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Securing access to critical raw materials in the United Nations Economic Commission for Europe region: challenges and opportunities

Securing Access to Critical Raw Materials in the United Nations Economic Commission for Europe Region: Challenges and Opportunities

Note by the Secretariat

Summary

This note delves into the significant issues of accessing critical raw materials, which play a vital role in low-carbon energy transition and various sectors, including renewable energy, digital technologies, and healthcare. It outlines the primary challenges and risks that impact the demand and supply of critical raw materials, such as geopolitical tensions, environmental impacts, market distortions, and technological changes. Additionally, it explores alternative policy options that can enhance the resilience and sustainability of the critical raw materials value chain. These options include diversifying primary sources, promoting a circular economy, fostering innovation and cooperation, strengthening governance and transparency, and increasing investments. It is recommended that these policy options be combined with the adoption of the United Nations Framework Classification for Resources (UNFC) and the United Nations Resource Management System (UNRMS) to ensure secure and responsible access to critical raw materials in the United Nations Economic Commission for Europe (ECE) region. By taking a comprehensive approach, the ECE region can ensure the continued availability of critical raw materials for years to come.



I. Introduction

1. Critical raw materials (CRMs) are essential for various sectors, such as renewable energy, digital technologies, health care, etc. For example, lithium, cobalt, and copper are needed for batteries and electric vehicles; rare earths are used for wind turbines and magnets; silicon is a crucial component of solar panels and microchips; and platinum is used for fuel cells and catalysts. CRMs are also vital to achieving the Sustainable Development Goals (SDGs) and the Paris Agreement, as they enable the transition to a low-carbon and circular economy. And the demand for CRMs is expected to increase exponentially by 2050¹, while their supply faces various challenges and risks.² Therefore, ensuring secure and responsible access to CRMs is a strategic priority for the United Nations Economic Commission for Europe (ECE) Region.³

2. This note serves as a follow-up to the document presented at the 31st Session of the Committee on Sustainable Energy in September 2022, which provided a rationale, background, and potential avenues for sustainably developing a framework to manage CRMs within the ECE region.⁴ The aforementioned document provides details of CRM applications and estimated demand and supply issues.

3. The ECE region is one of the major producers and consumers and has the world's highest trade flows of critical minerals. The region has a rich and diverse endowment of critical minerals, such as cobalt, copper, graphite, lithium, nickel, rare earth, silicon, and titanium, essential for various sectors and technologies. The region also has a strong capacity for innovation and value addition in the critical mineral value chain and environmental and social sustainability. However, the region faces challenges and risks in ensuring secure and responsible access to critical minerals, such as geopolitical conflicts, market volatility, supply disruptions, and negative environmental and social impacts. Therefore, there is a need for effective and coordinated policies to address these issues and enhance the resilience and competitiveness of the ECE region in the global clean energy transition.

4. The future of accessing critical raw materials in the ECE region will be impacted by various factors, including implementing closed-loop systems, intelligent resource management that utilizes Artificial Intelligence (AI) and Machine Learning (ML) technologies, and ongoing research into new materials. These strategies are designed to address the growing demand for these materials while creating a more sustainable and responsible approach to their use. By leveraging advanced technologies and innovative approaches to material management, we can ensure that these critical resources are utilized most effectively and efficiently as possible while minimizing waste and reducing our overall environmental impact.

5. This note examines the issue of access to CRMs in the ECE region based on recent studies, reports, and data from various sources. It identifies the main challenges and opportunities for the ECE region regarding CRMs supply and demand. It presents five policy alternatives that could address the problem. These policy alternatives are: diversifying primary sources, promoting a circular economy, fostering innovation and cooperation, strengthening governance and transparency, and increasing investments for sustainable CRMs production and use.

6. Further, this note provides policy recommendations on the best options for the ECE region and some practical suggestions for implementation. Furthermore, it highlights how the United Nations Framework Classification for Resources (UNFC) and the United Nations Resource Management System (UNRMS) can be effective frameworks for integrating these

¹ ECE - Critical Raw Materials. <https://unece.org/unece-and-sdgs/critical-raw-materials>.

² UN Climate Champions (2022) Geneva Forum signals blended climate finance and circularity of critical raw materials in UNECE regions. <https://climatechampions.unfccc.int/geneva-forum-signals-blended-climate-finance-and-circularity-of-critical-raw-materials-in-unece-regions/>.

³ ECE (2023) UN Framework Classification for Resources will be instrumental in the EU Critical Raw Materials strategy. <https://unece.org/media/press/376907>.

⁴ ECE (2022) Sustainable management of critical raw materials required for the low-carbon energy transition – Draft for discussion. https://unece.org/sites/default/files/2022-09/ECE_ENERGY_2022_6%20CRMs.pdf

policy alternatives and providing countries with a pathway for successful transformation to a new generation of low carbon energy and natural resource management. UNFC and UNRMS can help governments assess, classify, monitor, and manage their resources of CRMs holistically, transparently, and sustainably.

7. This note also pays special attention to Central Asia's landlocked developing countries (LLDCs), which face additional challenges in accessing CRMs due to their geographical isolation and lack of infrastructure. These countries have limited connectivity and high transport costs, which affect their trade competitiveness and economic diversification.⁵ ⁶ They also need higher infrastructure financing and investment levels, constraining their development potential and resilience.⁷ The note additionally explores how these countries could benefit from regional cooperation, integration, and international support and assistance to overcome their constraints and leverage their potential in CRMs production and use. For example, some of these countries have rich deposits of CRMs, such as copper in Kazakhstan and rare earth elements in Kyrgyzstan, which could be developed and traded within the region and beyond. They could also enhance their circular economy practices, innovation capacities, governance standards, and investment opportunities in CRM sectors.⁸

II. Why Critical Raw Materials Matter: The Opportunities and Challenges for the ECE Region

8. CRMs are those raw materials that are economically and strategically important for the economy, especially for energy transitions. They have a high-risk associated with their supply. The CRMs list could differ from country to country. There are over 40 materials that have been identified as critical by Canada, European Union, Japan, and the United States. The need for CRMs is predicted to rise significantly by 2050 due to the shift towards a more sustainable and circular economy.

9. The European Union estimates that the demand for lithium could increase by 18 times, cobalt by 15 times, and rare earths by ten times by 2050, compared to the 2015 baseline.⁹ However, the supply of CRMs faces various challenges and risks that could affect their availability and affordability, such as geopolitical conflicts, environmental degradation, market volatility, and technological disruption. These factors could undermine the ECE region's economic competitiveness, social well-being, and environmental sustainability, which relies heavily on CRMs for its industrial base and innovation potential. For example, Europe imports more than 90 per cent of its cobalt and rare earths outside the region, making it vulnerable to supply disruptions and price fluctuations.¹⁰ Moreover, the extraction and processing of CRMs have significant environmental and social impacts, such as greenhouse gas emissions, water pollution, land degradation, and human rights violations.

10. One of the main challenges is the need for more investment in mining and processing CRMs. The global investment in mining key energy transition minerals was less than 1 per

⁵ ECE (2019) Addressing challenges faced by Landlocked Developing Countries in Europe and Asia. <https://unece.org/transport/news/addressing-challenges-faced-landlocked-developing-countries-europe-and-asia>

⁶ ESCAP (2020) Infrastructure Financing in Asian Landlocked Developing Countries: Challenges, Opportunities and Modalities. https://www.unescap.org/sites/default/files/Infrastructure_Financing_Challenges_Opportunities_and_Modalities_in_LLDCs_ids.pdf

⁷ UN-OHRRLS (2019) Review of Progress made in structural economic transformation in Euro-Asian landlocked developing countries (LLDCs). https://www.un.org/ohrrls/sites/www.un.org.ohrrls/files/review-of-progress-made_2019.pdf

⁸ ECE (2022) Ensuring a sustainable supply of critical raw materials is essential for achieving low-carbon energy transition. <https://unece.org/media/press/372723>

⁹ European Parliament (2023) Securing Europe's supply of critical raw materials. [https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2023\)739394](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2023)739394)

¹⁰ European Parliament (2023) Critical raw materials act. [https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2023\)747898#:~:text=On%2016%20March%202023%2C%20the,technologies%20and%20vulnerable%20to%20shortages.](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2023)747898#:~:text=On%2016%20March%202023%2C%20the,technologies%20and%20vulnerable%20to%20shortages.)

cent of the total investment in the energy sector in 2020.¹¹ This could lead to supply shortages and higher prices in the future. Another challenge is the increased price volatility of CRMs, which is influenced by various factors, such as supply-demand imbalances, geopolitical tensions, trade disputes, and market speculation. For example, the price of cobalt increased by more than 300 per cent between 2016 and 2018 due to rising demand and supply disruptions.

11. A third challenge is the higher supply risk of CRMs, which is related to their geographic concentration and dependence on a few countries or regions. For instance, China accounts for more than 60 per cent of the global production and refining of rare earths, which are vital for magnets and electronics. This could expose the importing countries to potential supply disruptions or restrictions.

12. A fourth challenge is the negative environmental and social impacts of CRMs extraction and processing, such as greenhouse gas emissions, water pollution, land degradation, and human rights violations. These impacts could undermine the sustainability goals of the clean energy transition and create social conflicts and grievances. Therefore, there is a need for effective and coordinated policies to ensure secure and responsible access to CRMs in the ECE region. Responsible mining is a concept that encompasses various aspects of good governance, environmental stewardship, social responsibility, and economic viability in the mining sector. It aims to ensure that mining activities are conducted in a way that respects human rights, protects the environment, benefits local communities, and contributes to sustainable development. Responsible mining can also enhance the sustainability outcomes of the clean energy transition by reducing the demand for CRMs, improving their efficiency and circularity, and creating new opportunities for value addition and innovation.

13. It is crucial to address the challenges mentioned above to maintain the ECE region's economic competitiveness, social well-being, and environmental sustainability. Since CRMs are vital for the region's industrial base and innovation potential, it is essential to implement effective and coordinated policies. These policies must ensure responsible and secure access to CRMs while minimizing negative impacts and optimizing positive opportunities linked to CRMs' production and use.

A. Focus on landlocked developing countries of Central Asia

14. In the ECE region, Central Asia stands out as a sub-region of landlocked developing countries (LLDCs) that faces specific challenges to sustainable development due to its geographical isolation and lack of access to the sea. These challenges include high transport costs, limited connectivity, low trade competitiveness, and dependence on transit countries. These factors affect the economic growth, social well-being, and environmental sustainability of the countries. Moreover, Central Asia is highly vulnerable to the impacts of climate change, such as melting glaciers, water scarcity, desertification, and natural disasters. These impacts threaten their food security, energy security, and ecosystem services.¹² Therefore, Central Asia needs to enhance its resilience and adaptation capacities and regional cooperation and integration to overcome these challenges and achieve the SDGs.¹³

15. The region of Central Asia boasts a wealth of natural resources, including CRMs. The acquisition of CRMs is paramount in attaining the SDGs in this sub-region. However, Central

¹¹ G20 Policy Brief (2023) Ensuring Sustainable Supply of Critical Minerals for a Clean, Just and Inclusive Energy Transition. https://t20ind.org/wp-content/uploads/2023/05/T20_PolicyBrief_TF4_CriticalMinerals.pdf

¹² United Nations (2022) Amid challenges, hope emerges in Central Asia. <https://www.un.org/sustainabledevelopment/blog/2022/07/amid-challenges-hope-emerges-in-central-asia/>

¹³ COP 27 (2022) Summary Report of the High-level Side Event on “Strengthening Climate Action in landlocked developing countries: Experiences on adaptation and mitigation.” https://www.un.org/ohrrls/sites/www.un.org.ohrrls/files/2022_summary_report_lldcs_and_climate_action_-_9_nov.pdf

Asia faces unique challenges in accessing CRMs, owing to its geographical remoteness and inadequate infrastructure. As a result, there is a pressing need for sustainable, safe, and resilient development in Central Asia, facilitated by the integrated and sustainable management of natural resources.

16. A significant challenge facing initiatives aimed at enhancing CRM resources in Central Asia, especially Kazakhstan, is that information on these materials currently needs to be classified as a state secret. Therefore, it is essential to introduce new legislation that will enable the identification of CRM resources as per the UNFC and UNRMS framework. This will require implementing a modern reserve management system in Central Asian countries that can estimate, manage, and increase the volume of CRMs. Such a system can be linked to sustainable supply chains and demand, thus promoting responsible and effective utilization of these valuable resources.

17. Therefore, it is imperative to consider the unique needs and circumstances of each Central Asian country when considering the implementation of natural resource management strategies in the region. Adequate capacity must be established to carry out these strategies effectively. Furthermore, the engagement and consultation of local communities and stakeholders throughout the process are essential to ensure that the strategies are responsive to their needs and priorities. To optimize the utilization of Central Asia's critical raw materials for economic growth, social well-being, and environmental protection, efforts should be made to enhance regional cooperation and integration, as well as innovation and sustainability capacities.

B. United Nations Framework Classification for Resources and the United Nations Resource Management System

18. UNFC and UNRMS play crucial roles in promoting the sustainable and responsible development of CRMs). In light of the intricate interplay between the production, utilization, and recycling of CRMs and their impact on society, the environment, and the economy, comprehensive systems like UNFC and UNRMS are imperative for effective and integrated natural resource management. UNFC provides a standardized framework for classifying and categorizing resources, facilitating accurate assessment and comparison of resource potential across different regions and countries. This classification system enables improved decision-making processes regarding resource allocation, planning, and investment strategies. By establishing a common language and methodology, UNFC ensures that resource development is undertaken transparently and accountably, contributing to sustainable development goals.

19. Complementing UNFC, UNRMS is a comprehensive management system that addresses the entire life cycle of resources, encompassing exploration, production, utilization, recycling, and final disposal. It enables the efficient and responsible management of resources, considering environmental, social, and economic aspects. UNRMS promotes the adoption of best practices and encourages the integration of sustainability principles into resource management strategies. Together, UNFC and UNRMS provide a robust framework for the complex and integrated management of critical raw materials, emphasizing the importance of sustainable development and responsible resource utilization for the benefit of present and future generations.

20. UNFC and UNRMS have been adopted by a number of countries and organizations globally. UNFC provides a standardized framework for reporting and comparing natural resource data. It has been widely promoted by the European Union and its Member States as a resource governance strategy. In Africa, UNFC and UNRMS are adopted by the African Union and its Member States as valuable tools for sustainable natural resource management for implementing the African Mining Vision. Using UNFC and UNRMS as a framework for natural resource management has become increasingly important as critical raw material supply chains are increasingly globalized and complex. Using these frameworks, countries can effectively manage their natural resources to ensure future availability and security while promoting sustainable development.

III. The policy options

21. In addressing the issue of securing access to CRMs within the ECE region, a range of policy options can be considered. Specifically, five key policy options are available for examination to determine the most optimal path for moving forward. Careful analysis and consideration of these options must be undertaken to ensure the effective and efficient management of access to CRMs within this region (Figure I).

Figure I

Policy options for securing access to critical raw materials in the ECE Region



A. Diversifying primary sources

22. To ensure access to critical raw materials in the ECE region, it is crucial to address the challenges and opportunities associated with diversifying sources of CRMs. One practical approach is to expand and diversify the sources of CRMs by exploring new deposits and increasing primary production. This involves exploring and developing new deposits to expand and diversify the primary sources of CRMs. Doing so could reduce dependence on a few countries or regions, boost competition and innovation, and lower prices. However, this option may incur high costs, environmental impacts, social conflicts, and political risks.

23. The ECE region covers over 47 million square kilometres and includes 56 member states in Europe, North America, Central Asia, and Western Asia. These countries have diverse geological settings that may host deposits of CRMs. The geological potential for CRMs in the ECE region varies depending on the type and age of the rocks, the tectonic history and the mineral systems operating in different areas.¹⁴ For example, lithium and graphite are often associated with magmatic rocks that have undergone high degrees of fractionation or metasomatism, such as granites, pegmatites, and skarns.¹⁵ Cobalt and rare earth elements may be found in hydrothermal deposits related to volcanic or sedimentary processes, such as volcanogenic massive sulfides or carbonatites. Tungsten and antimony are typically concentrated in vein deposits formed during regional metamorphism or deformation, such as orogenic belts or shear zones.

24. The ECE region has a long mining and mineral exploration history. However, many CRM deposits still need to be explored or discovered. There is a need for more research and innovation to improve the understanding of the geology and mineralogy of CRM deposits, to develop new methods and technologies for exploration and extraction, to enhance the

¹⁴ Smelror, Morten, Karen Hanghøj, and Henrik Schiellerup, eds. (2023) *The Green Stone Age: Exploration and Exploitation of Minerals for Green Technologies*. Geological Society, London, Special Publications 526. London: Geological Society of London. <https://doi.org/10.1144/SP526>.

¹⁵ British Geological Survey (2023) *Critical raw materials*. <https://www.bgs.ac.uk/geology-projects/critical-raw-materials/>

efficiency and sustainability of mineral processing and metallurgy, and to promote the circular economy and recycling of CRMs.

25. The proposed European Union Critical Raw Materials Act¹⁶ aims to reduce the EU's dependency on imports of critical raw materials by increasing the domestic capacity for mining, extraction, processing, and refining. The Act proposes to:

- Establish a list of strategic raw materials that are crucial for strategic technologies and sectors, such as renewable energy, digital, space and defence
- Set targets for achieving a high degree of self-sufficiency by 2030, such as at least 10 per cent of domestic demand for mining and extraction and at least 40 per cent for processing and refining
- Support the development of sustainable and responsible mining projects in the EU in line with environmental, social and governance standards
- Enhance the EU's geological knowledge and data on critical raw materials' potential and availability
- Promote cooperation and coordination among EU Member States, regions, industry and civil society to foster a shared vision and strategy for critical raw materials.

26. The region, including Eastern, Southeastern Europe and CIS sub-regions, has diverse and significant mineral resources, including many critical materials. The sub-regions have large deposits of base metals (Cu, Pb, Zn), precious metals (Au, Ag), rare metals (W, Mo, Sn, Nb, Ta) and rare earth elements (REEs), as well as industrial minerals (borates, magnesite, kaolin).¹⁷ Some of the significant CRM deposits in the sub-regions are:

- The Borate Belt in Turkey hosts the world's largest borate reserves and production
- The Balkan Peninsula, which contains several polymetallic and gold deposits with high concentrations of Bi, Te, In and Sb
- The Carpathian Arc, which hosts porphyry copper deposits with significant by-products of Au, Ag, Mo and Re
- The Dinarides contain considerable resources of bauxite, magnesite and chromite
- The Urals, which host various types of ore deposits with high contents of Ni, Co, Pt, Pd and REEs
- The Central Asian Orogenic Belt is rich in porphyry copper, gold and polymetallic deposits with potential Li, Be, W, Sn and REEs.

27. Central Asia is rich in mineral resources, including many critical materials. The region has mineable reserves of most critical materials, such as lithium, cobalt, nickel, rare earth metals, tungsten, gallium, indium and tellurium. Kazakhstan, Uzbekistan and Tajikistan have the highest diversity and potential of critical materials. In contrast, Kyrgyzstan and Turkmenistan have moderate potential for some of them. Central Asia could become a significant global supplier of selected essential materials for the energy transition.¹⁸

28. The British Geological Survey (BGS) has identified areas of the United Kingdom that are potentially prospective for several CRMs, based on a mineral systems approach that combines geological data and criteria. Regions from Scotland's Highlands to south-west England that have the suitable geology to host deposits of CRMs, such as lithium and graphite in granites and pegmatites, cobalt and rare earth elements in volcanogenic massive sulfides

¹⁶ European Commission (2023) Critical Raw Materials Act. https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en

¹⁷ Jonsson, Erik, et al. (2023) Critical Metals and Minerals in the Nordic Countries of Europe: Diversity of Mineralization and Green Energy Potential. Geological Society, London, Special Publications, vol. 526, 2023, <https://doi.org/10.1144/SP526-2022-55>.

¹⁸ Roman Vakulchuk and Indra Overland (2021) Central Asia is a missing link in analyses of critical materials for the global clean energy transition, *One Earth*, Volume 4, Issue 12, <https://doi.org/10.1016/j.oneear.2021.11.012>.

and carbonatites, and tungsten and antimony in vein deposits. Being prospective does not necessarily mean that exploration and mining will be feasible or desirable in these areas, as there are many other factors to consider, such as environmental, social and economic aspects.

29. The North American sub-region has abundant and diverse mineral resources, including many critical materials for clean energy technologies.¹⁹ Large deposits of base metals (Cu, Ni, Zn), precious metals (Au, Ag, PGMs), rare metals (W, Mo, Sn, Nb, Ta) and rare earth elements (REEs), as well as industrial minerals (borates, graphite, lithium, potash), have been identified in:

- The Canadian Shield, which hosts world-class deposits of Ni-Cu-PGMs, REEs, Nb-Ta and graphite
- The Cordillera, which contains porphyry copper deposits with significant by-products of Mo, Au and Re
- The Appalachian Mountains, which host several polymetallic and gold deposits with high concentrations of Bi, Te, In and Sb
- The Great Basin, which is rich in gold and silver deposits with the potential for Li, Be and Ge
- The Colorado Plateau, which contains significant resources of uranium, vanadium and potash
- The Boron Basin in California hosts the world's largest borate deposit.

30. Diversification of sources of CRMs is a key strategy to enhance the security and sustainability of resource supply in the ECE region. By diversifying sources, countries can reduce their dependence on a few suppliers, mitigate supply risks, foster innovation and competition, and benefit from lower prices. However, diversification also entails challenges and risks, such as high costs, environmental impacts, social conflicts, and political uncertainties. To address these challenges, policies should encourage responsible and sustainable practices throughout the entire life cycle of critical minerals. This includes promoting research and development in recycling and substitution technologies, reducing waste and promoting circular economy approaches. UNFC and UNRMS are tools that support sustainable resource management by providing a common language and methodology for classifying, accounting and reporting on all types of resources. Policymakers in the ECE region should use these tools to pursue diversification strategies that balance social, environmental and economic objectives and ensure the availability of CRMs for economic growth and technological advancements.

B. Promoting circular economy

31. A practical option for securing access to CRMs in the ECE region is to increase the efficiency and durability of CRMs, by reducing waste, reusing materials, recycling products, and recovering resources. This could extend the life cycle of CRMs, decrease demand and consumption, and mitigate environmental impacts. However, this option could face technical, economic, and regulatory barriers, such as a need for more infrastructure, incentives, and standards. UNFC and UNRMS could offer excellent tools for addressing these issues and promoting a circular economy.

32. The circular economy is a concept that aims to minimize waste and maximize value by keeping resources in use for as long as possible, recovering and regenerating products and materials at the end of their service life and designing out waste and pollution. The circular economy can help reduce the environmental footprint of resource extraction and use, enhance resource security and efficiency, and create new business opportunities and jobs. Some of the ways to achieve a circular economy from an ECE regional perspective include:

¹⁹ Gadd, Michael G., et al. (2022) Public Geoscience Solutions for Diversifying Canada's Critical Mineral Production. Geological Society, London, Special Publications 526. <https://doi.org/10.1144/SP526-2021-190>.

- Developing and implementing policies and regulations that support circular economy principles, such as extended producer responsibility, eco-design, waste prevention and management, green public procurement, and resource efficiency
- Promoting innovation and digitalization in producing and consuming goods and services, such as using traceability systems, smart contracts, blockchain, and artificial intelligence to enhance transparency, accountability, and circularity along value chains
- Enhancing cooperation and coordination among stakeholders, such as governments, businesses, civil society, academia, and international organizations, to share knowledge, best practices, and experiences on circular economy solutions
- Investing in capacity-building and awareness raising on the benefits and opportunities of the circular economy for economic growth, social development, and environmental protection.

33. Integral to securing access to CRMs in the ECE region is to reduce carbon footprints associated with CRMs production and use. Reducing the carbon footprints of CRMs can help mitigate climate change impacts, improve air quality and public health, and enhance energy security and efficiency.

34. The Circular Carbon Economy (CCE) is a concept that applies circular economy principles to managing carbon emissions. CCE aims to minimize the release of carbon dioxide and other GHGs into the atmosphere by reducing, reusing, recycling and removing carbon. CCE can help mitigate climate change impacts, improve air quality and public health, and enhance energy security and efficiency.

35. CCE can support low-carbon technologies using CRMs, such as electric vehicles and renewables, to decarbonize sectors like transport and power. CCE can also incentivize CRMs producers and users to cut emissions through carbon pricing mechanisms, cleaner technologies, and low-carbon alternatives. CCE can also boost research and development on low-carbon CRM extraction, processing and utilization, leading to greener methods, carbon capture and storage, and sustainable manufacturing. CCE can also enable international collaboration on carbon reduction, such as knowledge sharing, technology transfer, and joint research on CRMs.

36. There are several ways to reduce carbon footprints related to CRM production and use, such as:

- Supporting developing and deploying low-carbon technologies that rely on CRMs can help reduce emissions across various sectors. For example, electric vehicles, wind turbines, solar panels, batteries and fuel cells can help decarbonize the transport, power generation and storage sectors
- Implementing carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, can create financial incentives for CRMs producers and users to reduce their carbon emissions. This can encourage the adoption of cleaner technologies, improve energy efficiency, and promote low-carbon alternatives
- Investing in research and development focused on low-carbon CRMs extraction, processing, and utilization can lead to technological advancements that reduce carbon emissions throughout the CRM life cycle. This can include developing greener extraction methods, exploring carbon capture and storage technologies, and advancing sustainable manufacturing processes
- Engaging in international collaboration on carbon reduction can provide a framework for addressing carbon emissions associated with CRMs production and use. Collaborative efforts can include knowledge sharing, technology transfer, and joint research and development initiatives aimed at reducing the carbon footprint of CRMs globally.

37. UNFC and UNRMS can support the implementation of circular economy principles by providing a common framework and methodology for classifying, accounting and reporting on all types of resources, including primary and secondary resources. Secondary

resources are derived from anthropogenic sources, such as waste materials, end-of-life products, industrial by-products and urban mining.

38. UNFC and UNRMS can help identify, quantify and evaluate the potential of primary and secondary resources, considering their social, environmental and economic viability, technical feasibility and degree of confidence. UNFC and UNRMS can also help monitor the progress of resource projects along the value chain, from exploration to extraction to processing to recycling to recovery. By applying UNFC and UNRMS to primary and secondary resources, policymakers, industry players, and investors can have a holistic view of the resource base and sustainably optimize its management.

39. Circularity is one of the core principles of UNRMS. The goal of circularity is to reduce waste and increase value by prolonging the use of resources, recycling and renewing products and materials at the end of their lifespan and eliminating waste and pollution through thoughtful design. Circularity is relevant to CRMs, as it can help reduce the environmental footprint of resource extraction and use, enhance resource security and efficiency, and create new business opportunities and jobs. UNRMS provides a comprehensive framework and methodology for classifying, accounting, and reporting primary and secondary resources, enabling the support of circularity. Furthermore, UNRMS facilitates tracking resource projects throughout the value chain, from exploration to extraction, processing, recycling, and recovery. Applying UNRMS to primary and secondary resources offers policymakers, industry leaders, and investors a holistic perspective of the resource base, allowing for sustainably optimized management.

40. Resource servitization is a concept that shifts the focus from selling products to providing services that meet customers' needs and outcomes. It can help reduce resource consumption, extend product life cycles, and create value for producers and users.²⁰ Resource servitization is addressed as a principle (service orientation) in UNRMS. Service orientation ensures that resource management delivers a public good supporting the transition to a circular economy. Service orientation also implies that resource management considers states' rights and responsibilities, people's health and safety, and the planet's responsibility. The implementation of UNRMS can facilitate adopting of a service-oriented approach by providing a standardized framework and methodology for categorizing, tracking, and reporting all types of resources, including primary and secondary ones. Additionally, UNRMS can assist in monitoring the progress of resource projects across the value chain, from exploration and extraction to processing, recycling, and recovery. By leveraging UNRMS for primary and secondary resources, policymakers, industry participants, and investors can comprehensively view the resource base and optimize its sustainable management.

41. A carbon-neutral digital platform could facilitate regional collaboration on reducing carbon footprints related to CRMs production and use. A carbon-neutral digital platform is a web-based platform that enables data collection, analysis and reporting on carbon emissions from various sources along the CRMs value chain. The platform could also provide information on best practices, policies and technologies for reducing carbon emissions and opportunities for networking, partnerships and funding. A carbon-neutral digital platform could help stakeholders in the ECE region to monitor their progress towards achieving net-zero targets and promote circular economy practices to reduce waste and conserve natural resources.

C. Fostering innovation and cooperation

42. To secure access to CRMs in the ECE region, fostering innovation and cooperation is essential. This can be achieved by enhancing research and development (R&D) efforts, supporting collaboration, and promoting knowledge sharing among various stakeholders, including industry, academia, government, and civil society.

²⁰ ECE (2022) Resources as a Service: A catalyst to accelerate the energy transition, safeguarding climate action targets within the circular economy – Draft for discussion.
https://unece.org/sites/default/files/2022-09/ECE_ENERGY_2022_7%20RaaS_0.pdf

43. Investing in R&D and innovation initiatives can yield significant benefits. By supporting the advancement of CRMs, new solutions and alternatives can be developed, enhancing their quality and performance. This, in turn, can foster competitiveness and drive economic growth in industries that rely on CRMs. Encouraging innovation also opens up opportunities for creating new materials and technologies that contribute to a non-carbon economy and sustainable development.
44. Fostering innovation and cooperation requires substantial investments and coordination. Adequate funding should be allocated to support R&D activities, facilitate collaboration, and establish platforms for knowledge exchange. Public-private partnerships can be formed to leverage the expertise and resources of both sectors, ensuring a more comprehensive and practical approach to innovation.
45. Protecting intellectual property rights is another crucial aspect when promoting innovation. Measures should be implemented to safeguard intellectual property and incentivize companies and researchers to share their findings while protecting their investments. This balance between openness and protection is crucial to create a vibrant and integrated ecosystem that stimulates ongoing research and development.
46. In terms of specific research areas, a broad range of fields should be explored to unlock the full potential of CRMs. Advanced research in materials science, energy conservation and transport, cryogenics, quantum matter, astrophysics, optical physics, high-energy physics, optoelectronics, non-silicon electronics, compressed matter theory, digitalization, big data, biology, chemistry, biotechnology, oncology, medicine, earth sciences, and others is essential. These interdisciplinary efforts can lead to groundbreaking innovations and discoveries that utilize the unique properties of CRMs.
47. Besides fostering innovation, enhancing stakeholder cooperation is crucial for securing access to CRMs. Establishing an International Centre of Excellence on Sustainable Resource Management (ICE-SRM) can be a platform for knowledge sharing, collaboration, and capacity-building. Such an ICE-SRM can facilitate the exchange of best practices, conduct joint research projects, and develop skills and expertise in sustainable resource management. This collaborative approach can yield valuable insights and foster international cooperation by bringing experts from different sectors and countries together.
48. To support these efforts, Governments should prioritize R&D initiatives focused on CRM technologies, exploration methods, extraction techniques, and recycling processes. By investing in the development of sustainable mining practices, governments can ensure that CRMs extraction is carried out responsibly, considering environmental protection, social responsibility, and the rights of local communities. This can be achieved through implementing regulations, conducting thorough environmental impact assessments, and supporting responsible mining initiatives.
49. International cooperation is essential in addressing CRM challenges collectively. International agreements and partnerships can foster collaborative efforts among countries within the ECE region. Sharing knowledge, best practices, and data on CRM resources, production, and recycling can help ensure a more secure and sustainable supply chain. By working together, countries can leverage each other's strengths, pool resources, and develop comprehensive strategies for CRM management.
50. Fostering innovation and cooperation is vital for securing access to CRMs in the ECE region. This involves enhancing R&D efforts, promoting stakeholder collaboration, supporting sustainable mining practices, implementing responsible trade policies, raising awareness, prioritizing resource efficiency and recycling, and fostering international cooperation. By taking these actions, countries can strengthen their CRM supply chains, reduce dependencies, and ensure the availability of these critical resources for sustainable development and economic growth.
51. Innovation is crucial for sustainable resource management. It drives the development of new technologies and approaches that improve resource efficiency, reduce environmental impacts, and promote sustainable use of resources. UNRMS encourages stakeholders to embrace research and development, promote collaboration, and foster a culture of continuous improvement. By adopting cutting-edge technologies and practices, countries can ensure the

long-term availability of critical raw materials while minimizing environmental impacts and social consequences.

D. Strengthening governance and transparency

52. To ensure fair and responsible access CRMs and prevent conflicts and abuses, it is crucial to strengthen governance and enhance transparency in managing these resources. This can be achieved by establishing clear and consistent rules, norms, and standards for the production, trade, and use of CRMs. While this option offers several benefits, such as accountability and trust, it presents challenges like complex negotiations, compliance costs, and enforcement issues.

53. One area where transparency is particularly crucial is understanding the origin of CRMs. To address this need, emerging technologies such as blockchain can play a significant role. Blockchain provides a decentralized and immutable record that allows for the transparent tracking of materials throughout the supply chain. By leveraging blockchain technology, companies and governments can provide valuable information about the production conditions and origin of CRMs, ensuring greater transparency and accountability.

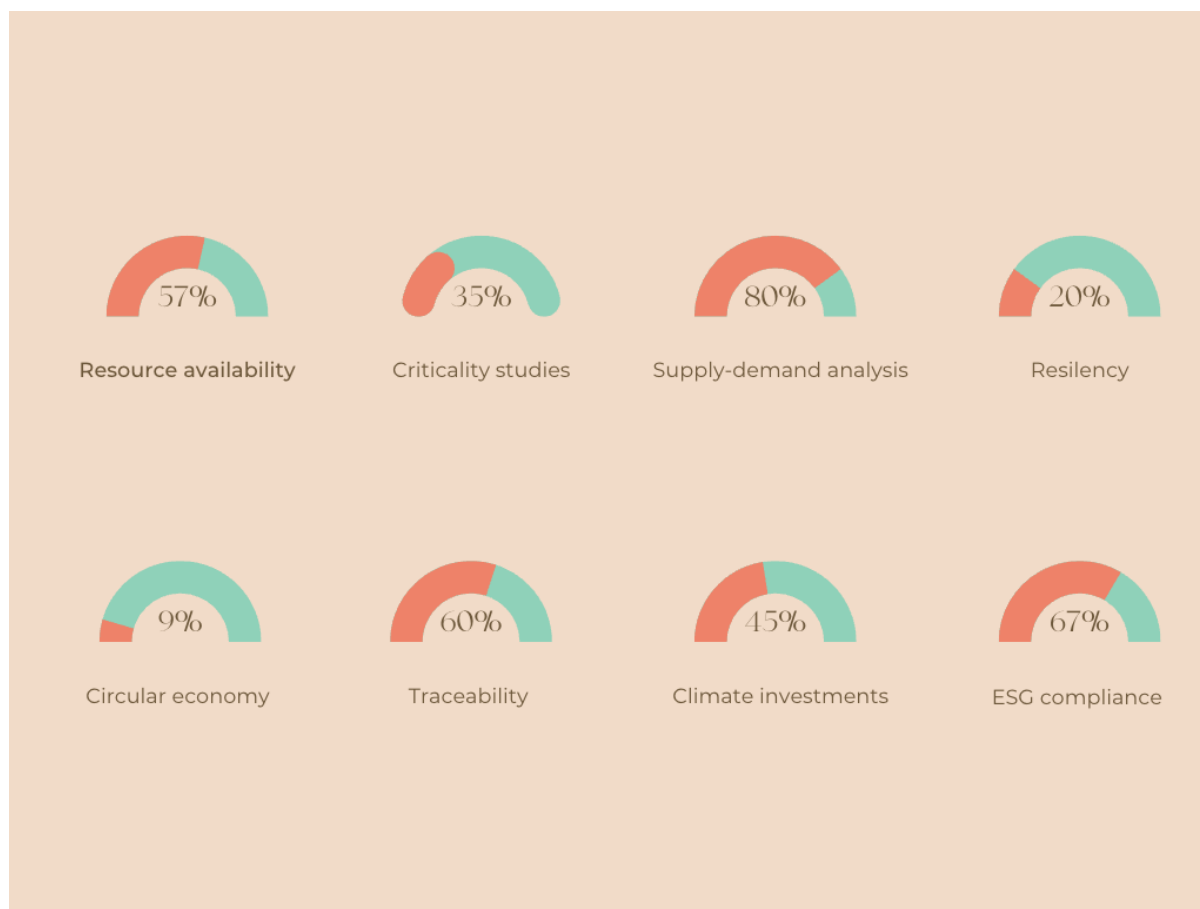
54. Supply-chain traceability is essential, starting from the mine site and extending down the supply chain. Alternatively, traceability can begin with downstream users who seek to understand the entities operating within their supply chain and the data that can be retrieved. This traceability can include information about carbon emissions, policies, willingness to share data, and documents facilitating international trade. By implementing such traceability measures, companies promote responsible sourcing and secure their supply chains, verify their purchases, and gain confidence in the data they rely on.

55. The needs of participants within the supply chain are diverse. Upstream suppliers seek market access, investment opportunities, and social license to operate, often through providing data and differentiating their products. Regulators and downstream companies prioritize transparency and supply-chain security. The needs of intermediaries and traders are shifting from merely protecting supply-chain information to active participation in sharing information. It is essential to recognize the needs of upstream suppliers. Demonstrating the value of traceability to producers, even if they participate individually, can enhance the scalability of blockchain solutions and improve supply-chain transparency.

56. In the context of natural resource management, it is vital to recognize the field's interdisciplinary nature. Natural resource management examines the physical, social, biological, environmental, and economic implications of utilizing natural resources. To address SDGs effectively, wise natural resource management requires collective analysis, informed decision-making, access to quality data, and the judicious use of information.

57. An international CRMs information dashboard based on UNRMS can be established to promote transparency and facilitate informed decision-making. This dashboard would be accessible to governments, industry members, and anyone with relevant information to share globally. By providing comprehensive social, environmental, and economic data on CRM projects, the dashboard would support government policymaking, industry business models, and the allocation of financial capital (Figure II). Given the inevitability of the circular economy, early knowledge of emerging practices, regulations, and standards worldwide is crucial for swift responses. Additionally, the dashboard should highlight the importance of utilizing “waste” materials for sustainable supply, such as mining waste, currently unused by-products (e.g., cadmium and rare earth elements from phosphate rock), and anthropogenic resources.

Figure II
UNRMS-based CRMs information dashboard: Indicative uses or metrics that can be tracked



58. Trade policies are crucial in promoting responsible sourcing and trading of CRMs. Governments can develop certification schemes, traceability requirements, and due diligence measures to ensure that CRMs entering the global market are ethically and sustainably sourced. These policies contribute to building a transparent and accountable supply chain, enabling stakeholders to make informed decisions about the origin and production methods of CRMs.

59. Education and awareness initiatives are essential in raising understanding and highlighting the importance of CRMs and responsible resource management. By promoting awareness among businesses, consumers, and stakeholders, these initiatives can encourage the adoption of sustainable practices and foster support for responsible use of CRMs.

60. Furthermore, resource efficiency and recycling should be prioritized in CRMs management. Implementing regulations or providing incentives to encourage the recycling and recovery of CRMs from products at the end of their lifecycle can contribute to a circular economy approach. Promoting the use of recycled materials in manufacturing reduces reliance on primary sources. It minimizes the environmental impact of CRMs extraction.

61. The sustainable management of critical raw materials can be achieved by strengthening governance and enhancing transparency through the measures above. This approach ensures fair access, prevents conflicts and abuses, and promotes responsible resource utilization to benefit society, the environment, and the economy.

E. Increasing investments for sustainable critical raw material production

62. To ensure the resilience and sustainability of the CRMs value chain, it is essential to mobilize and allocate financial resources and incentives for producers and users of CRMs. This can be achieved by diversifying production sources, adopting circular economy practices, and embracing low-carbon technologies. By doing so, the environmental impacts can be reduced, innovation can be fostered, and sustainable growth can be promoted. However, this option may encounter financial, institutional, and regulatory barriers such as funding limitations, coordination challenges, and the absence of standardized frameworks.

63. Collaboration among various actors, including governments, financial institutions, the private sector, and civil society, is crucial to creating enabling conditions and mechanisms for increasing investments in sustainable CRMs production and use. Together, they can develop strategies to overcome financial barriers and provide the necessary incentives to attract investments. Governments can offer financial support, grants, and tax incentives to encourage producers and users to adopt sustainable practices. Financial institutions can play a vital role by providing loans and investment opportunities for CRMs projects that align with sustainable and low-carbon objectives. Moreover, the private sector can invest in research and development to explore alternative sources of CRMs and develop innovative technologies for their extraction and processing.

64. Information on the resources of CRMs also helps to channel investments. This information gap often arises from the neglect of by-product materials like cadmium and indium, which have low value in mining and are supplied by only a few companies or countries. However, estimates can still be made about the potential supply of CRMs based on data on primary materials. Understanding the recoverability of CRMs and analyzing global market dynamics, market power, and trade flows are crucial for attracting investments. Improving data collection and reporting mechanisms, establishing reliable databases, and enhancing transparency in CRM markets are necessary to address these challenges.

65. To attract investment, including private finance, into the CRM sector, deploying Environmental, Social, and Governance (ESG) funding based on a common sustainable finance taxonomy and principles is crucial. ESG financing is rising and represents part of the solution for transitioning to a low-carbon future. However, there is a risk of “greenwashing”, where initiatives are misleadingly presented as sustainable. Therefore, it is essential to establish robust standards and frameworks to ensure the authenticity and credibility of ESG investments. Additionally, the mining and metals sector must improve its performance against crucial assessment indicators to build trust and attract responsible investors.

66. The principles-based UNFC and UNRMS provide an appropriate framework for sustainable resource management, which can help attract the necessary investments. These frameworks provide a common language and classification system for assessing and managing resources, including CRMs. By adopting UNFC and UNRMS, stakeholders can ensure consistent and transparent reporting of CRM reserves, facilitate resource planning, and guide investment decisions.

67. A crucial area that requires funding is raw material processing facilities. The processing of critical materials is complex and often energy-intensive, requiring advanced technologies and specialized infrastructure. Developing countries, in particular, may need more power infrastructure to support such projects. The capital expenditure (CAPEX) for material processing plants can reach billions of U.S. dollars, equivalent to the annual market size of certain materials. However, with an expected investment payback time of around four years and an internal rate of return of 20 per cent, investing in processing critical raw materials may only sometimes be feasible.

68. To address these challenges, public-private partnerships (PPPs) can significantly mobilize finance and expertise for CRMs processing facilities. Governments and private investors can collaborate to establish PPPs that provide the necessary funding and technical know-how to develop and operate processing plants in resource-rich countries.

IV. Policy recommendations

69. To enhance access to CRMs, the ECE region should implement a comprehensive strategy that involves a range of measures. These measures include expanding primary sources, promoting a circular economy, fostering innovation, enhancing governance and transparency, and attracting investments. It is crucial that all stakeholders, including governments, industry players, research institutions, and civil society, collaborate to execute these policies.

70. To improve access to essential raw materials, there must be an international collaboration between various stakeholders. This collaboration should focus on research and development to identify new and innovative ways to obtain these materials. Additionally, environmental management practices should be implemented to minimize the impact of these activities on the environment. Engaging with local communities and addressing social issues is equally essential. Finally, education and training programmes should be developed to enhance knowledge and skills in this field. By embracing these principles, the ECE region can attain sustainable and responsible management of critical raw materials. The following are specific recommendations for achieving this goal:

A. Diversifying primary sources

71. Promote research and innovation for diversifying sources of CRMs: Governments and institutions should fund and develop new exploration, mining, extraction, and processing methods. Collaboration between academia, industry, and research organizations can drive innovation in CRM production;

72. Facilitate geological surveys and exploration to find more CRMs deposits: Governments should help by sharing knowledge and data and promoting responsible production aligned with environmental and social standards and best practices;

73. Create supportive policy frameworks: Governments should incentivize and regulate CRM diversification with favourable investment conditions and financial incentives for exploration and extraction. Environmental and social safeguards, transparency, and governance should be considered to enhance investor confidence and responsible sourcing.

B. Promoting circular economy

74. Encourage circular economy and substitution: Governments should promote research in reducing, extending, recycling, reusing and substituting materials to reduce dependence on primary sources. They should encourage the recovery of CRMs from waste and use alternative materials to decrease demand. Collaboration with industry and research institutions is crucial for identifying viable options. Governments should support research and development and work with businesses to develop new solutions;

75. Develop and implement supportive policies and regulations: Governments should encourage circular practices by implementing policies and incentives such as extended producer responsibility, waste management, green procurement, and resource efficiency. Financial incentives and subsidies should also be provided to encourage businesses to adopt a circular economy approach;

76. Enhance cooperation and coordination: Collaboration is vital to circular economy success. Governments should facilitate stakeholder cooperation through knowledge-sharing platforms, workshops, and fora;

77. Invest in capacity-building and raising awareness: Governments should educate businesses and the public on the benefits of the circular economy through education, training and awareness campaigns. This creates a supportive environment for circular economy initiatives;

78. Support low-carbon technologies and carbon pricing mechanisms: Governments should promote low-carbon technologies like electric vehicles, renewable energy, and

energy-efficient systems to reduce carbon emissions associated with CRM production. Carbon pricing mechanisms, like taxes or cap-and-trade systems, can also incentivize the adoption of cleaner technologies and promote low-carbon alternatives;

79. Foster international cooperation on recycling and waste management: Collaboration at the international level can help address the challenges associated with the recycling and waste management of CRMs. Governments should explore opportunities to share best practices, harmonize recycling processes, and promote cross-border cooperation to maximize resource recovery and minimize environmental impacts;

80. Foster international collaboration on carbon reduction: Governments should collaborate internationally on reducing carbon emissions related to CRM production and use. Sharing knowledge, technology, and resources can lead to innovative solutions and best practices.

C. Fostering innovation and cooperation

81. Enhance research and development initiatives: Invest in R&D for CRM technology, exploration, extraction and recycling - foster industry-academia-research collaborations for interdisciplinary research in exploration, processing, materials science and energy conservation. Create public-private partnerships for joint R&D and knowledge sharing.

82. Prioritize resource efficiency and recycling: To conserve resources, prioritize efficiency through policies like extended producer responsibility and green procurement. Encourage recycling technologies to recover raw materials and increase awareness through education campaigns for individuals and businesses.

83. Protect intellectual property rights: Creating a safe environment for knowledge sharing and protecting intellectual property is crucial to encourage innovation. Balancing openness and protection can support the advancement of CRM-related technologies.

84. Establish International Centres of Excellence on Sustainable Resource Management: Create collaborative platforms that bring together experts from various sectors and countries to facilitate knowledge sharing, joint research projects, and sustainable resource management capacity-building. Prioritize the development of skills and expertise in CRM-related fields through training programmes, workshops, and conferences organized by the Centres. Promote international cooperation and partnerships through the centre to foster a collective approach to CRMs challenges.

85. Support sustainable mining, processing and recycling practices: Sustainable production practices should prioritize environmental protection, social responsibility, and local community well-being. Regulations and environmental impact assessments are necessary for the responsible extraction of raw materials. Encouraging sustainable practices through certification schemes and initiatives is crucial for responsible mining.

86. Foster innovation and digitalization: Governments should promote innovation and digitalization using technologies like blockchain, AI, and traceability systems.

87. Strengthen research and development partnerships: Collaboration between industry, research institutions, and governments should be further emphasized to foster innovation in CRMs production, processing, and recycling. This can be achieved through dedicated research and development programs, funding schemes, and technology transfer initiatives.

88. Foster international cooperation: International agreements and partnerships among ECE countries should promote cooperation in CRMs management. Sharing knowledge, best practices and data can ensure a secure and sustainable supply chain. Joint research programmes, data exchange, and technology transfer can accelerate CRMs exploration and development. Collaborative efforts can lead to comprehensive strategies for CRMs management.

Figure III

A holistic approach for securing access to critical raw materials in the ECE Region**D. Strengthening governance and transparency**

89. **Make data and information of CRMs open:** To address the challenge of managing CRM resources sustainably, governments should introduce new legislation that aligns with the UNFC and UNRMS framework. This will allow for adequately identifying and utilizing these resources, ultimately enhancing CRM initiatives in the region.

90. **Establish comprehensive environmental management systems:** Governments should require and support complete environmental management systems for CRM production. These should prevent and mitigate environmental impacts throughout the entire lifecycle of CRMs, including measures like impact assessments, monitoring, pollution prevention, and adherence to regulations. Collaboration with stakeholders and ongoing evaluation and improvement are crucial for sustainable practices and minimizing negative ecological footprints.

91. **Consider social and labour standards:** Besides environmental standards, it is essential to integrate social and work standards into the policies and regulations related to CRM production and use. This includes ensuring fair and safe working conditions, promoting the rights of workers and communities, including indigenous communities, affected by CRM extraction and processing, and addressing any potential social and economic impacts associated with these activities.

92. **Encourage responsible supply chain management:** Governments and industry stakeholders should cooperate to promote responsible supply chain management practices for CRMs. This includes transparency and traceability measures to ensure ethical sourcing and mechanisms to monitor and address potential human rights abuses, conflict minerals, and other issues throughout the supply chain.

93. **Implement blockchain technology for transparency and traceability:** Blockchain technology can securely track and clarify CRM production and supply chains. It should be adopted among companies and governments to monitor the source, production, and trade of CRMs. Work with industry associations and global organizations to establish uniform blockchain frameworks for CRMs tracing.

94. **Establish an international CRMs information dashboard:** Create an easy-to-use dashboard that shows social, environmental, and economic data of global CRMs projects. It should be accessible to stakeholders, governments, and industry participants for better policymaking and decision-making. The dashboard should highlight emerging practices,

regulations, and standards in CRM management and promote using “waste” or residue materials for sustainable supply.

95. **Develop responsible sourcing and trading policies:** To ensure ethical and sustainable sourcing of CRMs, certification schemes, traceability requirements, and due diligence measures should be included in trade policies. Governments and industry stakeholders should collaborate on responsible sourcing guidelines and standards, emphasizing transparency and adherence to human rights and environmental standards. Best practices for responsible CRMs trading should be developed industry-wide.

96. **Promote education and awareness initiatives:** Educational programmes and training should be conducted to increase understanding and encourage sustainable practices for responsible resource management. Collaboration with organizations can develop materials and workshops to promote this approach further.

97. **Prioritize resource efficiency and recycling:** Encourage manufacturers to use recycled materials to promote the recycling and recovery of critical raw materials from end-of-life products. Support research and development efforts to improve recycling technologies and processes for CRMs.

98. **Implement proper closure and sustainable land remediation practices:** Governments should prioritize the implementation of decommissioning and sustainable land remediation practices in areas affected by CRMs extraction and processing. This involves restoring ecosystems, conserving biodiversity, and mitigating the environmental impacts of mining and processing operations. Measures such as reforestation, soil erosion control, water management, and the creation of nature reserves can help restore the ecological balance and promote long-term environmental sustainability.

99. **Support local and community participation:** Engaging local communities and stakeholders in decision-making processes related to CRMs production and use can help ensure their concerns and interests are considered. Governments should facilitate meaningful participation and provide opportunities for local communities to be involved in planning, monitoring, and benefiting from CRM-related activities.

E. Increasing Investments for sustainable critical raw material production

100. **Foster collaboration among stakeholders:** Collaboration between governments, financial institutions, the private sector, and civil society is vital in increasing investments for sustainable CRM production and usage. Dialogue and partnerships should be facilitated through forums, working groups, and public-private initiatives. Coordination mechanisms should be established to prioritize sustainable practices in all sectors and jurisdictions.

101. **Enhance data collection and transparency:** Improve data collection and reporting in CRMs markets to boost transparency and attract investments. Develop reliable platforms with accurate information on CRM resources, including by-products, to help investors make informed decisions. Foster international collaboration for a better understanding of CRMs dynamics and to overcome data gaps.

102. **Establish standards and frameworks for ESG financing:** Establish strong ESG standards to attract responsible investments in the CRMs industry. Develop sustainable finance principles and enhance ESG performance in the mining sector to build investor trust.

103. **Adopt the United Nations Framework Classification for Resources (UNFC) and United Nations Resource Management System (UNRMS):** Use UNFC and UNRMS frameworks for transparent and consistent CRMs resource reporting. Encourage stakeholders to adopt them in resource management and investment decisions.

104. **Facilitate public-private partnerships (PPPs) for CRM processing facilities:** Encourage PPPs for CRM processing facilities. To attract investments, offer incentives and support mechanisms like tax breaks, grants, and technical assistance. Foster knowledge exchange and capacity-building through PPPs to enhance local skills in sustainable CRMs processing.

105. Support research and development for alternative sources and low-carbon technologies: Fund research for alternative CRMs, develop eco-friendly tech, encourage partnerships between industry, governments, and research institutions, and share knowledge to promote sustainable CRMs production and use.

106. By incorporating the policy recommendations and practical suggestions, secure access to crucial raw materials within the ECE Region can be guaranteed. Implementing such measures will foster resilience, promote environmental responsibility, and ensure the long-term availability of these raw materials. This, in turn, will play a significant role in facilitating the transition towards a more sustainable and resource-efficient economy.
