Writing Cheques We Can't Cash? Critical Minerals and the Energy Transition

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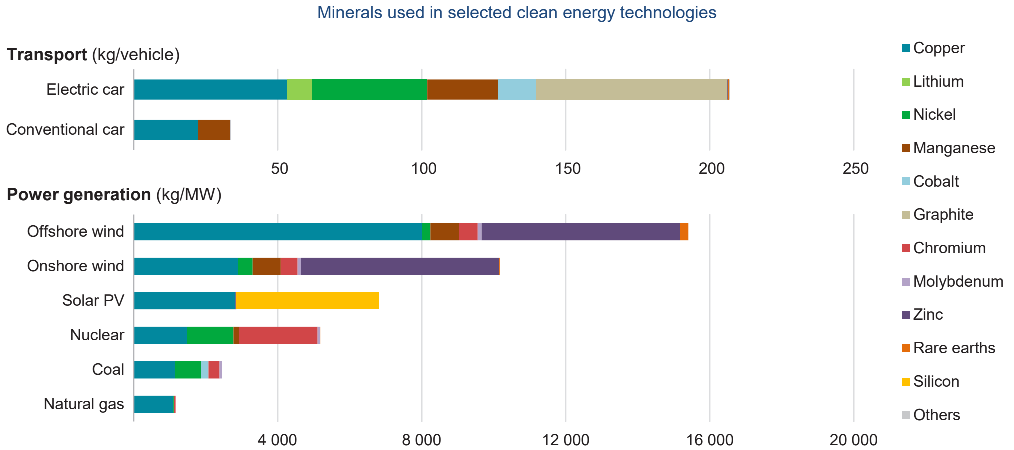
The energy transition is gathering momentum, encouraged by countries and companies alike. Over 170 countries have developed targets in relation to renewable energy, and many have included them as part of their Nationally Determined Contributions under the Paris Agreement.[1] The EU is considering regulations that would require member states to achieve net zero greenhouse gas emissions by 2050.[2] And companies formerly focused exclusively on carbon-intensive industries, such as Total, Equinor and BP, have stated their aims to become net-zero by 2050 (or sooner). The UN Climate Change Conference (COP26), to be held in the UK in November of this year, will put a spotlight on the energy transition and likely lead to further initiatives.

But one aspect of the commitment to fight climate change and reduce carbon emissions that has attracted less attention to date is the extent of the dependence of many parts of that transition on critical minerals. A new report from the the International Energy Agency (IEA)[3], released in early May, explains in clear terms the considerable extent to which the energy transition relies on critical minerals[4] and the supply issues this poses. This aspect of the energy transition urgently needs examination by policymakers and corporate decision makers, so that steps can be taken to ensure that the commitments being made as part of the energy transition can actually be realised.

The Building Blocks of the Energy Transition

It is no surprise that minerals are some of the building blocks of clean energy technologies, used in everything from batteries to solar panels, and from wind turbines to hydrogen electrolysers. What is perhaps surprising is the degree to which mineral inputs for clean energy technologies vary from those for conventional technologies. The IEA notes that clean energy technologies typically are more mineral-intensive than fossil-fuel based technologies—for example, 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 power plant.[5] Even between clean energy technologies there are significant differences in mineral inputs, as the table below illustrates.



Notes: *kg = kilogramme; MW = megawatt. Steel and aluminium not included. See Chapter 1 and Annex of the source report for details on the assumptions and methodologies*

Source: *IEA (2021) The Role of Critical Minerals in Clean Energy Transitions, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions. All rights reserved.*

A fundamental issue, however, is the extent to which many of the mineral inputs for clean energy technologies are critical minerals. For example, as illustrated in the table below, solar panels use a high amount of copper and aluminium. Wind turbines require significant quantities of copper, zinc and (depending on the technology) rare earth minerals, as well as moderate amounts of nickel, chromium and aluminium. Hydrogen electrolysers require high amounts of nickel and platinum group metals. Batteries require high amounts of lithium and a number of other metals (again, depending on the technology).

Critical mineral needs for clean energy technologies

	Copper	Cobalt	Nickel	Lithium	REEs	Chronium	Zinc	PGMs	Aluminium
Solar PV	High	Low	Low	Low	Low	Low	Low	Low	High
Wind	High	Low	Moderate	Low	High	Moderate	High	Low	Moderate
Hydro	Moderate	Low	Low	Low	Low	Moderate	Moderate	Low	Moderate
CSP	Moderate	Low	Moderate	Low	Low	High	Moderate	Low	High
Bioenergy	High	Low	Low	Low	Low	Low	Moderate	Low	Moderate
Geothermal	Low	Low	High	Low	Low	High	Low	Low	Low
Nuclear	Moderate	Low	Moderate	Low	Low	Moderate	Low	Low	Low
Electricity networks	High	Low	Low	Low	Low	Low	Low	Low	High
EVs and battery storage	High	High	High	High	High	Low	Low	Low	High
Hydrogen	Low	Low	High	Low	Moderate	Low	Low	High	Moderate

Relative importance of minerals for a particular clean energy technology: High: ● Moderate: ● Low: ●

Notes: *Shading indicates the relative importance of minerals for a particular clean energy technology, which are discussed in their respective sections in the source report. CSP = concentrating solar power; REEs = rare earth elements; PGM = platinum group metals. In the source report, aluminium demand is assessed for electricity networks only and is not included in the aggregate demand projections.*

Source: *IEA (2021) The Role of Critical Minerals in Clean Energy Transitions, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions. All rights reserved.*

But Can Supply Keep Up?

Renewables will be a key pillar of the energy transition, and the outlook for growth in the sector is strong. The International Renewable Energy Agency notes that in order to achieve the 1.5°C Paris Agreement goal for global warming, renewables, particularly wind and solar, will need to supply 90% of total electricity by 2050, up from 25% in 2018.[6] The industry is growing significantly. In 2020, renewable capacity additions increased by more than 45% from 2019, and the IEA expects similar annual additions in absolute terms in both 2021 and 2022.[7] As a share of the energy mix, renewables are expected to account for 90% of total global power capacity increases in both 2021 and 2022.[8] These increases are driven mostly by wind and solar capacity additions.

This strong growth in clean energy technologies will fuel parallel growth in demand for the critical minerals needed to sustain it. Just how great that demand will be depends upon the speed of the energy transition.[9] The IEA reports that even if existing policy frameworks and today's stated commitments are simply maintained, total demand for such minerals from clean energy technologies will double by 2040. However, if the energy transition gathers pace, and heads towards a scenario where the Paris Agreement goals on climate change are realised, total mineral demand from clean energy technologies will quadruple by 2040. Hitting net zero globally by 2050 would require six times more mineral inputs in 2040. In these scenarios, lithium accounts for the fastest growth in demand, but graphite, cobalt, nickel and copper demand also increases significantly.

What, then, about supply? Even with policy intervention and careful planning, supply will take time to respond. The IEA notes that it takes on average over 16 years to progress mining projects from discovery to first production, and so any market response is likely to lag demand.[10] Currently, focus is on increasing supply to meet demand as opposed to any management of the supply/demand dynamic through re-use, repurposing or recycling. The benefits (both monetary and environmental) of the "circular economy" remain relatively untapped. While some work has been done on recycling, repurposing or reusing certain renewables materials (for example, by the World Economic Forum's Global Battery Alliance), more needs to be done in this respect. Exacerbating the supply side concerns is the fact that reserves, production and processing of critical minerals are significantly concentrated in certain countries. Cobalt, used in lithium-ion batteries, is an example. In 2020, the Democratic Republic of Congo was the world's leading source of mined cobalt, supplying approximately 70% of world cobalt mine production, and China was the world's leading producer of refined cobalt (most of which was imported from the Democratic Republic of Congo).[11] The countries that are leaders in the energy transition are generally net importers of the minerals necessary to effect it.[12] For both industrial and strategic reasons, some countries have designated critical minerals issues a matter of national security.[13] Robust supply chains have never been more important.

The supply and demand dynamic will—absent changes such as policy interventions, significant technological advances in efficiency of materials, advances in recycling/repurposing/reuse, or all of the above—mean that there will be speed bumps on the energy transition road, leading to increased costs of components and ultimately of renewable energy. To look at one example: Copper prices on 10 May hit an all-time peak of $10,747.50 per tonne, with copper recently trading above $10,000 per tonne for the first time in a decade.[14] Analysts at Goldman Sachs and Trafigura believe that by 2025 prices could hit $15,000 per tonne or higher.[15] As noted above, copper plays a significant role in electric vehicles, solar panels, transmission lines and wind turbines, all key instruments of the energy transition. The CEO of Glencore has noted that the mining industry would need to produce an extra 1 million tonnes of copper per year to meet many net zero 2050 goals, but the investments in supply required would be in riskier jurisdictions or more challenging deposits, which would require higher prices to encourage such investments.[16] Although there are a number of dynamics at play here, what the copper example illustrates is the extent to which the adoption of clean technologies demanding critical minerals at scale could be delayed by supply-side issues.

The Challenge

Outlining the problem is easy, but solutions are harder to come by. It is clear that governments have a pivotal role to play through policies and incentives.[17] However, mining companies as well as companies that are involved in or customers of the clean energy supply chain would do well to think about these matters and factor them into business planning decisions. Societally, investments in solutions to mineral scarcity issues will need to be made in tandem with investments in the energy transition. This is vital to ensure that the commitments to the energy transition are ones on which countries and companies can deliver.

Endnotes

1 International Renewable Energy Agency, *World Energy Transitions Outlook*: 1.5°C Pathway (Preview), March 2021, p. 4, available at https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/March/IRENA_World_Energy_Transitions_Outlook_2021.pdf ("**IRENA Report**").

2 Such as the EU Climate Law Regulation currently under review, which includes a legal objective for the bloc to achieve net zero greenhouse gas emissions by 2050, Regulation of the European Parliament and of the Council on establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law), COM/2020/563 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020PC0563.

3 International Energy Agency, *The Role of Critical Minerals in Clean Energy Transitions*, May 2021, available at https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions ("**IEA Report**").

4 The IEA Report has an expansive definition of critical minerals insofar as they relate to clean energy technologies. These include chromium, copper, major battery metals (lithium, nickel, cobalt, manganese and graphite), molybdenum, platinum group metals, zinc, rare earth elements and others. Annex A of the IEA Report contains a complete list.

5 IEA Report, p. 5.

6 IRENA Report, p. 18.

7 International Energy Agency, *Renewable Energy Market Update 2021*: *Outlook for 2021 and 2022, May 2021*, p.4, available at https://www.iea.org/reports/renewable-energy-market-update-2021.

8 *Ibid*.

9 IEA Report, pp. 8, 50.

10 IEA Report, p. 12.

11 U.S. Geological Survey, *Mineral commodity summaries 2021: U.S. Geological Survey, 2021*, p. 51, available at https://doi.org/10.3133/mcs2021.

12 IEA Report, p. 29.

13 For example, a United States Department of Commerce report states, "The assured supply of critical minerals and the resiliency of their supply chains are essential to the economic prosperity and national defense of the United States. The United States is heavily dependent on foreign sources of critical minerals and on foreign supply chains resulting in the potential for strategic vulnerabilities to both our economy and military. Mitigating these risks is important and consistent with our country's National Security Strategy and National Defense Strategy to promote American prosperity and to preserve peace through strength." The report goes on to note that imports are more than 50% of annual consumption for 31 of the 35 minerals designated as critical by the United States Department of the Interior, and the United States relies wholly on imports for 14 of these critical minerals. *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, June 4, 2019, p. 3, available at https://www.commerce.gov/sites/default/files/2020-01/Critical_Minerals_Strategy_Final.pdf. Access to critical minerals also features in the UK Government's assessment of the national security and international strategic context to 2030, which notes that there will be increased competition for scarce natural resources, and countries controlling supplies of critical minerals may use them as leverage with respect to other political-economic issues. The UK Government is exploring options for domestic extraction and processing of critical minerals, as well as looking at ways to recycle, reuse and/or repurpose such critical minerals, as a way of reducing dependence on externally-controlled supplies. HM Government, *Global Britain in a Competitive Age: The Integrated Review of Security, Defence, Development and Foreign Policy*, March 2021, available at https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy.

14 "METALS-Copper turns higher as strike risk offsets weak China data", Reuters, 17 May 2021; "Copper hits 10-year high above $10,000 a tonne", *Financial Times*, 29 April 2021.

15 "Copper must rally 50% for supply to meet demand, Glencore chief says," *Financial Times*, 6 May 2021.

16 *Ibid*.

17 See, for example, the recommendations in the IEA Report, p. 18.

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