218 million])
- Policies advancing SDGs

AREAS FOR IMPROVEMENT

- Regional cooperation and initiatives
- Reliance on imported fossil fuel–based energy
- Policies advancing SDGs

LAC

Argentina
Brazil
Mexico

STRENGTHS

- Financial incentives for companies in mid- and downstream segments (e.g. tax rebates and exemptions)
- State-owned company for lithium value chain
- R&D frameworks and initiatives
- Industry-led initiatives to coordinate stakeholders: Mining Hub
- Multilateral development bank (MDB) support (e.g. International Finance Corporation [IFC] loans and Inter-American Development Bank [IDB] programmes)
- Policies advancing SDGs

AREAS FOR IMPROVEMENT

- Stringent circular economy policies on critical minerals
- Policies governing mid- and downstream activities are fragmented across different ministries and minerals, lacking cohesive national frameworks
- Regional cooperation and initiatives
- Policies advancing SDGs

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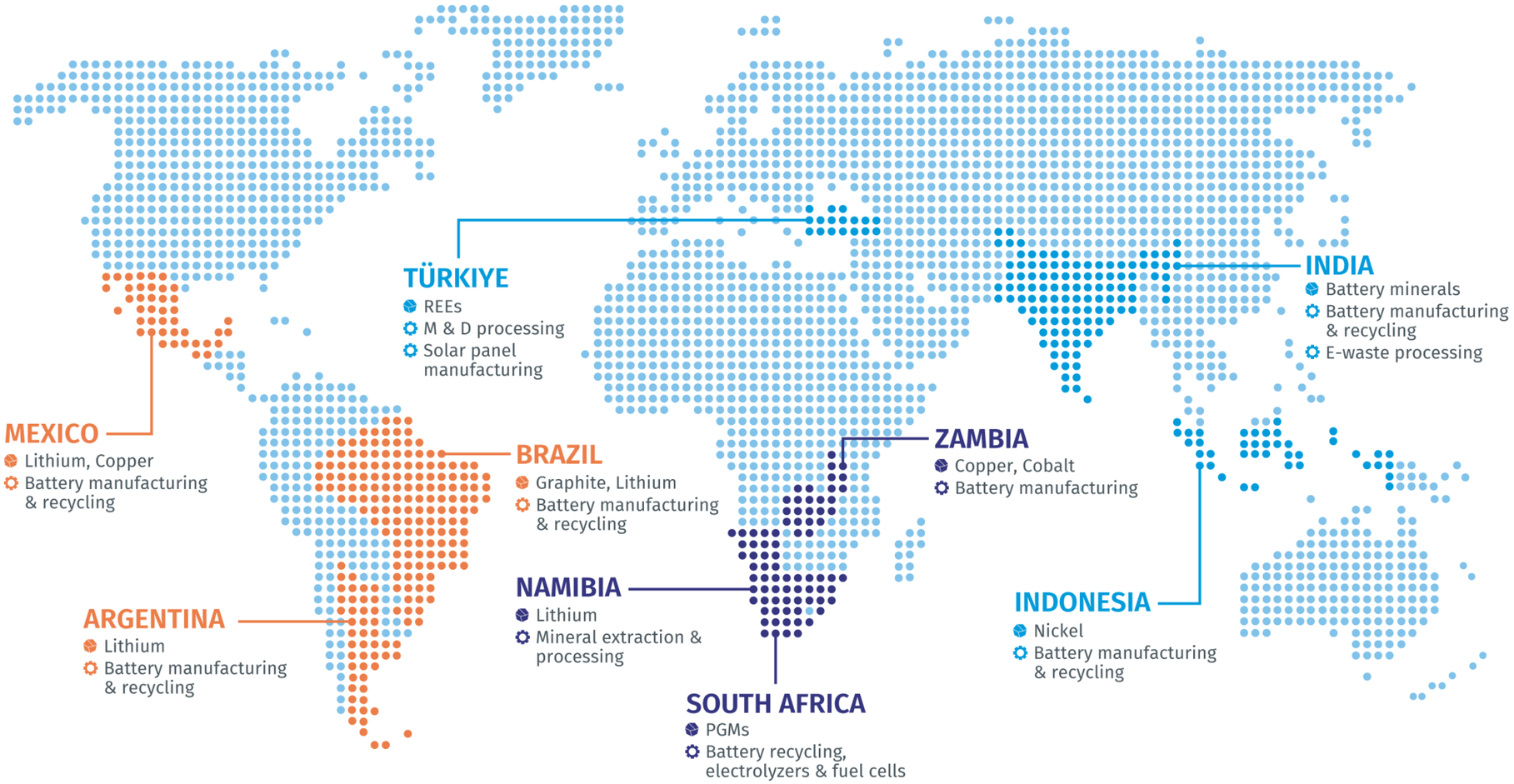
Innovators, Technologies, and Projects



LAC

- Tech for extracting and refining lithium from salar brines and producing battery-grade lithium carbonate (M)
- Tech for extracting and refining lithium from clay deposits and producing battery-grade lithium carbonate (M)
- Tech for producing lithium-ion batteries using lithium carbonate (D)

AFRICA

- Modular tech for recycling lithium-ion batteries using safer chemicals and environmentally sound processes (D)

ASP

- Tech for processing nickel laterites (U/M)
  Tech for producing battery raw materials and battery-grade products (M)
- Tech for producing high-purity silicon ingot for silicon wafers, and solar cells, for solar panel manufacturing (D)
- Tech for recovering energy-critical metals (e.g. nickel hydroxide) from recycled lithium-ion batteries (D)

U = upstream	M = midstream	D = downstream

Challenges for Innovation in Critical Minerals in Developing Countries

- Insufficient **existing R&D and ecosystems** for innovation
- **Power and logistics infrastructure constraints** to industrial development
- **High cost** and **long lead time** of technological innovation and infrastructure development
- **Gaps in local skills** and access to skills development opportunities
- **Government institutional capacity** to build up and enforce regulatory frameworks
- Insufficient **economic incentives and government support** for startups and innovators
- **Country-specific challenges and investment risks** depending on geology, mineral resource availability, material complexity, and technology requirements

Opportunities for Innovation in Critical Minerals in Developing Countries

- Implementing already available and proven technologies at higher TRLs in developed countries
- Adapting technologies to local conditions and constraints and improving operational efficiency
- **In countries with primary mineral resources:** leveraging existing upstream industry, technology, infrastructure, workforce, and skills for vertical integration across the value chain (e.g. PGMs in South Africa, nickel in Indonesia, and lithium in Argentina)
- **In countries with limited primary mineral resources:** investing in downstream processing and assembly (e.g. battery manufacturing and recycling in India, solar panel production in Türkiye)
- Making a positive impact on SDGs

SDG Assessment – Theory of Change

Direct Linkages

Mid- and downstream activities can drive poverty alleviation and economic growth by creating jobs, fostering skill diversification, and increasing government revenues.

Investment in R&D and mid- and downstream facilities promotes industrial development, technological innovation, and expansion of resilient infrastructure.

Mid- and downstream activities produce components essential for renewable energy systems and decarbonisation technologies, reducing local and global emissions.

Indirect Linkages

Targeted interventions can promote gender equality by encouraging women's participation in technical and leadership roles and reducing time poverty for women.

Mid- and downstream activities produce components essential for clean energy technologies. Local operations support just transitions and renewable energy deployment.

Mid- and downstream activities can promote responsible consumption and production by enabling efficient refining, manufacturing, and recycling practices that minimise impacts.

Innovation in the mid- and downstream segments can reduce the impact on terrestrial ecosystems by minimising emissions, waste, and stress on water, land, and biodiversity.

Ten Recommendations to Ramp Up Technological Innovation in the Mid- and Downstream Segments

International support to developing country governments and stakeholders in the innovation ecosystem should be increased, including through technical assistance, capacity building, policy advice, and access to finance.

International and regional organizations and development finance institutions should build on initiatives for the **enabling environment** (e.g. World Bank's RISE Partnership) and **specific innovation projects** (e.g. UNIDO's A2D Facility).

A global multi stakeholder platform should be created to coordinate initiatives, foster collaboration, and share knowledge and data on technological innovation. UNIDO is well-positioned to house such a platform.

UNIDO should lead in ensuring the **continuous gathering, transparency, and analysis of data on innovation**—for example, through rolling surveys and public databases—going beyond the discrete exercise of this assessment.

Developing country policy should provide regulatory guidelines, support domestic collaborations, and offer innovation incentives; **developed country policy** should promote international cooperation, facilitate knowledge transfer, and provide access to finance.

Ten Recommendations to Ramp Up Technological Innovation in the Mid- and Downstream Segments

Developing countries should prioritise **the development of energy, communications, and logistics infrastructure** to address broader industrial development constraints, in line with the SDGs and national priorities and strategies.

Special programmes should be created to **support small and medium enterprises (SMEs)** involved in technological innovation in developing countries to partner with other stakeholders and access funding opportunities, including UNIDO's A2D Facility.

Policymakers should **incentivise circular policies and practices** through regulations, incentives, and innovation funding; the private sector should **strengthen the business case for circularity** by showcasing cost savings, new revenue streams, and improved resource efficiency.

Industry-led initiatives to coordinate mining value chain stakeholders around common challenges and priorities for innovation—such as Brazil's Mining Hub and other initiatives led by mining associations—should be encouraged.

Besides fostering technological innovation in developing countries, international organizations and governments should put in **place regulatory and financial conditions to facilitate technology transfer** from companies based in developed countries.