

Research Material
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Recent Trends in Mineral Resources for the Clean Energy Transition

Mineral resources are a fundamental component of modern industry and energy technologies, playing a vital role in the transition to clean energy. As the global push for carbon neutrality accelerates, the significance of these resources has never been greater. Critical minerals are directly tied to the growth of clean energy technologies such as electric vehicles, solar panels, and wind turbines. These technologies require significantly larger quantities of mineral resources compared to traditional fossil fuel-based systems, and the minerals subject to increased demand are referred to as the “six critical minerals.” **Lithium** is a cornerstone of secondary batteries and vital for energy storage systems. **Nickel** is extensively used in batteries and energy storage, as well as in catalysts, plating, and various industrial applications. **Cobalt** functions as a cathode material in lithium-ion batteries. **Platinum** is indispensable as a catalyst for hydrogen production, a crucial element for the clean energy future. **Graphite** is highly valued for its exceptional ion storage capacity and stability, making it a key resource. **Rare earth** elements are integral to advanced industries, including permanent magnets, lasers, and alloys.

According to the International Energy Agency (IEA), global demand for minerals is projected to increase at least fourfold—and possibly as much as sixfold—by 2040 compared to 2020. In particular, demand for battery-related minerals such as lithium, nickel, and cobalt is expected to surge up to 40 times, driven by the growth of electric vehicles and energy storage systems. Similarly, copper demand is forecast to more than double due to the expansion of power grids. Meanwhile, demand for nickel and zirconium for electrolysis, as well as platinum group metals for fuel cells, is expected to rise with the growth of the hydrogen market. The challenge, however, lies in the uneven distribution of these mineral resources around the world. Major reserve are concentrated in a few specific countries, and there is a significant economic disparity between major producing and consuming nations. For example, lithium is predominantly sourced from Chile and Australia, while the Democratic Republic of Congo accounts for about 70% of global cobalt production. China produces over 60% of the world’s graphite and rare earth elements and controls more than 80% of the related refining processes. As a

result, any disruptions in mineral supply, trade restrictions, or significant policy changes in these countries could directly affect the global market's ability to maintain a stable supply of these critical resources.

IFP Energies nouvelles (IFPEN) has indicated that, along with the significant increase in demand for mineral resources, the pace of mining is also expected to accelerate. According to IFPEN, to limit global temperature rise to below 4 degrees Celsius by 2050, 62% of currently identified cobalt reserves, 82% of copper, and 48% of nickel will need to be mined. However, such large-scale mining can lead to significant environmental, and social challenges. The long lead time needed to develop mining projects further complicates efforts to meet growing demand. On average, it takes over 16 years for mining projects to progress from the exploration phase to initial production highlighting the structural challenges in promptly responding to increasing demand. Excessive resource extraction can also intensify soil erosion and water pollution, reducing agricultural productivity. In addition, mining activities may cause health issues and destabilize living conditions for nearby communities, increasing the potential for social conflict. These challenges can have adverse effects on the global market, highlighting the urgent need for strategies that address the interconnected dynamics of climate change and resource extraction.

In response, the international community has been actively promoting actively promoting global initiatives and multilateral partnerships focused on critical minerals and the clean energy transition. Key initiatives include the Minerals Security Partnership (MSP), an international cooperative framework launched in 2022 under U.S. leadership to ensure the stability and diversification of critical mineral supply chains. In 2023, the IEA hosted the first-ever Critical Minerals and Clean Energy Summit, bringing together major countries to explore strategies for strengthening critical mineral supply chains. The *OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas* offers actionable recommendations to prevent human rights abuses and mitigate conflicts related to mineral resource management. Similarly, the World Bank launched its Climate-Smart Mining (CSM) Initiative to promote sustainable mineral production while supporting developing nations in fully leveraging the opportunities presented by the clean energy transition. These collective international efforts are generating positive momentum for the responsible use of mineral resources and accelerating the transition to clean energy.

In summary, critical minerals are essential for achieving the clean energy transition and carbon neutrality. Hence, establishing stable mineral supply chains and managing these resources in an environmentally and socially responsible

manner have become urgent priorities. Addressing these challenges requires international cooperation and coordinated policy responses. Given that the production and processing of critical minerals is concentrated in a few countries, these nations must actively engage in mineral initiatives through international organizations and multilateral forums to develop collaborative solutions. Moreover, global efforts to promote sustainable development should focus on efficient mineral management, recycling, and the adoption of circular economy principles. Ultimately, securing a stable supply of critical minerals is not just about the energy transition, it is a vital issue that cuts across sectors, essential for achieving sustainable development and tackling climate change. These efforts will ensure sustainable mineral resource management and pave the way for a successful clean energy transition.