



# THE GREEN TRANSITION IMPACT ON MINERAL RAW MATERIALS SUPPLY

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## Abstract

Minerals are an essential component of many parts of today's fast-growing clean energy technologies – from wind turbines and power grids to electric vehicles. Demand for these minerals will grow rapidly as the clean energy transition accelerates. The paper examines some prospects for the transformation of the complex relationships between minerals and the energy sector in the green transition, focused mainly on electric vehicles expansion and related mineral resources demand increase.

**Keywords:** *green transition, mineral raw material, electric vehicles.*

## 1. Foreword

The global clean energy transitions will have far-reaching consequences for mineral demand over the next 20 years. By 2040, total mineral demand from clean energy technologies are projected to double in the STEPS (STATED-POLICIES-SCENARIO) and quadruple in the SDS (SUSTAINABLE DEVELOPMENT SCENARIO).<sup>[1]</sup>

In both scenarios, EVs and battery storage account for about half of the mineral demand growth from clean energy technologies over the next two decades, spurred by surging demand for battery materials.

Mineral demand from EVs and battery storage grows tenfold in the STEPS and over 30 times in the SDS over the period to 2040.

By weight, mineral demand in 2040 is dominated by graphite, copper and nickel. <sup>[2]</sup>

Lithium sees the fastest growth rate, with demand growing by over 40 times in the SDS. The shift towards lower cobalt chemistries for batteries helps to limit growth in cobalt, displaced by growth in nickel. <sup>[3]</sup>

The mineral requirement is actual for the following clean energy technologies:

- Solar PV (utility-scale and distributed)
- Wind (onshore and offshore)
- Concentrating solar power (parabolic troughs and central tower)
- Hydro-power
- Bioenergy for power
- Nuclear power
- Electricity networks (transmission, distribution, and transformer)
- Electric vehicles (battery electric and plug-in hybrid electric vehicles)
- Battery storage (utility-scale and residential)
- Hydrogen (electrolysers and fuel cells).

All of these energy technologies require metals and alloys, which are produced by processing mineral-containing ores.

Ores – the raw, economically viable rocks that are mined – are utilised to liberate and concentrate the minerals of interest.<sup>[4]</sup>

Those minerals are further processed to extract the metals or alloys of interest.

Processed metals and alloys are then used in end-use applications. While this analysis covers the entire mineral and metal value chain from mining to processing operations, we use “miner-

als” as a representative term for the sake of simplicity.

Minerals are not only used in the clean energy sector, but are also used widely across the entire energy system, in technologies that improve efficiency and reduce emissions.

For example, the most efficient coal-fired power plants require a lot more nickel than the least efficient ones in order to allow for higher combustion temperatures.

However, here we focus specifically on the use of minerals in clean energy technologies, given that they generally require considerably more minerals than fossil fuel counterparts.

## 2. Critical minerals and green transition

While minerals play a vital role in supporting clean energy transitions, energy is also crucial in the production of minerals.

Due in part to declining resource quality, the production and processing of energy transition minerals are energy-intensive, involving higher emissions to produce the same quantity of product. [5]

In recent years, mining and processing companies have faced growing pressure to address these and other issues related to their social and environmental performance. A growing number of consumers and investors are requesting companies to disclose targets and action plans on these issues.

An energy system powered by clean energy technologies differs profoundly from one fuelled by traditional hydrocarbon resources.

While solar PV plants and wind farms do not require fuels to operate, they generally require more materials than fossil fuel-based counterparts for construction minerals.

A typical electric car requires six times the mineral inputs of a conventional car and an onshore wind plant requires nine times more mineral resources than a gas-fired plant of the same capacity.

Since 2010, the average amount of minerals needed for a new unit of electricity generation capacity has increased by 50%, as the shares of renewable energy sources grow from the total capacity expansion..

The transition to clean energy means a shift from a fuel-intensive to a material-intensive system.

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 three times to 2040.

Lithium sees the fastest growth, with demand projected to grow 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. (Fig. 1).

Wind takes the lead, bolstered by material-intensive offshore wind. Solar PV follows closely, due to the sheer volume of capacity that is added. (Fig. 2)

Hydro-power, 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 electrolyzers, and for platinum-group metals for fuel cells. [6]

A typical electric car requires six times as many minerals as a conventional car, and an onshore wind farm requires nine times as many mineral resources as a gas-fired power plant of the same capacity. (Fig. 3)

Since 2010, the average amount of minerals needed for a new unit of electricity generation capacity has increased by 50%, as the shares of renewable energy sources grow from the total capacity expansion. [7]

As can be seen from the above, it is not only the supply of so-called critical mineral raw materials that causes problems, but also the need for traditional metals is seriously affected by the green transition. [8]

For example, aluminium and copper.

Aluminium is mainly needed to reduce the weight of electric cars to compensate for the weight of batteries.

The drastic increase in copper demand is caused by its need for renewable energy production and transportation technologies.

The production of both metals, on the other hand, is energy-intensive, at each stage of the production chain, so most of the surplus green energy is consumed by these processes, so the reduction of net emissions is questionable.

In the case of copper, the critical situation is based on the fact that existing and foreseeable reserves have a lower content, their processing is more energy-intensive, and according to Hubert, peak production will be achieved in a few years. [9]

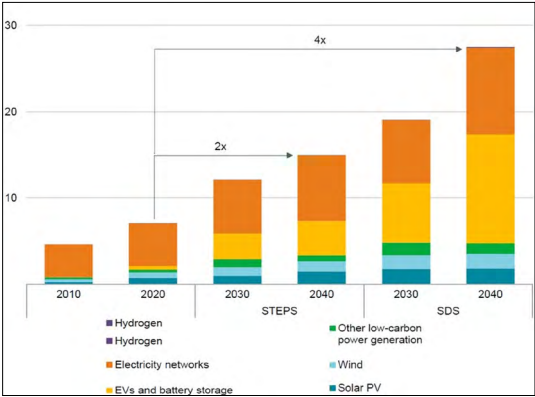


Fig. 1. Dynamics of demand for minerals under different scenarios.

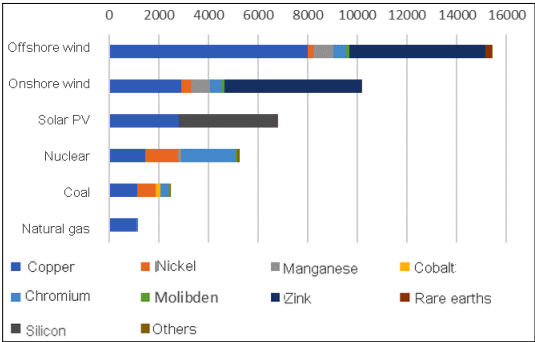


Fig. 2. Comparison of metal requirements of different energy generation technologies.

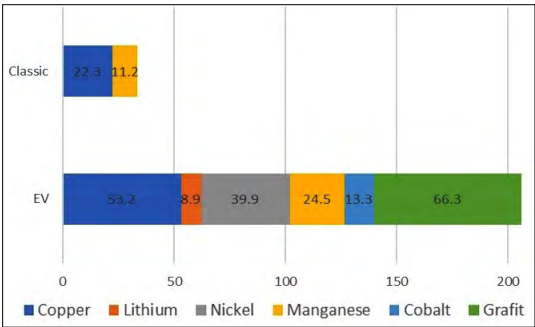


Fig. 3. Comparison of metal requirements of conventional and electric cars.

### 3. Europe and the supply of critical minerals

In September 2020 the European Commission published a set of policy documents to make Europe's raw materials supply more secure and sustainable.

It updated its policy directions from previous studies to align with new 2030 and 2050 climate ambitions. [8]

The policy package extended the list of critical minerals to 30, compared to 14 in 2011.

Together with bauxite, titanium and strontium, lithium was added to the list for the first time in 2020, reflecting the region's ambition to nurture a battery and EV manufacturing industry.

Some EU member states have a strong metal refining and manufacturing base. Finland refines around 10% of global refined cobalt output. There are major manufacturers of solar PV components, wind turbines and EVs in the region.

However, the region is almost entirely reliant on external mining supplies for many energy transition minerals such as lithium, cobalt and REEs.

The European Union plans to seek opportunities for sourcing critical minerals domestically, for example by tapping opportunities for enhanced metal extraction in post-mining regions.

The EU Action Plan estimates that this could lead to 80% of Europe's lithium demand being supplied from European sources by 2025.

To implement the plan, the European Union established the European Raw Materials Alliance, which involves industrial actors along the value chain, member states and regions, trade unions, civil society, research organisations, investors and non-governmental organisations.

The alliance aims to diversify supply chains, attract investment into the raw material value chain, foster technology innovation and create an enabling framework for the circular economy.

### 4. Conclusions

Minerals are an essential component of many parts of today's fast-growing clean energy technologies, from wind turbines and power grids to electric vehicles.

Demand for these minerals will grow rapidly as the clean energy transition accelerates.

The global clean energy transition over the next 20 years will have far-reaching consequences for mineral demand.

Total mineral demand from clean energy technologies will double under the Sustainable Development Strategy (STEPS) and quadruple under the Sustainable Development Strategy (SDS) by 2040.

In both scenarios, electric vehicles and battery storage account for about half of the growth in mineral demand from clean energy technologies over the next two decades, driven mainly by growing demand for battery materials.

Minerals are used not only in the clean energy sector, but are widely used throughout the energy system, in technologies that improve efficiency and reduce greenhouse gas emissions.

The transition to clean energy means the transition from a fuel-intensive system to a material-intensive system.

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