Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

MISSION INNOVATION AUSTRIA

International Collaboration for ensuring Secure and Sustainable Critical Minerals in Clean Energy Technologies

EXECUTIVE SUMMARY REPORT

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Webinar organized under the auspices of the IEA Experts' Group on R&D Priority-setting and Evaluation (EGRD), 13 May 2022. Hosted by Austria Mission Innovation Week.

On 13 May 2022, the EGRD organized a webinar in cooperation with Mission Innovation Austria aiming to identify a number of crucial research activities related to critical minerals, the landscape of international collaboration to ensure a secure and sustainable development and how IEA TCPs may contribute to raising global knowledge around certain clean energy technologies.

Minerals are essential components in many of today's rapidly growing clean energy technologies – from wind turbines and electricity networks to electric vehicles. To give you some examples: Lithium, nickel, cobalt, manganese and graphite are crucial to battery performance, longevity and energy density. Rare earth elements are essential for permanent magnets that are vital for wind turbines and EV motors. To successfully deliver our ambition of carbon neutrality the requirements for these minerals will hugely increase, meaning that the energy sector is emerging as a major force in mineral markets.

However, their rising importance in a decarbonising energy system requires energy policy makers to consider potential new vulnerabilities, such as price volatility and security of supply.

The IEA has put forward six recommendations to build mineral security[1], one of which is to step up technology innovation at all points along the value chain - from extraction, processing to end-use in clean energy technologies such as wind turbines, solar cells, electric cars, power grids etc. This webinar aims at identifying a number of crucial research activities related to critical minerals, the landscape of international collaboration to ensure a secure and sustainable development and how IEA TCPs may contribute to raising global knowledge around certain clean energy technologies.

Key questions to be answered at the webinar were:

- What RD&D is crucial to unlock new supplies, promote more efficient use of materials, enable material substitutions, scale up recycling and improve environmental and social performance of production operations?
- Is it possible to shortcut the knowledge creation from basic science to application by means of new methods, technologies and mechanisms?
- How can governments support and accelerate RD&D in critical minerals?
- What are the best opportunities for the IEA TCPs to take forward these research questions?

The recording of the webinar is available here.

Key messages from the webinar can be clustered in three statements

Statement 1: Governments should promote R&D along the whole value chain from extraction and processing to manufacturing and end-use and recycling and decommissioning. Support should also be given to research that accelerates the innovation process itself.

Statement 2: Governments should strengthen international collaboration between producers and consumers, an area where the IEA's energy security framework could usefully be leveraged. Such an initiative could include actions to

(i) provide reliable and transparent data;
(ii) conduct regular assessments of potential vulnerabilities of supply chains and potential collective responses;
(iii) promote knowledge transfer and capacity building to disseminate sustainable and responsible development practices;
(iv) and strengthen environmental and social performance standards.

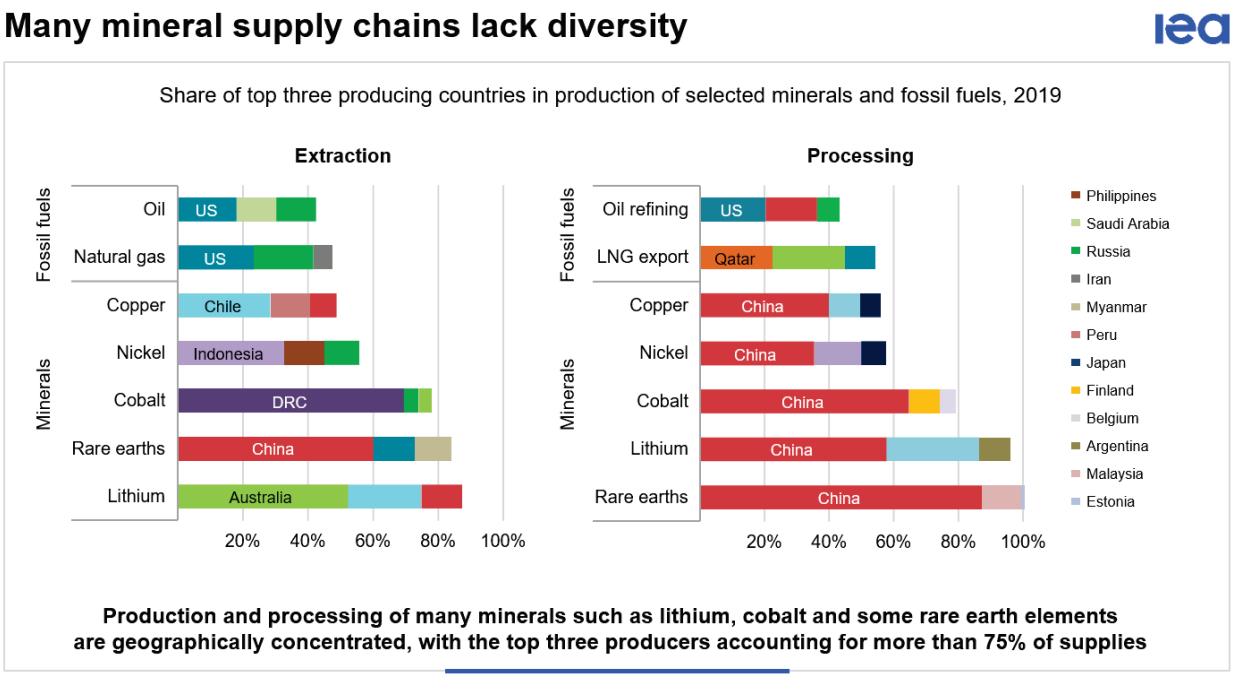
Statement 3: Governments should in particular support international cooperation related to critical minerals. The IEA has a well-functioning set-up for international technology cooperation in the Technology Cooperation Programmes (TCPs), where all member and associated countries are welcome. However, critical minerals are not properly addressed. Therefore there is a need for a higher level coordination across the TCPs and countries on R&D prioritization.

[1] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

In her welcome statement, Austrian Federal Minister for Climate Action, **Leonore Gewessler**, addressed the importance of minerals as essential components in many of today's rapidly growing clean energy technologies. In connection to successfully deliver on our climate and energy targets, the requirements of minerals will hugely increase. However, the rising importance requires policy makers to consider potential vulnerabilities, such as price volatility and security of supply.

Birte Holst Jørgensen, chair of EGRD, stressed the point that minerals are indeed critical to the transformation of our energy system, providing the example of raised ambitions of wind energy use in the North Sea. Critical minerals will be highly required in many clean energy technologies – such as in permanent magnets, batteries, electrolysers, in the power grid, etc.

In his keynote presentation, **Tae-Yoon Kim**, Energy Analyst, elaborated on the report 'the Role of Critical Minerals in Clean Energy Transitions'[2], advancing the shift from a fuel-intensive to a mineral-intensive energy system. Ultimately, clean energy technologies emerge as the fastest growing segment of demand for most minerals, evolving from a niche consumer to a leading source of demand. In many future scenarios the demand for critical minerals is set to soar as the world pursues net zero goals resulting in a mismatch between mineral supply and climate ambition. Prices for certain commodities (such as lithium or cobalt) doubled since 2021, threatening a decades-long trend in cost declines for clean energy technologies. Focusing on supply chains, many minerals are geographically concentrated, with the top three producers accounting for more than 75 % of supplies. The level of concentration is even higher for processing and refining operations, putting diversification of supply on the top of the policy agenda.



Another key issue, Tae-Yoon highlighted, is a continuous decline in resource quality leading to more energy used for the extraction, exerting upward pressure on production costs, greenhouse gas emissions and tailings volumes.

[2] https://iea.blob.core.windows.net/assets/ffd2a83b-8c30-4e9d-980a-52b6d9a86fdc/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf

Key take-away messages for R&D policy makers:

- **Promote technology innovation at all points along the value chain**. Stepping up R&D efforts for technology innovation on both the demand and production sides can enable more efficient use of materials, allow material substitution and unlock sizeable new supplies, thereby bringing substantial environmental and security benefits.
- **Scale up recycling**. Policies can play a pivotal role in preparing for rapid growth of waste volumes by incentivising recycling for products reaching the end of their operating lives, supporting efficient collection and sorting activities and funding R&D into new recycling technologies.
- **Enhance supply chain resilience and market transparency**. Policy makers need to explore a range of measures to improve the resilience of supply chains for different minerals, develop response capabilities to potential supply disruptions and enhance market transparency.
- **Mainstream higher environmental, social and governance standards**. Efforts to incentivise higher environmental and social performance can increase sustainably produced volumes and lower the cost of sourcing them. If industry players with h environmental and social standards are rewarded in the marketplace, it can bring new suppliers to a more diversified market.
- **Strengthen international collaboration**. An overarching international framework for dialogue and policy co-ordination among producers and consumers can play a vital role. Such an initiative could include actions to (i) provide reliable and transparent data; (ii) conduct regular assessments of potential vulnerabilities of supply chains and potential collective responses; (iii) promote knowledge transfer and capacity building to spread sustainable and responsible development practices; and (iv) strengthen environmental and social performance standards to ensure a level playing field.

Session II focused what RD&D topics and priorities along the value chain of critical minerals are needed or should be prioritised. Speakers and representatives from Canada, the European Union, the U.S. and Japan provided inputs on national strategies, their research on material and mineral supply chain analysis or innovative technologies and methods relevant to securing and strengthening mineral supply.

Mark S. Kozdras, Natural Resources Canada, put light on new material discovery and supply chain aspects. Mark started from the point that it needs new ways to connect supply chains, especially when it comes to circularity approaches. Opportunities can be seen in (i) novel process technologies, such as improved refinement and recovery methods from waste and dilute sources, (ii) novel materials and devices and (iii) an increased localisation of process systems, such as end-product markets. Mark went into detail about his work at the Mission Innovation Initiative advocating autonomous or self-driving materials laboratories. Through experimental planning, artificial intelligence (AI) and robotic systems new materials that can replace critical minerals are studied on a laboratory scale leading to better and more rapid results given the highly complex environment. Mark highlighted some of the various applications where accelerated materials development is relevant to critical minerals, such as the silicon replacement in organic thin films and organic solar cells, platinum group metal optimisation and replacement in electrolysers and fuel cells or novel processes for lithium extraction from brine solutions.

Michalis Christou, Senior Expert at the European Commission JRC, provided a critical look at the material and supply chain challenges in the European Union. In the light of the REPowerEU action plan for more affordable, secure and sustainable energy the resilience of supply chains is critical to the EU. In line with the analysis of the IEA, the material demand projections result in a significant increase for materials used

in clean energy technologies, especially rare earth elements (REE) used in wind power. The following supply chain analysis identified supply risks, key players and bottlenecks. In order to increase the resilience of the EUs supply chains, R&D policy makers should (i) systematically identify risks and diversify the material supply, (ii) increase the domestic manufacturing capacity, (iii) foster research and practices enhancing recycling, reuse and substitution, and (iv) promote R&D and international cooperation.

Diana Bauer, Acting Deputy Director at the U.S. Department of Energy, reflected on the big picture strategy and priorities of the Department of Energy. As a focal point, the strategy can be seen as a comprehensive approach to secure and strengthen the rare earth element supply chain, from basic research, development and demonstration activities to the expansion to commercialisation and deployment activities. Policies to put the strategy in action include a critical mineral stockpile, bilateral and multilateral cooperation as well standards to promote supply chain transparency and traceability. By providing the example of a neodymium-iron-boron magnet, Diana visualised the reliance and dependencies of U.S. commercial capacities in the up-, mid- and downstream. Like in the EU, the U.S. is vulnerable especially in mid- and downstream activities, such as the separation, processing and the manufacturing of clean energy technology components.

In the final presentation of session II, **Chiharu Tokoro**, Professor at Waseda University in Tokyo, focused on her research of resources separation technologies. Currently, these technologies are often highly energy-intensive, expensive, and have a negative environmental impact. To change this, she developed an innovative separation process using electrical power for the separation of rare earth elements (REE) from solar panels and from lithium-ion batteries (LIBs) used in electric vehicles. By peeling off the positive electrode particles from aluminium foil in LIBs, the material is less damaged and can be even reused. In the case of PV cells, copper and silver wires were selectively recovered from the cell and completely liberated. The positive environmental impact compared to conventional recycling processes is remarkable in terms of GHG emissions and resource depletion.

Key take-away messages from this session for R&D policy makers:

- **Reducing material intensity and encouraging material substitution** via technology and process innovation can also play major roles in alleviating strains on supply. Policy makers should assess public RD&D spending on these technologies.
- **Material informatics**, such as autonomous or self-driving material laboratories using AI and robotic systems offer a high potential to increase productivity and to find optimal materials from multivariable characterisation.
- **Novel disintegration processes and technologies** offer quite some potential for the recovery and reuse of materials and REE. The emerging research field would strongly benefit from international collaboration and cooperation.

A panel of distinguished experts discussants - **K.C. Michaels** (Legal Advisor, IEA), **Bert Witkamp** (representative from TCP HEV – task 40 Critical raw materials for EV) and **Mark Kozdras** further discussed how to bridge the gap between basic and applied research and speed up the knowledge transfer and in particular the role for international coordination/cooperation in critical materials.