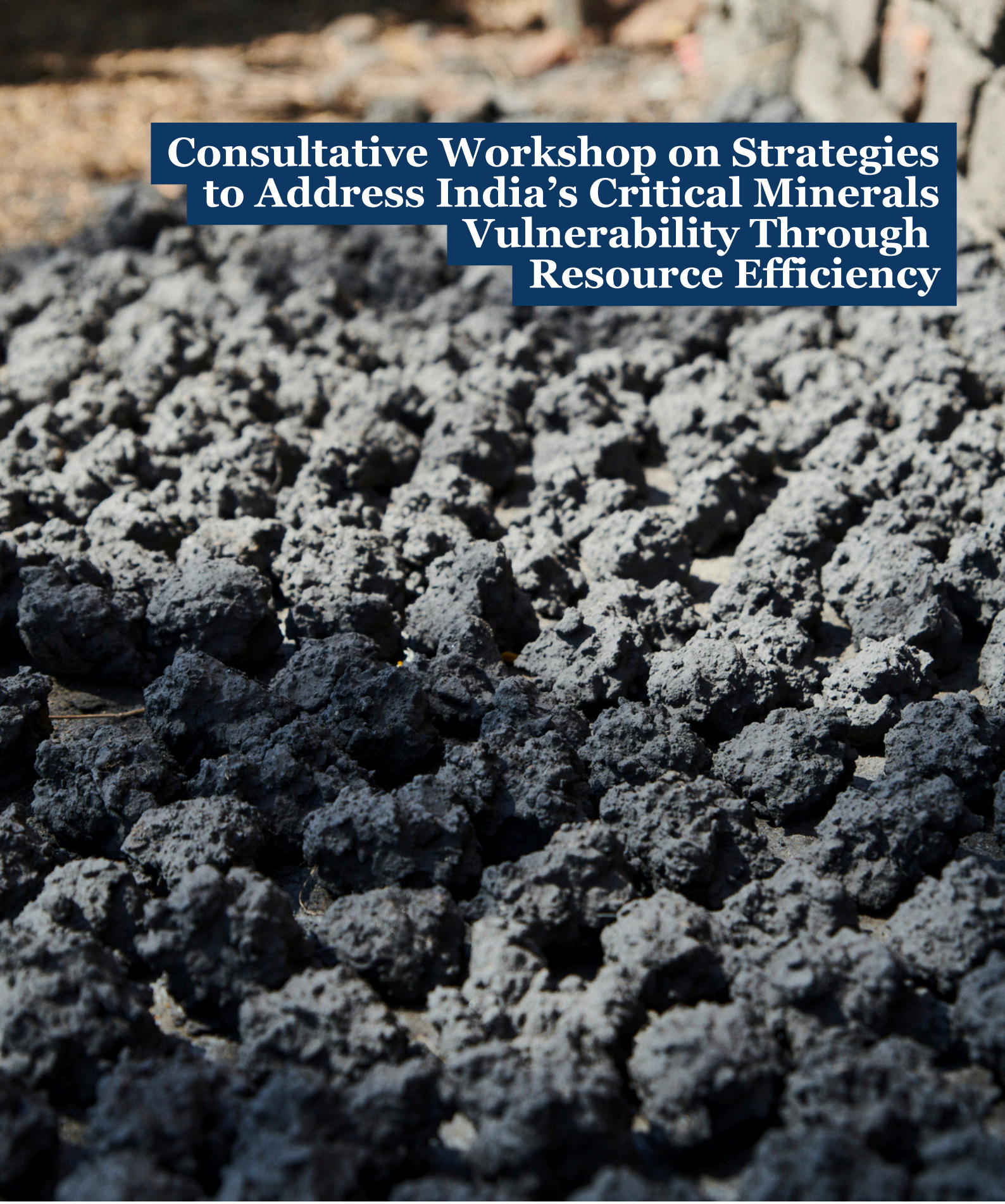


Consultative Workshop on Strategies to Address India's Critical Minerals Vulnerability Through Resource Efficiency

10 YEARS OF EXCELLENCE
ASHOKA UNIVERSITY

CENTRE FOR A
People-centric
Energy Transition

Moderator

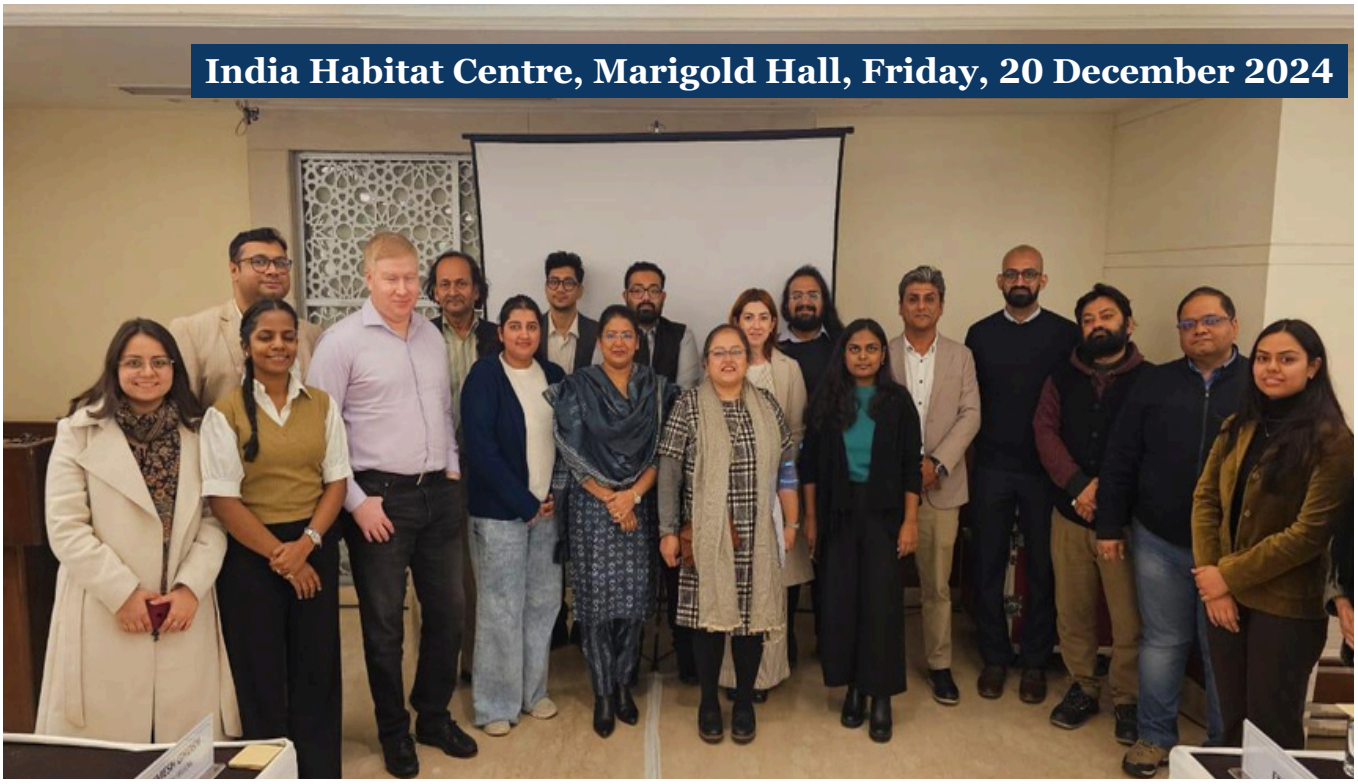
Mr Animesh Ghosh, Research Fellow, ACPET

Speakers

Mr Animesh Ghosh, Research Fellow, ACPET
Dr. Amrita Goldar, Senior Fellow and thematic lead CCUS, ICRIER
Mr. Karthik Bansal, Research Associate, CSEP

Report Drafted by

Ms. Anvesha Adhikari & Mr. Animesh Ghosh



India Habitat Centre, Marigold Hall, Friday, 20 December 2024

Executive Summary

On December 20, 2024, the Ashoka Centre for People-Centric Energy Transition (ACPET) organized a consultation workshop to address critical challenges in India's energy transition. The event focused on ensuring a stable supply of essential minerals required for clean energy technologies. Discussions covered vulnerabilities in critical mineral supply chains, strategies for enhancing resource efficiency, and the role of the circular economy in material recovery.

Experts from ACPET, ICRIER, and CSEP highlighted the urgency of reducing India's reliance on imports, improving recycling rates, and fostering vertical integration in mineral processing to strengthen the domestic market. ACPET presented mineral demand projections for emerging clean energy technologies (Technology Readiness Level 4 and above) aligned with India's Net-Zero target for 2070. ICRIER emphasized innovative recycling technologies and circular practices for mineral recovery, while CSEP explored the geographical distribution of mines and monopolistic behaviors at different extraction stages.

The workshop underscored the importance of collaboration among stakeholders to develop sustainable practices, strengthen domestic capabilities, and establish effective frameworks for critical mineral supply chains and circular economy principles. Participants committed to addressing these challenges collectively, ensuring sustainable mineral supply chains that support India's renewable energy goals while balancing environmental and economic priorities. The event fostered stronger relationships among stakeholders and laid a solid foundation for future planning in the mineral resource sector.

Objective of the Workshop

The workshop aimed to bring together key stakeholders from academia, industry, and government to discuss strategies for addressing India's critical mineral vulnerabilities through resource efficiency.

Key objectives included:

- Facilitating the exchange of research ideas, including critical minerals demand assessment, resource reserves, supply chains, and recovery strategies.
- Analyzing India's mineral supply chains, focusing on shortages and the social, environmental, and economic effects of mining and material recovery.
- Encouraging collaboration to solve challenges through research and policy advocacy.

List of Participating Organizations

- NITI Aayog
- Centre for Social and Economic Progress (CSEP)
- World Resources Institute (WRI)
- Indian Council for Research on International Economic Relations (ICRIER)
- Shakti Foundation
- International Council for Circular Economy (ICCE)
- Cement Manufacturers Association (CMA)
- Institute for Energy Economics and Financial Analysis (IEEFA)
- EkGaon
- Hindalco

Workshop Agenda

- Welcome Address: Mr. Vaibhav Chowdhary, Director, ACPET
- Guest of Honour: Mr. Vipul Tuli, Advisor, ACPET, and Chairman, South Asia CEO, Hydrogen Business & Middle East, Executive Director, UK Sembcorp Industries
- Presentations:
  - Mr. Animesh Ghosh, Research Fellow, ACPET: "Strategies to Address India's Critical Minerals Vulnerability Through Resource Efficiency"
  - Dr. Amrita Goldar, Senior Fellow, ICRIER: "Ecosystem Requirements for Circular Economy Solutions"
  - Mr. Karthik Bansal, Research Associate, CSEP: "Critical Mineral Supply Chain Challenges for India"
- Closing Remarks: Mr. Vaibhav Chowdhary, Director, ACPET
- Vote of Thanks: Mr. Animesh Ghosh, Research Fellow, ACPET

Context Setting

The workshop began with an address by Mr. Vaibhav Chowdhary, who outlined ACPET's mission to prioritize socio-economic resilience in energy policies. He highlighted ACPET's work in four key areas: Energy Policy, Decarbonization and Resource Efficiency, Energy Transition Financing, and Social Impacts of Energy Transition.

Mr. Chowdhary elaborated on ongoing initiatives such as the Transition of Coal Mine Communities Towards Sustainable Lives and Livelihoods (Trans-Mine) project, which aims to provide sustainable alternatives for coal-dependent communities. He also emphasized ACPET's collaboration with NITI Aayog in projecting mineral demand aligned with India's Net-Zero goals and developing energy and climate modeling capabilities.

Special Remarks by Mr. Vipul Tuli

Mr. Vipul Tuli, Advisor to the Ashoka Centre for People-Centric Energy Transition and Chairman, South Asia CEO for Hydrogen Business & Middle East, as well as Executive Director at UK Sembcorp Industries, highlighted the critical importance of securing supply chains for essential minerals amid the rapid transformation of the global energy ecosystem.

He identified three key challenges influencing mineral demand projections:

1. Evolving Energy Mix: Shifting dynamics in the energy landscape make demand forecasts increasingly complex.
2. Technological Advancements: The variability in material intensity required for emerging technologies adds further complexity to projections.
3. Manufacturing Dynamics: Uncertainty around the balance between imports and domestic manufacturing complicates modeling efforts.

Mr. Tuli acknowledged the inherent uncertainties in projection exercises but emphasized their value in identifying directional trends. He praised the diverse institutions participating in the workshop, noting their collective ability to address these complex challenges.

Additionally, Mr. Tuli shared insights from Sembcorp's work in advancing hydrogen technologies and fostering international partnerships, underscoring the importance of collaboration in navigating the evolving energy and mineral landscape.

Presentation by Mr. Animesh Ghosh, Research Fellow, ACPET

Mr. Animesh Ghosh, Research Fellow at ACPET, delivered the first presentation of the day, titled 'Strategies to Address India's Critical Minerals Vulnerability Through Resource Efficiency.' He highlighted the essential role of critical minerals, such as copper, nickel, cobalt, graphite, and lithium, in clean energy technologies and their increasing importance in achieving India's ambitious net-zero target by 2070. Mr. Ghosh emphasized that the projected transformation in the energy ecosystem would lead to a significant rise in the demand for these minerals. He also underlined India's challenges, including limited domestic reserves and a heavy reliance on imports. For example, nickel and cobalt currently have no domestic production and are entirely imported, adding considerable vulnerability to India's energy transition plans.

Mr. Ghosh explained the method for projecting future mineral demand using three scenarios: business as usual, deterministic, and heroic. He incorporated the concept of circularity in his analysis, focusing on minerals needed for clean energy technologies at Technology Readiness Level (TRL) 4 and above, aligned with India's 2070 net-zero goal.

The analysis considered two key factors:

- Recovery Rate: Mineral-specific rates that remain constant over time.
- Global Circularity Rate: Variable rates reflecting the proportion of recovered materials re-entering the supply chain.

Mr. Ghosh presented detailed data projections, showing that by 2070, the demand for copper would reach 7.08 million tons, but only 159 kilotons could be recovered using current recycling methods. Similarly, the demand for graphite, cobalt, and lithium far exceeds current recycling or domestic production capabilities. He highlighted specific challenges, such as the lengthy process of developing lithium mines and the absence of a robust recovery system for graphite.

Mr. Ghosh addressed the study's limitations, noting uncertainties in projection models due to rapidly evolving technologies and incomplete data on material intensity variations with technological advancements. He clarified that while cumulative demand is compared with total reserves for a broad understanding, the exact outcomes depend on variables such as technological improvements, material efficiency, and policy interventions. Despite these challenges, he emphasized that the trends identified in the study provide reliable directional insights.

He concluded by emphasizing the need for:

- Enhanced Recovery Technologies: Innovations to improve recycling and recovery processes.
- Strategic Partnerships: Collaborations to secure critical mineral supplies.
- Sustainable Mining Practices: Policies and practices to build domestic capacities and mitigate risks in India's energy transition.

The presentation highlighted the importance of coordinated efforts to develop resilient and sustainable critical mineral supply chains, ensuring the success of India's clean energy goals.

Comments by Discussants

- **Dr. Praveen Kumar, Program Head for Sustainable Batteries at WRI**, emphasized the importance of addressing resource circularity challenges by tailoring approaches to the unique issues posed by solar, wind, and battery technologies. He highlighted that for batteries, factors such as scrap production and recovery rates should be incorporated into projections to better reflect resource availability. In India, the informal sector significantly impacts recovery and recycling processes, but its role varies across technologies. For solar energy, the informal sector plays a prominent role due to the non-hazardous nature of materials, whereas batteries require stricter regulation because of their hazardous components.

Dr. Kumar underscored the need for targeted strategies to effectively manage recovery and recycling dynamics, considering the informal sector's role.
He also raised two key questions and a suggestion. The first question focused on the exclusion of EV batteries in the analysis. The second question addressed rare earth metals, specifically those used in electric vehicles, which were not included as the study focused on their application in wind turbines.

In response, Mr. Ghosh clarified that the EV battery component was assigned to TERI, while this study focused on stationary batteries. Dr. Kumar suggested incorporating measures to secure raw materials from end-of-life products and secondary resources by developing domestic markets for recovery and recycling. Mr. Ghosh acknowledged the importance of this suggestion and confirmed that the proposed studies are already aligned with these objectives.

- **Dr. Nidhi Srivastav, a representative from UNEP** and an independent consultant, raised pertinent questions and offered suggestions for improving assessment models and methodologies for renewable energy (RE) materials. She inquired whether the material intensity calculations assumed that all RE equipment would be produced domestically, pointing out that such assumptions might oversimplify the model. Dr. Srivastav suggested incorporating factors such as the proportion of imported versus domestically produced components and the existing processing capacities in India, which are crucial for understanding the complete supply chain and its implications.

On circularity, she recommended enhancing strategies to ensure materials re-enter the value chain and are appropriately accounted for in the model. She also emphasized aligning with ongoing global efforts, such as the United Nations' initiatives to develop traceability and circularity standards, which could provide a framework for inclusion in future studies. Furthermore, she stressed the need for more robust data to substantiate policy discussions on the reliance on imports for critical minerals like cobalt, lithium, and nickel. She noted that the presence of these raw materials alone does not guarantee progress in the energy transition without adequate processing capabilities and a comprehensive domestic value chain. These insights were presented as key considerations for revising and enhancing future research and analysis.

In response, Mr. Chowdhary clarified that the manufacturing of modules and materials was beyond the scope of the phase one work. He acknowledged that incorporating such elements would add complexity to the model, which might be considered in subsequent phases. Mr. Ghosh added that this issue was already acknowledged in the study's limitations section. He explained that the current projections are based on available data and that achieving the projected numbers might be challenging even with an import-dependent approach. Ongoing efforts aim to further substantiate these projections and ensure a more robust analysis.

- **Mr. Karthik Bansal, Research Associate at CSEP**, commended the study's focus on technology readiness and suggested that the model could have accounted for delays in technology adoption and phase-out timelines in India. He proposed including recovery input rates to evaluate how much recovered material is reintegrated into manufacturing processes. He also urged caution when comparing mineral demand projections with reserve data, particularly when reserves are measured in ore rather than processed material. Mr. Ghosh acknowledged the value of these suggestions, explaining that assumptions regarding lag times and recovery were already included in the analysis. He clarified that comparisons were intended as directional insights rather than exact evaluations.

Presentation by Dr. Amrita Goldar, Senior Fellow and Thematic Lead for CCUS, ICRIER

The second presentation of the day was delivered by Dr. Amrita Goldar, Senior Fellow and Thematic Lead for CCUS at ICRIER, titled "Ecosystem Requirements for Circular Economy Solutions." Dr. Goldar discussed ICRIER's recent focus on circularity in waste management, supported by partnerships with organizations like Shakti and CWF, while also highlighting the challenges of conducting quality research in data-scarce environments.

Dr. Goldar outlined ICRIER's unique approach to circular economy modeling, which covers a broader range of waste types than other studies, including electronic waste and IT equipment. The study forecasts waste generation and recovery through to 2047-48, with an interim reporting period in 2030-31. She emphasized that recovery rates differ significantly based on material and technology. For instance, while ferrous metals can achieve high recovery efficiencies, lithium-ion batteries face challenges that lower their recovery rates. The study examined 13 types of waste, focusing on both critical and non-critical minerals, and utilized various recovery technologies. ICRIER's model assessed recovery efficiencies for seven critical and 11 non-critical minerals, considering three technologies: Pyrometallurgy (TRL 9), Hydrometallurgy acid-leaching (TRL 9), and Hydrometallurgy bioleaching (TRL 6).

Key findings indicated that conventional electronic waste will be the primary source of recoverable materials like copper and aluminum until 2030, while lithium-ion batteries are expected to dominate recoveries by 2047, driven by the rise of electric vehicles and renewable technologies. Dr. Goldar also addressed challenges in the circular economy, including public awareness, infrastructure issues, and the prevalence of informal recycling. She suggested improvements such as incentivizing recycling technologies and creating circular economy parks.

In conclusion, Dr. Goldar emphasized the need for behavioral change, mineral-specific analyses, frameworks for technology assessments, and the exploration of substitutes for critical minerals to align with sustainability goals. She underscored that collaborative efforts are essential to strengthening circular economy initiatives and enhancing sustainable recycling practices in the clean energy transition.

Comments by Discussants

- Mr. Chowdhary sought clarification on how the study on e-waste integrates with India's broader net-zero trajectory. He emphasized the importance of aligning the circular economy's potential with projections from institutions like NITI Aayog.

Dr. Goldar explained that the study aimed to demonstrate how circular economy practices could provide a steady supply of critical raw materials (CRMs). While materials like copper have significant recovery potential from conventional waste streams such as consumer durables and IT hardware, others from emerging technologies require greater effort due to low volumes and processing challenges. Mr. Chowdhary also inquired whether the study included photovoltaic (PV) modules and wind turbine waste. Dr. Goldar clarified that the study's focus was limited to three new-age technologies identified in consultations with NITI Aayog, while other technologies were part of broader research conducted by different stakeholders.

- Mr. Vivek Chandran, a representative of NITI Aayog, addressed the use of a flat 7.5% recovery rate in circular economy projections. He emphasized the variability in recovery efficiencies across materials and technologies and suggested integrating existing policy targets into the model to provide a realistic baseline for scenario-building and to guide efforts toward achieving recovery goals.

In response, Dr. Goldar acknowledged the challenges of using policy targets, noting that many are overly ambitious and fail to reflect current ground realities. She explained that recycling activity is often influenced by economic factors, such as the market value of materials. For instance, recycling batteries or other technologies becomes more attractive during periods of mineral scarcity but diminishes when market conditions are less favorable.

Dr. Goldar added that the study's focus on partial equilibrium—sector-specific deep dives—provides valuable insights but cannot fully capture the broader dynamics of circularity. She advocated adopting a general equilibrium framework to better quantify material flow across sectors. For example, recycled steel, though unsuitable for precision engineering, could have significant value in construction or manufacturing applications.

Expanding on this, Mr. Ghosh clarified the methodology behind the study. He explained that recovery and circularity were treated as separate components, with recovery rates calculated material-wise using available literature. However, he highlighted a significant gap in the literature regarding data on the circularity of specific minerals or technologies, limiting the study's ability to model these aspects comprehensively. He referenced the Global Circularity Report, noting that the global circularity rate had declined to 7.1% in 2023–24 from 9.1% when first published. While this benchmark was considered, specific circularity rates for individual minerals were excluded due to insufficient data.

- Ms. Shalini Goyel, MD of ICCE, emphasized that current e-waste practices prioritize dismantling over recovery, driven by economic incentives targeting high-value metals. She noted that environmental and socio-economic impacts are often overlooked. Ms. Goyel urged expanding circularity studies to include material innovation, modular design, and strategies to reduce material use—elements often neglected in favor of recycling. These broader parameters, she argued, are vital for a holistic approach to sustainability and resource efficiency.

Mr. Bansal raised the potential for improved vertical integration in India, particularly in the battery sector. He suggested that companies producing batteries could actively engage in recycling end-of-life batteries, thereby improving recovery and recycling rates.

Dr. Goldar agreed and pointed out that earlier efforts to involve aggregators as intermediaries between manufacturers and recyclers had been discontinued. She suggested renewed discussions on vertical integration to streamline recovery operations and enhance efficiency.

Mr. Tuli highlighted the issue of low recovery rates and recommended leveraging economic incentives and optimized market structures to improve recycling efficiency. He stressed the need for differential recovery rates across various minerals and technologies. Mr. Tuli also emphasized the importance of establishing policy targets as a baseline for scenario-building to guide discussions on actionable measures to achieve these targets.

Presentation by Mr. Karthik Bansal, Research Associate, CSEP

The final presentation of the day was delivered by Mr. Karthik Bansal, Research Associate at CSEP, on 'Critical Mineral Supply Chains Challenges for India.' Mr. Bansal shared insights from CSEP's ongoing work on critical minerals and renewable energy supply chains. He began by outlining the study's trajectory, which includes assessing critical minerals, projecting their demand, and analyzing supply chain challenges. The research also examines global and domestic policy interventions affecting the extraction, processing, and end-use of these minerals, with a focus on renewable energy technologies such as solar, wind turbines, and battery energy storage systems (BESS).

CSEP's projection study, based on data from NITI Aayog, indicated significant increases in mineral demand by 2027, with copper demand expected to rise 5.4 times and neodymium becoming critical due to its lack of substitutes. The study also highlighted the potential impact of technological advancements, projecting a 30% reduction in mineral requirements if efficiency and recycling rates improve. However, challenges such as low recycling rates and delays in operationalizing new mines remain pressing, underscoring the need for accelerated policy action.

Mr. Bansal identified three key stages in the supply chain—extraction, processing, and end-use—and analyzed the challenges specific to each:

1. Extraction:
    - Globally, the ownership of critical mineral mines is highly concentrated. For instance, Tianqi Lithium and Ganfeng Lithium, two Chinese companies, control majority stakes in several of Australia's and Chile's top lithium mines, which account for 60% of global lithium consumption.
    - These companies have strong processing capabilities in China, resulting in extracted minerals being exported for processing rather than being processed in the host countries. This structure poses significant challenges for countries like India seeking to secure access to critical resources.
    - Mr. Bansal emphasized rethinking policies around critical mineral auctions in India. While auctions are essential, they must better address global dynamics. Suggested reforms include separating bulk and critical minerals in auctions and capping bid percentages.
2. Processing:
    - China dominates mineral processing due to its ownership of mining assets worldwide and strategic offtake agreements. Major companies like Albemarle, Tianqi, and SQM control mines and operate processing plants, predominantly in China.

- These offtake agreements enable China to secure raw materials and process them domestically, further consolidating its control over the global supply chain for critical minerals.
- While India's copper processing capacity is globally competitive, concerns remain about the availability of raw materials and the lack of advanced domestic processing technologies.

1. End-Use:
   - Offtake agreements have expanded to manufacturing and end-use. Companies producing electric vehicles (EVs) and wind turbines invest directly in mines and processing plants to secure raw materials, giving them a competitive edge.
   - Indian manufacturers face challenges in sourcing critical minerals and lack similar agreements. The Production Linked Incentive (PLI) Scheme has boosted domestic manufacturing of low-carbon technologies. However, concerns persist that the scheme focuses predominantly on end-use manufacturing rather than upstream integration.
   - Mr. Bansal suggested evolving the PLI scheme to include incentives for domestic procurement and securing raw materials through strategic agreements.

In conclusion, Mr. Bansal emphasized the urgency of addressing supply chain challenges to meet India's renewable energy goals. He underscored the need for integrating upstream and downstream policies, fostering global collaborations, and driving domestic innovation to secure India's position in the critical minerals and renewable energy landscape.

Comments by Discussants

- Dr. Kumar emphasized the need to extend Performance-Linked Incentives (PLIs) to active material manufacturing, with a particular focus on material recycling. He highlighted that India is losing valuable resources by exporting black mass, a byproduct of e-waste and battery recycling. Dr. Kumar recommended introducing incentives for recycling to create a robust domestic market for these materials, which would make it more economically viable for companies to process and utilize recycled materials locally.

- Mr. Chowdhary raised a critical question about India's reliance on importing critical minerals, particularly ores, and why these materials are often processed abroad before being re-imported into India. He pointed out the high costs associated with importing processed materials and emphasized the need for local processing capabilities. He also highlighted the lack of a clear policy mandate for mineral processing in India.

Mr. Bansal acknowledged the issues raised and added that no ministry in India currently oversees mineral processing, resulting in significant policy gaps. This absence of clear guidance has created uncertainty about which government body should lead initiatives for domestic processing. Mr. Bansal emphasized the need for policies that foster a competitive advantage by focusing on building India's processing capacity to compete in global markets.

Regarding cost comparison and modeling, Mr. Bansal acknowledged the complexity of these analyses but expressed optimism about the potential for future modeling studies to offer clearer insights. He shared hope that ongoing discussions would contribute to the development of more refined models and strategies to effectively address the challenges associated with mineral processing in India.

Concluding Comments by Discussants

- Mr. Gib Hordes, Senior VP of Corporate Strategy & Business Development at Hindalco, delved into the complexities of competing in global mineral processing and production markets. He highlighted China's systematic investment strategies and competitive advantage, particularly in primary resource sectors like aluminum, steel, and copper smelting. China's approach of building production capacities that exceed global demand—often operating at an economic loss—gives it a significant edge in processing, making it challenging for other countries, including India, to compete effectively.
- Regarding specific minerals such as lithium, Mr. Hordes noted that the cost of shipping low-concentration resources like lithium brine or spodumene often renders these ventures economically unfeasible. In India, even where copper mining opportunities exist, low mineral concentrations and inefficiencies in the auction process for mining rights limit economic viability.
- He also addressed challenges in recycling, particularly for batteries and e-waste. While recycling is critical, it is often economically unviable due to high chemical processing costs and difficulties in obtaining battery-grade materials from recycled products. He commended China's focus on closed-loop systems in recycling, which has been more effective. Hindalco is working to formalize and improve its recycling processes by building an e-waste facility.
- Mr. Hordes further highlighted the difficulties in sourcing scrap from the informal sector, noting that local recyclers often avoid formal processes, taxes, and environmental regulations. This creates challenges for formal companies like Hindalco in establishing a reliable supply chain for recycled materials.
- Mr. Ghosh acknowledged these points and shared that ACPET is interested in studying red mud and secondary waste recovery. A proposal has been submitted to Hindalco, and ACPET looks forward to collaborating on initiatives promoting resource efficiency and sustainability.

- Mr. Chandran discussed a major challenge faced by companies regarding mine exploration. He pointed out the "chicken-and-egg" problem, where Public Sector Undertakings (PSUs) are hesitant to invest in exploration without clear market demand. This uncertainty arises from the absence of clear policy goals for clean energy technologies and local production. He stressed the need for clear and practical policies to build confidence among companies and encourage investments in mine exploration, which would support India's clean energy goals.
- Mr. Vijay Pratap Singh Aditya from EkGaon highlighted the issues within India's unorganized e-waste recycling sector. He explained that small producers lack incentives to invest in better technology or cleaner methods. To address this, he proposed creating a marketplace for recycled minerals to connect buyers and sellers, including quality checks and certification for marketability. Large companies like Hindalco could play a role in facilitating such marketplaces, creating steady demand, and encouraging the formalization of recycling initiatives. This would enable small recyclers to increase profits, invest in better technology, and adopt cleaner practices, benefiting both the industry and the environment.
- Mr. Hordes added that recycling poses additional challenges, including price competition, customer reluctance to pay a premium for green metals, and the informality of the sector.
- Dr. Amrita Goldar highlighted challenges faced by the informal sector, particularly in the steel industry. She pointed out that intermediaries stockpile scrap, leading to price volatility. To address this, she suggested creating a marketplace for scrap steel, ensuring quality assurance and traceability of materials. This marketplace could function similarly to Maruti True Value, where certified quality checks back each transaction.
- Dr. Goldar also emphasized the importance of formalizing the informal sector, noting the trade-offs between job creation and growth in the formal economy. She suggested that informal operators are likely to fall under the legal framework over time, especially with the growing push for GST compliance. She further recommended a clustered approach to incentivize technological advancements, enabling small players to pool resources and invest in better technology through subsidies or other support mechanisms.
- Mr. Vipul Tuli suggested enhancing India's mineral extraction process by focusing on the exploration phase. He noted that many resources are only identified at the reserves stage, creating gaps in early-stage exploration. He emphasized the need for exploration incentives, particularly for junior explorers, and encouraged partnerships with high-potential resource countries like Chile and Australia.
- Mr. Karthik Bansal added that their study focused on exploration and noted that poor exploration practices stem from a lack of incentives and data gaps in the bidding process for mining blocks. He emphasized the importance of addressing these issues to strengthen India's mineral resource capabilities.

Closing Remarks

In conclusion, Mr. Vaibhav Chowdhary expressed gratitude to the participants for their valuable contributions to the discussion. He noted that the conversations were insightful and yielded several important takeaways. A significant finding from the research was highlighted—informal labor challenges, particularly the involvement of child laborers in e-waste processing, which could serve as a crucial point for future discussions. He also referenced organizations like Kro Sambhav, which play a key role in implementing Extended Producer Responsibility (EPR) rules for e-waste management.

Mr. Chowdhary wrapped up the session by thanking everyone once again for their time and input, emphasizing the importance of ongoing dialogue on these critical issues.
Mr. Animesh Ghosh concluded the event with a heartfelt vote of thanks. He expressed gratitude to all the speakers and attendees for their time and active participation, which greatly enriched the discussions. Special thanks were extended to Mr. Vaibhav Chowdhary, Director of ACPET, for his unwavering support, and to Mr. Soumit Pandey and Ms. Anvesha Adhakari for their contributions to the research study. He also acknowledged Kasvi Sansanwal for her role as the emcee during the introductory session and thanked Mr. C. Surendran for managing the event arrangements. Additionally, he expressed appreciation for the efforts of other ACPET team members and Ms. Sarala Yadav from the Finance team for their contributions to the successful organization of the event.

Way Forward

ACPET and other think tanks may collaborate on the following areas to support India's critical mineral and recycling goals:

Improving Data and Research:

- Develop standardized frameworks for quantifying mineral circularity across supply chains.
- Incorporate emerging technologies and international trade dynamics into these frameworks to ensure consistent measurement and reporting.
- Bridge gaps between government data collection, industry research, and technical methodologies.
- Provide policymakers with actionable intelligence for resource security planning.

Recycling & Circularity:

- Offer evidence-based recommendations for developing India's mineral recycling ecosystem.
- Focus on regulatory frameworks, infrastructure needs, and incentives for private sector investment in circular economy parks.

- Establish measurable targets and build domestic recycling capabilities through targeted policies and skill development.
- Create robust recycling networks and regulated marketplaces for recovered minerals to enhance competitiveness in global mineral markets.

Market Development:

- Analyze and propose incentive structures to support junior mining companies in domestic mineral exploration.
- Develop strategic international partnerships with resource-rich nations like Chile and Australia.
- Design comprehensive frameworks to formalize the informal recycling sector while protecting existing jobs.
- Strengthen India's position in both primary and secondary mineral markets through collaborative efforts between think tanks and the government.

Policy Actions:

- Research and recommend financial and regulatory frameworks to enhance the commercial viability of mineral recycling.
- Evolve the Production Linked Incentive (PLI) scheme to prioritize domestic mineral processing.
- Establish clear implementation guidelines and set ambitious recovery targets based on think tank analysis.
- Ensure evidence-based policies guide investment in the mineral recycling sector to provide the industry with clear direction.

Campus Location
Plot No. 2, Rajiv Gandhi Education City,
National Capital Region P.O. Rai,
Sonepat Haryana-131029 (India)

Delhi Office
Ashoka University Plot no.222,
Second floor, Okhla Industrial Estate,
Phase III, New Delhi-110020