Green energy minerals

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Minerals are essential components in many of today"s rapidly growing clean energy technologies - from wind turbines and electricity networks to electric vehicles. Demand for these minerals will grow quickly as clean energy transitions gather pace. This new World Energy Outlook Special Report provides the most comprehensive analysis to date of the complex links between these minerals and the prospects for a secure, rapid transformation of the energy sector.

Alongside a wealth of detail on mineral demand prospects under different technology and policy assumptions, it examines whether today"s mineral investments can meet the needs of a swiftly changing energy sector. It considers the task ahead to promote responsible and sustainable development of mineral resources, and offers vital insights for policy makers, including six key IEA recommendations for a new, comprehensive approach to mineral security.

The types of mineral resources used vary by technology. 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. Electricity networks need a huge amount of copper and aluminium, with copper being a cornerstone for all electricity-related technologies.

This is why the IEA is paying close attention to the issue of critical minerals and their role in energy transitions. This report reflects the IEA"s determination to stay ahead of the curve on all aspects of energy security in a fast-evolving energy world.

Our bottom-up assessment of energy policies in place or announced suggests that the world is currently on track for a doubling of overall mineral requirements for clean energy technologies by 2040 (in the IEA Stated Policies Scenario, STEPS).

However, a concerted effort to reach the goals of the Paris Agreement (climate stabilisation at "well below 2?C global temperature rise", as in the SDS) would mean a quadrupling of mineral requirements for clean energy technologies by 2040. An even faster transition, to hit net-zero globally by 2050, would require six times more mineral inputs in 2040 than today.

Which sectors do these increases come from? In climate-driven scenarios, mineral demand for use in EVs and battery storage is a major force, growing at least thirty times to 2040. Lithium sees the fastest growth, with demand growing by over 40 times in the SDS by 2040, followed by graphite, cobalt and nickel (around 20-25 times). The expansion of electricity networks means that copper demand for grid lines more than doubles over the same period.

The rise of low-carbon power generation to meet climate goals also means a tripling of mineral demand from

this sector by 2040. Wind takes the lead, bolstered by material-intensive offshore wind. Solar PV follows closely, due to the sheer volume of capacity that is added. Hydropower, biomass and nuclear make only minor contributions given their comparatively low mineral requirements. In other sectors, the rapid growth of hydrogen as an energy carrier underpins major growth in demand for nickel and zirconium for electrolysers, and for platinum-group metals for fuel cells.

Clean energy transitions offer opportunities and challenges for companies that produce minerals. Coal is currently the largest source of revenue for mining companies by a wide margin. Today"s revenues from coal production are ten times larger than those from energy transition minerals.

However, accelerating clean energy transitions are set to change this picture. There is a rapid reversal of fortunes in a climate-driven scenario, as the combined revenues from energy transition minerals overtake those from coal well before 2040.

Our analysis of the near-term outlook for supply presents a mixed picture. Some minerals such as lithium raw material and cobalt are expected to be in surplus in the near term, while lithium chemical, battery-grade nickel and key rare earth elements (e.g. neodymium, dysprosium) might face tight supply in the years ahead. However, looking further ahead in a scenario consistent with climate goals, expected supply from existing mines and projects under construction is estimated to meet only half of projected lithium and cobalt requirements and 80% of copper needs by 2030.

Today"s supply and investment plans are geared to a world of more gradual, insufficient action on climate change (the STEPS trajectory). They are not ready to support accelerated energy transitions. While there are a host of projects at varying stages of development, there are many vulnerabilities that may increase the possibility of market tightness and greater price volatility:

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Web: https://www.hollanddutchtours.nl/contact-us/
Email: energystorage2000@gmail.com
WhatsApp: 8613816583346