Royal Academy of Engineering (RAEng) UK
Indian National Academy of Engineering (INAE)
Bilateral Exchange on Critical Minerals

Strategic Outcomes, Value Proposition & A Collaborative Roadmap

Proceedings & Recommendations Report

Jointly Convened By:

Royal Academy of Engineering (UK) Indian National Academy of Engineering (INAE)

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Prepared for Government & Strategic Stakeholders

UK–India Bilateral Exchange on Critical Minerals

Strategic Outcomes, Value Proposition & A Collaborative Roadmap

Genesis:

1. It is a well-acknowledged fact that the foundations of our human civilization are the natural resources we have found and utilized for our well-being and growth. Currently, we are witnessing two revolutions in the making – one, the digital revolution including artificial intelligence, which is transforming the way we live, work, and communicate with each other, and the other is the energy transition, which is enabling the switch from fossil fuels to renewable energy-based electricity as the main source of energy for human living and growth. Both these revolutions are intimately connected and there is a synergy between the two but even more importantly, they have created a huge demand for certain specific elements – lithium, nickel, cobalt, vanadium and graphite (battery materials), neodymium, praseodymium, dysprosium, terbium (rare earth permanent magnets), gallium, germanium, indium, tellurium, scandium, selenium (electronics and semiconductors including PV Solar cells), titanium, niobium, tungsten, tantalum (structural materials), just to cite a few for illustration. Various countries around the world, including INDIA and the UK, are developing their own strategies to build robust, resilient supply chains for these critical minerals (as sources of much-needed specific elements), which also include international collaboration as an important part of these strategies.

2. Critical minerals, as sources of these specific elements, are thus becoming strategically essential to future economic resilience, technological advancement, and sustainability. The global critical minerals landscape is undergoing a profound structural transformation, driven by the accelerating energy transition, rapid technological advancements, increasing geopolitical realignments, and rising demands.

3. However, global supply chains for these minerals remain highly concentrated, opaque, and vulnerable to disruptions, underscoring the urgent need for a diversified, resilient, and transparent supply ecosystem.

4. Against this backdrop, both India and the United Kingdom have articulated on different forums their strong national priorities to secure and strengthen their critical mineral ecosystems:

    a) ***India****, through the National Critical Mineral Mission (NCMM), is pursuing a comprehensive strategy encompassing exploration, resource development, circular economy, and supply chain intelligence, supported by policy reforms, international partnerships, and increasing industrial demand driven by its clean energy and manufacturing ambitions.*

b) ***The United Kingdom****, through its Modern Industrial Strategy and the UK–India Technology Security Initiative (TSI), is advancing its capabilities in critical mineral processing, advanced materials, recycling technologies, and supply chain risk intelligence, supported by a robust innovation ecosystem spanning leading universities, research institutions, and industry.*

5. Recognising the strengths of our countries (India and the UK) in research, technology, demand, and deployment capabilities of advanced innovative solutions in this domain, both countries have been discussing the way forward, through various joint forums and meetings aimed at developing appropriate mechanisms for impactful collaboration between the professionals (academia, industry and research organizations) in both the countries working across the critical minerals value chain.

6. This evolving partnership is further reinforced by ongoing joint initiatives, including:

   a) The UK–India Critical Minerals Supply Chain Observatory aims to build shared digital intelligence and risk-assessment capabilities.
   b) The UK–India Critical Minerals Processing and Downstream Collaboration Guild (STRATA), facilitating industry-led partnerships, investments, and technology collaboration
   c) Expanding engagement between academic institutions, industry leaders, and government stakeholders

7. In this strategic context, the UK–India Bilateral Exchange Programme on Critical Minerals (9–11 March 2026) was convened by the Royal Academy of Engineering (UK) and the Indian National Academy of Engineering (INAE) to provide a high-level platform for dialogue, knowledge exchange, and the co-creation of actionable pathways for collaboration.

8. The Exchange was conceived not merely as a forum for discussion, but as a catalytic step towards building a long-term, structured, and outcome-oriented India–UK partnership, anchored in:

   a) Supply chain resilience and transparency
   b) Circular economy and resource efficiency
   c) Advanced processing and materials innovation
   d) Shared digital intelligence and policy coordination
   e) Developing innovative solutions across the critical minerals value chain and their scale-up and commercialization with the help of innovative business models and appropriate policy initiatives.

9. A key area of focus during the discussions was an urgent need to make impactful advances in recycling and recovery of critical minerals from batteries, electrolysers, rare earth permanent magnets, E waste and other used industrial products containing critical

minerals and metals highlighting the need to devote efforts towards recovery and reuse through improvements in technology readiness, regulatory frameworks, and market development, alongside opportunities to accelerate bilateral learning including around policy framework and skills development.

10. This brief report summarizes the strategic outcomes, value proposition, and a few recommendations for the way forward, with a view to developing policy, enabling partnerships, and guiding future bilateral initiatives in the critical minerals domain.

Summary of Deliberations (March 9-11, 2026)

11. The Bilateral Exchange Program (9–11 March 2026 – Hybrid Mode), jointly convened by the Royal Academy of Engineering (UK) and the Indian National Academy of Engineering (INAE), represents a strategic transition from dialogue to structured collaboration in the critical minerals domain.

12. Among the various issues deliberated upon during the meeting, it was clearly established that critical mineral security is no longer about access alone — it is about intelligence, processing capability, circularity, and system-level resilience.

13. This exchange also aimed to unlock India's vast critical mineral reserves and set out ambitions for the UK and India to reduce their current dependency on China. Business opportunities will be explored, including through processing agreements that can strengthen the UK–India industrial base and through regional hubs that can enhance leadership.

14. **Structure of the 3-Day Exchange (Hybrid Mode):** The programme was structured across three tightly integrated layers:

a) **Day 1 – Strategic & Technical Themes**

The discussions on the first day were organized under the following 4 sessions, namely

- Sustainable and Traceable Critical Minerals Supply Chains for the Energy Transition
- Re-use, Recovery, Recycling of Critical Minerals
- Designing for Resource Efficiency and Circularity in the Energy Technologies
- Reducing Dependency on Scarce Materials

b) **Day 2 – Industry & Institutional Engagement**

- Interaction with Johnson Matthey (processing & materials innovation)
- Engagement with the RA Eng partnerships team (industry-academia collaboration models)

c) **Day 3 – Policy, Platforms & Way Forward**

- UK priorities (Cabinet Office, DBT)
- India's perspective (NCMM-aligned approach)
- Observatory-led collaboration (Cambridge + IIT/TEXMiN – TTRP ecosystem)
- Closing strategic outcomes

15. **Key Strategic Insights from the Deliberations:** Drawing strongly from the workshop flow and synthesis presented in the closing session:

a) **Shift from Linear Supply Chains to System Resilience**

The most important shift observed:

- From "resource access" → "system resilience."
- From "transactional sourcing" → "predictive, intelligence-driven supply chains."

As highlighted in the closing outcomes, Traceability, stress-testing, and scenario planning must become central to mineral strategy.

b) **Circularity as a Strategic Imperative**

A unanimous position across sessions:

- Recycling, re-use, and recovery are not sustainability add-ons
- They are core instruments of supply security

This includes:

- Battery ecosystems
- Industrial residues
- Rare earth magnets
- Catalysts and advanced materials

c) **Digital Intelligence as the New Strategic Layer**

A critical emerging pillar:

- Shared data platforms and supply-chain intelligence systems
- Real-time mapping of:
  - Dependencies
  - Risks
  - Trade flows

16. The engagement revealed a way forward for strategic collaboration in certain selected areas. It is recommended that both the countries together create a joint India–UK critical minerals platform anchored around:

- Digital supply chain intelligence (Observatory-led)
- Joint R&D and pilot deployment
- Industrial-scale circular economy programs
- Strategic overseas asset partnerships

The UK–India Critical Minerals Supply Chain Observatory is positioned as a cornerstone initiative.

17. **Reducing Dependency through Innovation**

a) Beyond mining, discussions emphasized:

- Substitution technologies
- Material efficiency
- Next-generation chemistries

18. **Full-System Approach to Critical Minerals**

a) The exchange broadened the scope to include:

- Exploration
- Processing
- Recycling
- Standards
- Finance
- Data & governance

INDIA – Ongoing Critical Minerals Initiatives

19. **National Critical Mineral Mission (NCMM), launched in January 2025,** which aims to
    a) Enhance domestic exploration and mining of critical minerals (not only primary deposits but also secondary resources – abandoned mines, mine waste dumps, mine-tailings, smelter slag dumps, acid mine drainage, fly ash, red mud, and other accumulated waste)
    b) Development of appropriate mineral beneficiation, processing and extraction technologies and scaling them up to commercial success
    c) Recycling of critical minerals (recovery of critical elements from end-of-life products)
    d) Overseas acquisition of critical mineral assets through KABIL (Khanij Bidesh India Ltd)
    e) Research & Innovation (Creating Centres of Excellence to strengthen our technology capabilities, including human resource development and incubating startups – 9 of them functioning)
    f) Creation of Strategic Stockpiles of key minerals for supply security – National Critical Minerals Stockpile/Reserves

g) The Centres of Excellence have been entrusted with the mandate to undertake innovative and transformational research to strengthen and advance the nation's science and technology capability in the area of critical minerals. Each centre will aim to reach TRL 7/8 for the technologies they work on, and it is expected that, in collaboration with their industrial partners, they will be able to set up pilot-plant-scale technology demonstration plants.

20. **Nine Recognized Centres of Excellence (CoEs) for Critical Minerals:**
    a) IIT Bombay: Focusing on advanced research, processing, and application.
    b) IIT Hyderabad: Specialized in material science and engineering for critical minerals.
    c) IIT (ISM) Dhanbad: Focusing on mineral exploration and beneficiation techniques.
    d) IIT Roorkee: Research on mineral extraction and processing efficiency.
    e) CSIR – IMMT, Bhubaneswar: Specializing in mineral processing and metal extraction.
    f) CSIR – NML, Jamshedpur: Focused on metallurgical innovations, smelting, and refining.
    g) NFTDC, Hyderabad: Dedicated to non-ferrous material development and technology.
    h) IISc Bangalore: Research on advanced materials and sustainable technology.
    i) C-MET Hyderabad: Specialized in electronics materials processing.
21. The proposed collaborative program between India and the UK must leverage the expertise available at these centres of excellence, as well as at several other laboratories and institutions, to launch a few collaborative projects of interest and value to both countries.

UK-based industries in the critical mineral space

22. The UK's advantage in critical minerals lies less in mining and more in processing, recycling, finance, and advanced materials integration. UK-based industries and companies actively working in the critical minerals space from exploration and mining through to processing, recycling, and supply-chain development
    a) **Cornish Lithium Ltd –** UK company focused on lithium exploration and extraction in Cornwall, including innovative direct lithium extraction technology.
    b) **Tungsten West –** Developer of the Hemerdon tungsten project in Devon, also exploring associated minerals, including lithium potential.
    c) **Cornish Metals** – Leading tin (and associated critical metals) mining and exploration company at South Crofty, part of the UK's critical minerals strategy

Rare Earths & Magnet Materials

- **Pensana Saltend (Pensana plc) –** Developing a rare earth processing plant at Salt End in Yorkshire to refine magnet-grade rare earth elements (neodymium, praseodymium), aiming for significant share of global output.

- **Less Common Metals (LCM)** – UK rare earth metals and alloys producer, active in refining and downstream materials (planning expansion beyond the UK).

Recycling & Circular Supply Chain

- **Hy Pro Mag Ltd** – UK company developing rare earth magnet recycling technologies, supported by innovation funding and working with partners.

- **Mint Innovation / Li Batt Recycling project** – EV battery recycling initiative in the West Midlands, backed by Jaguar Land Rover and government funding, aimed at recovering lithium, nickel, cobalt, and other critical metals.

UK Critical Minerals – Value Chain Overview

Upstream: Exploration & Mining

- Lithium, tin, tungsten (Cornwall & Devon)
- Players: Cornish Lithium, Cornish Metals, Tungsten West
- Support: British Geological Survey
  Limited scale, long permitting timelines

Midstream: Processing & Refining (Key UK Strength)

- Rare earth separation & alloys
- Chemical processing clusters (Humber, Teesside)
- Players: Pensana (Saltend), Less Common Metals, Johnson Matthey
  Critical bottleneck where the UK adds most strategic value

Downstream: Manufacturing & Use

- Automotive & EV supply chains
- Aerospace & defence alloys
- Advanced steels & magnets
  Demand pull for secure, traceable supply

Circular Supply: Recycling & Urban Mining

- Battery recycling & rare earth magnet recovery
- Players: **HyProMag, LiBatt, Mint Innovation**
  Fastest route to domestic critical-mineral supply

Enablers: Finance, Policy & Skills

- London mining finance & trading hub
- UK Critical Minerals Strategy
- Universities & innovation funding (UKRI, Exeter)

UK Catapults in Core Areas

23. One of the strengths of the UK Innovation Ecosystem is the Catapult's facilities (https://catapult.org.uk/about-us/why-the-catapult-network/), which include state-of-the-art infrastructure and expertise in certain areas. It is worth exploring whether bilateral collaborative programs can be developed to accelerate technology development and scale up solutions with support from the UK Catapults' infrastructure.

Highlights of Deliberations (Key Takeaways)

24. Based on synthesis across all sessions:

a) **Traceability & Transparency**

- Supply chain visibility is now a market requirement
- ESG-linked traceability is becoming non-negotiable

b) **Recycling as Industrial Strategy**

- Secondary supply must be industrialized
- Requires:
  - Collection systems
  - Processing infrastructure
  - Standards

c) **Processing Gap is the Key Bottleneck**

- India’s major gap lies in:
  - Refining
  - Separation
  - Value-added materials

d) **Need for Joint Institutional Mechanisms**

- Collaboration must move beyond MoUs
- Requires:
  - Working groups
  - Joint funding models
  - Programmatic execution

e) **Observatory as Strategic Backbone**

- Enables:

- Shared intelligence
- Policy coordination
- Investment prioritization

f) **Immediate Collaborative Opportunities (0–24 Months)**

Operationalization of the India–UK Observatory

- Joint datasets
- Dashboard for priority minerals
- Risk analytics and scenario planning

Hyperspectral & Digital Mineral Intelligence Platform

- India: Data generation (TEXMiN, field labs)
- UK: Algorithms, modeling, analytics

Circular Economy Demonstration Projects

- Battery black mass recovery
- Rare earth magnet recycling
- Industrial waste valorization

Joint Industry-Academia Programs

- UK–India fellowships
- Exchange programs
- Joint research calls

Policy & Standards Alignment

- ESG frameworks
- Traceability protocols
- Certification systems

Proposed High-Impact Collaborative Projects

A. India–UK Critical Minerals Digital Twin

- Real-time simulation of supply chains
- Risk forecasting
- Decision support system

B. Joint Processing & Refining Pilot Facilities

- UK → technology and pilot plant testing
- India → scale deployment

C. Global Supply Chain Observatory Expansion (GSCO-type)

- Expand to:
  - Africa

  - Latin America
- Position India–UK as global leaders

D. Circular Battery Ecosystem Program

- Integrated:
  - Collection
  - Recycling
  - Re-manufacturing

E. Rare Earth & Magnet Value Chain Initiative

- Strategic for:
  - EVs
  - Defence
  - Electronics

F. Critical Mineral Exploration from Primary and Secondary Resources

- Target critical minerals (Ni, Co, PGE) in mafic–ultramafic complexes of Sukinda, Baula–Nuasahi, and Singhbhum Craton via integrated petrography and geochemistry.
- Explore under-investigated Indian coasts for placer-hosted ilmenite, zircon, monazite, and REEs through systematic studies.

G. Advanced analytics for exploration data from mapping, drilling, and excavations.

- Assess the feasibility of targeted field data collection.
- Combine field data with multispectral datasets.
- Develop AI tools to analyze integrated datasets and identify prospective features in unexplored regions.

H. Mineral beneficiation economics and flow sheet development

- Critical minerals often occur in secondary deposits, increasing beneficiation costs.
- Processing depends on mineral type and concentration.
- Multiple beneficiation pathways may exist for a given mineral.
- Emphasis should be on selecting economically viable and environmentally sustainable processing routes.
- Establishing Pilot Plant Scale and Technology Demonstration Facilities
- Leveraging recent advances in modelling, simulation, circuit analysis, optimization & control, data analytics and AI-ML to leverage the past knowledge, data and experience to accelerate development of highly efficient flowsheets for the production of critical minerals from both primary resources and secondary resources including mine-waste, tailings, abandoned mines, acid mine drainage, industrial waste products including slags, fly ash, red mud etc.

I. Multi-metal extraction strategies from complex ores

- Develop integrated extraction strategies for low-grade polymetallic ores (Cu, Ni, Co, REEs).
- Apply hydrometallurgical and pyrometallurgical routes for selective recovery.
- Optimize via computational thermodynamics and AI.
- Deliver scalable, sustainable, resource-efficient process flowsheets for Indian ores.

J. Solar PV cells recycling

- Develop industrially viable end-of-life PV module delamination for maximum material recovery.
- Evaluate thermal, electrical, and chemical recycling methods.
- Recover critical metals (Cu, Ag, Al, etc.) and valorize polymer by-products.
- Enable module-specific, high-quality secondary resource generation.

K. Battery mineral research

- Focus on Li, Co, Ni, and graphite from ores and end-of-life batteries.
- Develop selective green hydrometallurgical recovery (>98% efficiency, >99% purity).
- Deliver scalable, circular, resource-efficient recycling strategies and AI for optimization.

L. Urban mining from e-waste

- Develop integrated urban mining for Cu, Au, Ni, REEs, and PGMs from e-waste.
- Employ dismantling, comminution, and advanced characterization to guide extraction.
- Use optimized hydrometallurgical and selective solvent extraction, complemented by pyrometallurgical pre-treatment.
- Leverage AI and thermodynamics for scalable, high-purity, environmentally sustainable recovery (>95–99.9%).

M. Digital Supply Chain and Critical Minerals Tracking Solutions
Modern mineral governance needs

- Blockchain traceability
- AI Supply Risk Monitoring
- Digital Mineral Passports
- ESG Compliance tracking

The UK-India Supply Chain Observatory program aims to build the necessary infrastructure to conduct the tasks outlined above.

N. Environmental impacts assessment (EIA) and management, including socio-economic

- Provide EIA and environmental management for critical mineral mining with socio-economic integration.

- Establish geological and hydrogeological baselines (rock, soil, groundwater, geochemistry).
- Predict impacts: land degradation, acid mine drainage, contamination, instability.
- Design monitoring frameworks for water, slopes, and landforms.
- Support sustainable mine closure and reclamation planning.

O. Mine planning strategies and methods of mining

- Critical minerals occur in discontinuous deposits, making conventional mine planning inadequate.
- Long-term planning requires adaptive approaches accounting for stochastic mineral grades and price variability.

P. Industry-Academia Collaboration

- Industrial Collaboration in line: Gainwell Commosales Pvt. Ltd. (GCPL) is interested in participating in bidding for critical minerals blocks and requested technical support from IIEST Shibpur with an integrated approach from different allied departments.
- Joy Mining Services (JMS) is planning to go for the extraction of critical minerals abroad (Chile and Argentina). A technical support is also expected from IIEST Shibpur.
- Synergy with IBM, MECL, GSI, SoI, IREL and HCL and other companies can help target some of these areas in a coordinated way.
- More partnerships and clarity are envisaged in the chosen target areas as the interaction begins.
- Leverage the presence of IIT(ISM) Dhanbad, CoE in critical minerals and other CoEs, as applicable, through collaborative projects in some of these areas.

Q. <u>Development of Human Resources</u> with specific skill sets needed to meet the challenges of Establishing a Robust Critical Minerals Value Chain in India

Recommendations – The Way Forward for Collaborative Efforts Between the Two Countries

1. As an outcome of visit of Prime Minister of UK to India, certain initiatives on technology and innovation were agreed upon. One important outcome was initiatives like the UK–India Critical Minerals Processing and Downstream Collaboration Guild (STRATA) which can evolve into the primary platform for project identification, industry matchmaking, and co-investment structuring between India and the UK. This initiative can be further strengthened by integrating the National Academies of both nations in the said Guild.

2. **Expediting the launch of the UK-India Critical Minerals Supply Chain Observatory** – a program which has been in progress under the UK-India Technology Security Initiative, supported by the UK Department of Science, Innovation and Technology (DSIT) and brings together University of Cambridge, IIT Bombay, TEXMiN at IIT (ISM) Dhanbad and Gujarat Mineral Development Corporation (GMDC) as an industry partner and Google Cloud as the technology partner – we should also involve other academic institutions and industry partners in India as appropriate.

   It also emerged during the discussion that this important India-UK collaborative program can also be extended to build a comprehensive data repository (with necessary protocols built into the repository for context sensitive search) of various critical minerals available in India across various primary deposits, operating mines, mine waste, tailings, mine overburden, abandoned mines, acid mine drainage, waste slags, fly ash, red-mud etc. This data repository will be extremely useful to researchers who wish to leverage recent advances in AI/ML, hyperspectral imaging, drone-based exploration, and related technologies to identify new sources of critical minerals in India. The details will have to be worked out once it is approved, but the extension of the ongoing collaborative effort between the University of Cambridge and TEXMiN to explore new deposits will be of great interest and value.

3. Considering the current priorities of India and the UK in the domain of the critical minerals as well as the commitment of both the UK government and Indian government to strengthen our ongoing partnership, it is advisable to consider pooling together our resources from both the countries and embark on an **India-UK Collaborative Centre of Excellence in Critical Minerals** for promoting Innovation Across the Complete Value Chain- the details of the proposed centre can be worked out but we have a successful centre of this kind – CEFIPRA, which has been operating for decades now. The organizational structure of the center can be worked out, but it will, of course, have an executive council with professional leaders (from academia, research institutions, and industry) active in this domain from both countries.

   We must invite proposals, consisting of principal investigators from both the countries with at least one industrial partner – with a focus to start with, scaling up some of the

proof of concepts to pilot plant or plant scale operations – the proposals must also include the development of a prefeasibility or feasibility or techno-economics of the plant operations (as applicable) – the list of challenge problems related to certain specific area of current priority can be prepared for funding - for instance,

- Innovative technologies for battery recycling, alternative battery chemistries which reduce dependence on critical minerals,
- Filling the gaps in the rare-earth magnets production value chain, including recycling of spent magnets,
- Projects to help establish the full value chain to produce lithium-ion batteries, starting from exploration of new deposits to exploitation of current deposits available in India, to developing the full value chain from lithium minerals to high-purity lithium compounds needed for lithium-ion batteries and the production of lithium-ion batteries in India, the
- Accelerated design, development and deployment of novel highly selective, green reagents for exploitation of India critical mineral resources.
- Developing innovative technology solutions for recovery of critical mineral values from secondary resources which also include mine-waste, slags, fly-ash, red-mud, abandoned mines, acid mine drainage etc. besides of course end-of-life recycling of manufactured products
- Innovative solutions to the challenging problems facing us in critical minerals domain by leveraging advances in AI-ML, including digital twins technology – for example in accelerated exploration, discovery, enhancing safety, energy efficiency and productivity of mining operations, accelerated design of novel reagents customized for a given deposit…

Appropriate IP agreements will have to be entered into by the collaborating partners and we must build appropriate protocols to facilitate it as part of the India-UK Collaborative Centre.

The proposed centre will also help develop the future professional leaders in this domain since it would not only target accomplishing certain ambitious goals in a time-bound fashion with appropriate monitoring mechanisms but will necessarily involve collaboration amongst several extremely competent professional leaders working in the industry or academic institutions in both countries and it will also include graduate students who will complete their Masters' or PhD theses (or post-doctoral fellows who will develop professional skills) while working on these projects and spending time in the reputed institutions as well as industries in both the countries, as an important component part of the project.

Our centres of excellence in this domain will provide the necessary support to embark on an ambitious program of collaboration between India and the UK in selected areas related to critical minerals, aiming to set up technology demonstration plants in each of those areas.

The proposed Indo-UK Centre can help create a database (which is continuously updated) for experts available in both countries, as well as the facilities available for testing & scale up (academic institutions/industries/national research and innovation institutions) to help those interested in building collaboration networks for specific problems/projects and/or scale up PoCs.

Based on the deliberations over these 3 days, as well as our delegates' prior experience in close interactions and collaboration with the R&D Innovation ecosystem in the UK, a few suggestions are enclosed as part of our recommendation for the way forward.

Potential Projects for Collaborative Efforts Between the Two Countries

Urban Mining

To unlock the full potential of urban mining, concerted action is needed across the supply chain:

- **Technological Upgrades:** Invest in artificial intelligence (AI), machine learning (ML), and advanced automated sorting systems to improve the speed and accuracy of material recovery.
- **Design for Disassembly:** Product manufacturers must create electronics and buildings that are easier to disassemble, repair, and recycle, prioritizing modularity in design.
- **Strengthen Regulatory Frameworks:** Governments should implement and enforce Extended Producer Responsibility (EPR) policies, forcing producers to take responsibility for the entire life cycle of their products. This includes creating standardized "end-of-waste" criteria and quality certifications for recycled materials to build trust.
- **Digitalize Urban Mines:** Develop comprehensive, AI-driven databases to map the location and volume of secondary materials, including utilizing 3D city models, BIM (Building Information Modelling), and hyperspectral imaging to track urban stock.
- **Formalize the Informal Sector:** Integrate independent waste collectors into the official supply chain by providing training, safety equipment, and fair compensation, which improves efficiency and protects workers.
- **Create Financial Incentives:** Offer tax breaks, subsidies, and grants for companies investing in urban mining infrastructure to make it financially competitive with traditional mining.

Implementing these steps can help turn "waste" into a stable source of secondary raw materials, reducing reliance on environmentally destructive traditional mining.

Urban mining in the UK is strongest in collection and innovation, but scaling extraction, refining, and a guaranteed offtake is the main bottleneck. India-UK Partnership with will help.

Hydrogen Electrolyzer Technologies

Hydrogen electrolyzers use PGM (platinum group metal)- based components, and it is desirable to develop innovative technology solutions to recover PGMs from E-waste and other secondary resource streams. Preliminary discussions with Prof Michael Turner Jones, Global Technical Director, and Dr. Elizabeth Rowsell, OBE, CTO, Johnson Matthey, suggest the possibility of developing a joint India-UK collaborative program in this domain. The Johnson Matthey team will be visiting India in June 2026, and it is proposed to organize a joint meeting during their visit.

Sodium Ion Battery Technologies

Preliminary discussions with Prof Magda Titirici, Professor of Sustainable Energy Materials in the Department of Chemical Engineering at Imperial College London, who is working on sodium-ion batteries and is also interested in collaborating with those in India, suggest the possibility of initiating a collaborative program in this area. It is of great interest and value to India.

Responsible and Sustainable Standards related to Critical Minerals

Preliminary discussions with Ms Naomi Ettrick, UK Department of Business and Trade – International Policy Adviser on Critical Minerals and Mr Simon Strickland, Critical Minerals Lead, UK Cabinet office indicate that as a follow up of the joint meeting of the Standards Bodies in both India and UK (that is, BIS – BSI) in New Delhi, we can work together to develop standards to assist professionals and industries working in the critical minerals domain in their efforts.

Conclusion: This bilateral engagement clearly establishes that India–UK collaboration can evolve into a global model for trusted, sustainable, and intelligence-driven critical mineral systems. The opportunity is not limited to securing supply chains—it is to:

- Build next-generation industrial ecosystems
- Lead global standards and governance frameworks
- Create a replicable model for allied economies
- Initiatives like the UK–India Critical Minerals Processing and Downstream Collaboration Guild (STRATA) can evolve into the primary platform for project identification, industry matchmaking, and co-investment structuring between India and the UK.
- Build a Critical Mineral midstream and downstream processing partnership between the respective industries to accelerate the scale-up and commercialization of innovative solutions in this domain
- Facilitate technology agreements across battery materials and permanent Magnet manufacturing involving graphite and rare-earth element (REE) supply chains.
- Create the necessary infrastructure to scale up innovative solutions, conduct appropriate feasibility studies, and find appropriate business models to commercialize them.
- To build a case for a ‘special economic Critical Mineral corridor’, catalyze bilateral investment corridors, and drive joint ventures.

Attendees:

List of Indian Delegates:

INAE delegates attending the in-person event in London:

1. Dr Vilas Tathavadkar, FNAE, Chief Technology Officer, Hindalco Industries Limited
2. Professor Ramaswamy Murugavel FASc FNA, Head, CoE on Critical Minerals, Metals, and Materials, IIT-Bombay
3. Dr. Samson Patole, FRSC, Principal Scientist, Tata Steel Research and Innovation Limited, United Kingdom
4. Mr. Kamisetty Yelaiah Vikram, Founder, Critical Mineral Trackers & Chairman & Managing Director, RESCMM (Rare Earths Strategic Critical Minerals, Metallurgical) and Technological Solutions Pvt Ltd

INAE delegates attending the event in online mode:

5. Mr Pradeep Chaturvedi, Vice-President, INAE
6. Dr Pradip, FNAE - Delegation Lead, Former Vice-President, INAE; Former Vice President & Former Chief Scientist, Tata Consultancy Services Ltd, Tata Research Development and Design Centre (TRDDC); International Member, NAE, USA
7. Prof Sukumar Mishra, FNAE, Director, IIT (ISM) Dhanbad
8. Prof Dheeraj Kumar, Dy. Director & Project Director (Mining Technology Innovation Hub (TEXMiN), DST), IIT(ISM) Dhanbad
9. Dr. Sandip Ghosh Choudhury, FNAE, Director, CSIR-National Metallurgical Laboratory (NML), Jamshedpur
10. Prof KK Pant, FNAE, Director, IIT Roorkee
11. Dr. Venkataramana Runkana, FNAE, Chief Scientist, TCS Research
12. Prof. V M S R Murthy, FNAE, Director, Indian Institute of Engineering Science and Technology, Shibpur (IIEST)
13. Prof BS Murty, FNAE, Director, IIT Hyderabad
14. Dr. Chinmaya Kumar Sarangi, Senior Principal Scientist, CSIR- Institute of Minerals and Materials Technology (Formerly Regional Research Laboratory), Council of Scientific & Industrial Research, Bhubaneswar
15. Muhammed Danish, CBDO, TEXMiN Foundation, DST, GoI

List of UK delegates

16. Professor David Knowles FREng, CEO, Henry Royce Institute (Technical lead)
17. Professor Frances Wall, Professor of Applied Mineralogy, University of Exeter
18. Professor Hylke J. Glass, Professor of Mining and Minerals Engineering, University of Exeter
19. Dr. Michael Turner Jones, Global Technical Director, Johnson Matthey

20. Professor Rebecca Lunn MBE FREng, Professor and Head of Centre for Ground Engineering and Energy Geosciences, University of Strathclyde
21. Dr Colin Church, CEO, The Institute of Materials, Minerals, and Mining (IOM3)
22. Dr Elizabeth Rowsell OBE, Corporate R&D Director for Johnson Matthey plc.
23. Professor Jeff Kettle, Professor of Electronic Engineering (Electronic & Nanoscale Engineering), University of Glasgow
24. Dr. Michael Keenan, Senior Principal Scientist, Ceres Power
25. Professor Magda Titirici, Professor of Sustainable Energy Materials, Imperial College London
26. Dr Gavin Harper, Engineering and Physical Sciences Faraday Institution Research Fellow, University of Birmingham
27. Dr Mukesh Kumar, Director of Global Supply Chain Observatory, University of Cambridge
28. Ms Naomi Ettrick, UK Department for Business and Trade's International Policy Advisor on Critical Minerals
29. Mr. Simon Strickland, Critical Minerals lead at the UK Cabinet Office

Bilateral exchange program on "Critical Minerals"
Royal Academy of Engineering and Indian National Academy of Engineering

Hybrid mode- 9th -11th March 2026
Agenda

9th March 2026: 9:30-12:30 GMT (15:00-18:00 IST)

9:30-9:50 UTC 15:00-15:20 IST	**Welcome and Introduction** • Opening Remarks and Address on national strategy and state of critical minerals in the UK from Professor David Knowles, FREng (UK) - 10min • Opening Remarks Address on national strategy and state of critical minerals in India Dr Pradip, FNAE (India) - 10min
9:50-10:25 UTC 15:20-15:55 IST	**Topic 1 – Sustainable and Traceable Critical Minerals Supply Chains for the Energy Transition** **Presenter**: **Professor Frances Wall** OBE - 10min **Panel Discussion:** 25min • Moderator: Professor Hylke Glass (UK) • Panellists: • Dr Colin Church • Professor Rebecca Lunn MBE FREng • Professor Dheeraj Kumar • Mr KY Vikram, FNAE (in-person) • Professor VMSR Murthy, FNAE • Q&A
10:25-11:00 UTC 15:55-16:30 IST	**Topic 2 – Re-use, Recovery, Recycling** **Presenter**: Dr Michael Turner Jones - 10min **Panel Discussion:** 25min • Moderator: Dr Colin Church (UK) • Panellists: • Professor Hylke Glass • Dr Elizabeth Rowsell OBE • Dr Sandip Ghosh Chowdhury, FNAE • Dr Venkat Runkana, FNAE • Dr Vilas Tathavadkar, FNAE (in-person) • Dr Samson Patole (in-person) • Q&A

11:00-11:35 UTC 16:30-17:05 IST	**Topic 3 – Designing for Resource Efficiency and Circularity in Energy Technologies** **Presenter**: Prof Sukumar Mishra, FNAE - 10min **Panel Discussion:** 25min • Moderator: Professor Rebecca Lunn MBE FREng (UK) • Panellists: • Dr Michael Keenan (UK) • Dr Gavin Harper (UK) • Prof KK Pant, FNAE • Prof R Murugavel (in-person) • Q&A
11:35-12:15 UTC 17:05-17:45 IST	**Topic 4 – Reducing Dependency on Scarce Materials** **Presenter**: Dr CK Sarangi & Professor Magda Titirici – (10min each) **Panel Discussion:** 20min • Moderator: Professor David Knowles FREng • Panellists: • Professor Magda Titirici • Prof BS Murty, FNAE • Prof R Murugavel (in-person) • Q&A
12:15-12:30 UTC 17:45-18:00 IST	**Concluding Remarks** Dr Pradip, FNAE (India) and Professor David Knowles FREng (UK)

Afternoon in-person schedule *Monday 9 March 2026* *Royal Academy of Engineering, Prince Philip House*	
12:40-13:40	**Lunch**
13:40-15:10	**UK x India Critical Minerals Supply Chain Observatory Discussion**
15:10-15:40	**Coffee Break**
15:40-16:20	**UK x India Technology Security Initiative Discussion**
16:20-17:00	**Discussion: Ongoing Collaboration & Next Steps**
1830 onwards	**Dinner for in-person delegates**

Tuesday 10 March 2026:

1. Virtual meeting with Johnson Matthey (where RAEng had planned a site visit). RAEng can arrange for delegates to meet virtually with site visit leads to learn more about Johnson Matthey's technologies and opportunity to ask questions.

2. Meeting with the Academy's Transforming Systems through Partnerships team, which leads on international Industry-Academia partnerships and work frequently with India.

Wednesday 11 March 2026:

1530 – 2000 IST (ONLINE) (1000-1430 UK Time):

1. **1530-1615 IST : Address by the President, RAEng**

2. **1615- 1630 IST: Short coffee break**

3. **1630- 1730 IST: Virtual Presentations**

   - **Dr Mukesh Kumar**, Director of Global Supply Chain Observatory, University of Cambridge: Presentation and discussion on the UK-India Critical Minerals Supply Chain Observatory, under the UK-India Technology Security Initiative (supported by the UK Department for Science, Innovation and Technology (DSIT) and brings together the University of Cambridge (lead), IIT Bombay, TEXMiN at IIT (ISM) Dhanbad and the Gujarat Mineral Development Corporation (GMDC), with Google Cloud as the technology partner)

   - **Prof Dheeraj Kumar**, INAE speaker to speak on India's perspective – (10-15 min)

4. **1730-1830 IST: Break**

5. **1830-1930 IST: Virtual Presentations**
   - **Naomi Ettrick**, UK Department for Business and Trade's International Policy Advisor on Critical Minerals and **Simon Strickland**, Critical Minerals lead at the UK Cabinet Office: focused discussion on UK's work and priorities in the critical minerals sector, with opportunity to discuss future of UK-India policy collaboration on this topic.

   - **Prof BS Murty**, **FNAE** INAE speaker to discuss future of UK-India policy collaboration and way forward - (10-15 min)

6. **1930-2000 IST: Virtual Presentations**
   - Presentation on the outcomes of the three days program – by Prof Dheeraj Kumar
   - Concluding remarks by Mr Pradeep Chaturvedi, Vice-President, INAE