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The 'Critical factor' in India's clean energy ambitions

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India's ambition to become a global leader in clean energy and sustainable development hinges on access to critical minerals such as lithium, cobalt, and Rare Earth Elements (REEs). These minerals are indispensable for technologies like electric vehicles (EVs), solar panels, wind turbines, and energy storage systems. Achieving India's renewable energy target of 500 GW by 2030 and net zero emissions by 2070 necessitates securing a reliable supply of these resources.

Importance of Critical Minerals in India's Green Transition

1 Role in Renewable Energy Technologies

- **Electric Vehicles (EVs):** Lithium and cobalt are key components of EV batteries. With India's EV market projected to grow at a CAGR of 49% (2023–2030), these minerals are vital for reducing fossil fuel dependence.
- **Battery Storage:** Lithium-ion batteries and other storage technologies rely on these minerals to ensure grid stability amid intermittent renewable energy generation.
- **Wind and Solar Energy:** REEs like neodymium, praseodymium, and dysprosium are critical for high-performance magnets used in wind turbines and solar panel efficiency.

2 Strategic Importance:

- **Energy Security:** India currently imports nearly 100% of lithium, cobalt, nickel and over 90% of REEs, making it vulnerable to geopolitical tensions and supply chain disruptions.
- **Global Competition:** China dominates 60% of global REE production and 85% of processing capacity, underscoring the need for domestic supply chains.
- **Industrial Growth:** Availability of critical minerals is essential to support India's EV manufacturing, renewable energy industries, and green technology innovation.

3 Contribution to Sustainable Development:

- **Decarbonisation:** By enabling EV adoption and renewable energy deployment, critical minerals help reduce carbon emissions.
- **Circular Economy Potential:** Recovery of these minerals from e-waste and batteries strengthens recycling, reduces environmental impact, and supports a sustainable resource cycle.
- **Job Creation and Innovation:** Mining, processing, and recycling activities create skilled employment and promote R&D in green technologies.

Challenges in securing critical minerals for India's clean energy transition

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1 Heavy Dependence on Imports

- India imports nearly 100% of lithium, cobalt, nickel and over 90% of REEs.
- Reliance on global suppliers, especially China, which controls 60% of REE production and 85% of processing capacity, makes India vulnerable to geopolitical tensions, trade restrictions, and global competition.

2 Limited Domestic Production

- Despite untapped reserves (lithium in J&K and Rajasthan, REEs in Odisha and Andhra Pradesh), India contributes <1% of global REE production.
- Exploration and mining are still in early stages, requiring significant investment and technological expertise.

3 Infrastructure and Technological Gaps

- Lack of processing, refining, and recycling infrastructure limits domestic utilization of minerals.
- Mechanized mining, automated processing plants, and waste management systems are underdeveloped.

4 Regulatory and Environmental Challenges

- High costs, complex licensing procedures, and environmental concerns slow down mining operations.
- Weak enforcement of Battery Waste Management Rules (2022) and limited e-waste recycling further constrain circular economy potential.

5 Investment and Market Constraints

- Private sector participation is limited due to high capital requirements and perceived risks.
- Scaling domestic production requires subsidies, tax incentives, and R&D support to attract investment.

Government Steps Taken:

1 Policy Initiatives:

- National Mineral Exploration Policy (NMEP), 2016 promoted private sector participation and advanced geophysical surveys.
- Mines and Minerals (Development & Regulation) Amendment Act, 2023 opened up private exploration.

2 National Critical Mineral Mission (NCMM): Launched with a ₹34,300 crore plan to strengthen exploration, mining, processing, and recovery from end-of-life products.

3 State-backed Companies

- NMDC and IREL (India) Ltd expanding into critical minerals.
- KABIL (Khanij Bidesh India Ltd.) acquiring overseas mineral assets to secure supply chains.

4 Auctions and Exploration: Recent auctions of 20 critical mineral blocks covering lithium, graphite, and REEs attracted Indian and multinational companies.

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5Circular Economy Initiatives:Battery Waste Management Rules, 2022 and e-waste policies promote recycling of critical minerals.

Way forward

1Domestic Mining & Processing: Operationalize mining leases and expand processing/refining capacity through public-private partnerships.

2Infrastructure Upgradation: Invest in mechanized mining, automated processing, and waste management systems.

3Research and Development: Support innovation in battery technology, mineral recovery, and recycling through R&D grants and subsidies.

4Urban Mining & Recycling: Promote recovery of critical minerals from e-waste and end-of-life batteries to strengthen the circular economy.

5Financial Incentives:Streamline licensing, provide production-linked subsidies, tax breaks, and attract private investment.

6Integration with National Goals: Align mineral strategies withAtmanirbharBharat to build resilient, self-reliant supply chains for clean energy technologies.

Conclusion

Critical minerals form the backbone of India's clean energy transition, enabling EVs, renewable energy, and energy storage technologies. Securing domestic and global supply chains for these minerals is vital for achieving energy security, industrial competitiveness, and sustainable development, while positioning India as a global leader in the green economy.

Source: The Hindu

Practice question:Discuss the significance of critical minerals in India's clean energy transition. Examine the challenges, steps taken, and future measures to ensure a self-reliant critical mineral ecosystem.