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Responsible minerals sourcing for renewable energy

PREPARED FOR:
Earthworks

About the authors

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Cover photograph: Lithium mine at Salinas Grandes salt desert in Jujuy province, Argentina

Executive summary photograph: A creuseur, or digger, descends into a copper and cobalt mine in Kawama, Democratic Republic of Congo (Photo by Michael Robinson Chavez/The Washington Post via Getty Images)

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Executive Summary

Introduction:

The transition to a 100% renewable energy system is urgently needed to meet the goals of the Paris Climate Agreement and increase the chance of keeping global temperature rise below 1.5 degrees. Renewable energy technologies are now the most cost competitive technologies for new installations – and recent investment in new renewable energy infrastructure globally has been double that of new energy investment in fossil fuels and nuclear.

Renewable energy technologies, electric vehicles and battery storage require high volumes of environmentally sensitive materials. The supply chains for these materials and technologies need to be appropriately managed, to avoid creating new adverse social and environmental impacts along the supply chain.

This report presents the findings of an assessment of the projected mineral demand for fourteen metals used in renewable energy and storage technologies, the potential to reduce demand through efficiency and recycling, and the associated supply risks and impacts. Solar photovoltaic (PV) and wind power have been chosen for this assessment because these two technologies make up the majority of new global renewable electricity installations. Batteries have been assessed because of their importance for use in electric vehicles (EVs) and energy storage systems.

This research aims to identify the main 'hotspots' or areas of concern in the supply chain, including technologies, metals and locations, where opportunities to reduce demand and influence responsible sourcing initiatives will be most needed.

Key metals for renewable energy and storage technologies

Lithium-ion batteries: cobalt, lithium, nickel, manganese

EVs: rare earths (neodymium and dysprosium)

Solar PV: cadmium, indium, gallium, selenium, silver, tellurium

Wind power: rare earths (neodymium and dysprosium)

Aluminium and copper used in all technologies

Research overview:

The key findings presented in this report are drawn from an assessment of five important factors:

- The challenges for substitution, efficiency and recycling to offset demand
- The projected metal demand in a 100% renewable energy scenario
- The supply risks, considering concentration of producers and reserves, and the share of end-use for renewable energy technologies
- The social and environmental impacts of supply
- Current levels of industry awareness and responses

The overall key findings are outlined below, followed by the detailed findings for each of these factors.

Key findings:

Encouraging recycling and responsible sourcing are the key strategies to promote environmental stewardship and the respect of human rights in the supply chain.

The transition towards a renewable energy and transport system requires a complex mix of metals – such as copper, cobalt, nickel, rare earths, lithium and silver – many of which have only previously been mined in small amounts. Under a 100% renewable energy scenario demand for these metals could rise dramatically, and require new sources of primary and recycled metals. Recycling and responsible sourcing are fundamental to improving the sustainability of the renewable energy transition.

Recycling is the most important strategy to reduce primary demand.

Recycling of metals from end-of-life batteries was found to have the greatest opportunity to reduce primary demand for battery metals, including cobalt, lithium, nickel and manganese. Increasing efficiency or shifting away from cobalt also has a significant impact (although this may increase demand for other metals including nickel and lithium). Many electric vehicle (EV) and battery manufacturers have been proactive in establishing recycling initiatives and improving the efficiency of battery technologies. However, there is potential to improve recycling rates as not all types of metals are currently being recovered in the recycling process (e.g. lithium and manganese), or only at low rates.

Improving the efficiency of material use was found to have the greatest potential to reduce primary demand for metals for solar PV, owing to the long lifetime of these products. The industry has already made significant improvements to minimising the demand for materials, improve performance and reduce costs. However, the PV industry also needs to engage further in recycling to avoid future waste streams, and recover more metals from the process. Recycling remains a particular challenge for the solar PV industry as there is not always a strong business model.

Overall recycling is the most important strategy for the renewable energy and battery industries going forward, as the industry is already very focused on improving the efficiency of material use, which is expected to continue to improve over time.

Responsible sourcing is needed where supply cannot be met by recycled sources.

Recycling can significantly reduce primary demand, especially for batteries, however it cannot meet all demand and there is a time delay for when recycled metals become available. New mining is likely to take place to meet demand in the short term, and new mines are already under development linked to renewable energy (e.g. for cobalt, copper, lithium, rare earths, nickel). If not managed responsibly, this has the potential for new adverse environmental and social impacts.

Impacts associated with the mining of key metals used in renewable energy and storage include pollution and heavy metal contamination of water and agricultural soils, and health impacts on workers and surrounding communities. When supply cannot be met by recycled sources, engaging in responsible sourcing through verified certification schemes and due diligence of supply chains is needed to reduce potential negative social and environmental impacts.

The EV and battery industries have the most urgent need to avoid negative impacts in their supply chains.

Cobalt, lithium and rare earths are the metals of highest concern, considering their projected future demand and supply risks. Batteries for EVs are the main driver of demand for these metals, rather than stationary storage or wind power. The industry as a whole can engage further with responsible sourcing, and by doing so will encourage more mines to engage in responsible practices and certification schemes. As EV manufacturers are strong consumer facing brands, they can drive change up the supply chain and influence their suppliers upstream.

It is expected that with the renewable energy transition, renewable energy technologies will consume a growing share of these metals and in many cases may be the major driver of demand. The renewable energy transition is an opportunity to promote stewardship of both primary sources and technologies at end-of-life. This has the potential to improve the sustainability of the supply chain for these metals more broadly.

Challenges for substitution, efficiency and recycling:

Copper, lithium, silver and rare earths are the metals most challenging to reduce total demand through substitution and efficiency, and offset primary demand through recycling.

Copper is used in all technologies, and is difficult to substitute, as it is used for its high electrical conductivity. Lithium is challenging to substitute as it is used in the dominant battery technologies, as well as technologies predicted to be important in future, and currently only has limited recycling from batteries. Silver is used in 95% of PV panels, and while the industry is continuously increasing its efficiency in material use, it is not currently recycled and is technologically difficult to do so. Similarly, the rare earths neodymium and dysprosium are not currently recycled, and substitution is possible but currently nearly all EVs use this technology.

There are less challenges to reduce demand for the remaining metals as they have high recycling rates (such as aluminium, cobalt and nickel) or can more easily be substituted with other metals or other technology types (e.g. cadmium, tellurium, gallium, indium and selenium are only used in niche PV technologies). These challenges inform the projections of future metal demand.

Projected metal demand in a 100% renewable energy scenario:

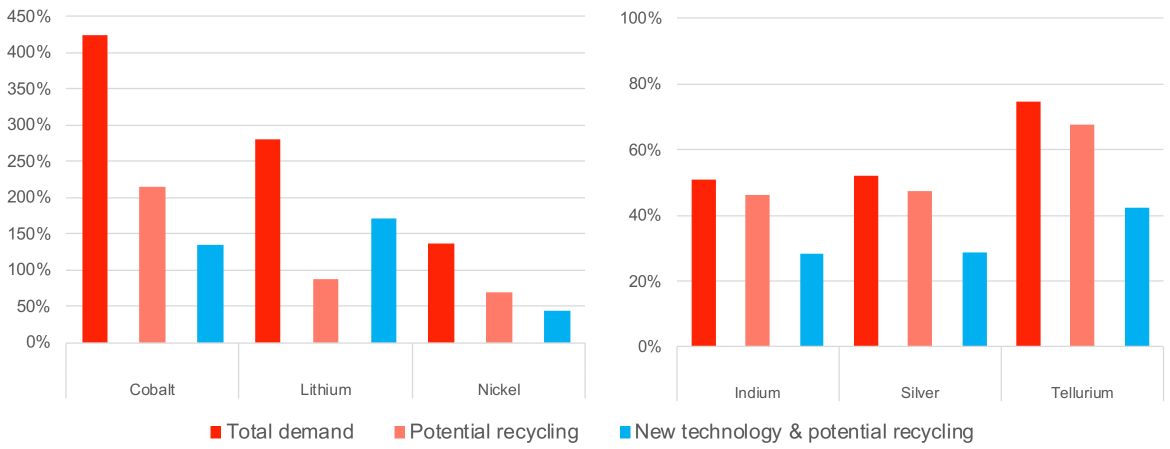
The potential metal demand from clean energy has been modelled against an ambitious scenario for a 100% renewable electricity and transport system by 2050, that limits climate change to 1.5 degrees. This scenario estimates material demand for high levels of solar PV and wind power, which provide two-thirds of electricity by 2050, as well as batteries for electric passenger cars, commercial vehicles, buses and stationary storage.

This study focuses only on the metal demand for renewable energy and storage technologies, and does not consider other demands for these metals, which may also increase or decline over time. It is also important to note that this scenario is an ambitious renewable energy scenario based on current technologies, and these results should be considered a high-demand scenario, as over time new technologies may become more efficient or new technologies may emerge. The potential to reduce primary demand is based on recycling at end-of-life of the three technologies in this study, and using recycled metals from other sources could further reduce primary demand.

- **Demand compared to reserves:**

Demand from renewable energy and storage technologies could exceed reserves for cobalt, lithium and nickel, and reach 50% of reserves for indium, silver, tellurium.[1] Primary demand can be reduced significantly, with the greatest potential to reduce demand for metals in batteries through high recycling rates, and for PV metals through materials efficiency.

Figure A: Cumulative demand from renewable energy and storage by 2050 relative to reserves in three scenarios for selected battery metals (left) and solar PV metals (right)



[1] Reserves are the estimated amount of a mineral that can be economically mined under current conditions. Reserves are a subset of resources, which are the total known amount of a mineral for which extraction may be potentially be feasible.

- **Increases in production:**

The rapid increase in demand for cobalt, lithium and rare earths is of the most concern. Demand for lithium and rare earths from lithium-ion batteries for EVs and storage exceeds current production rates by 2022 (for all uses). Demand for cobalt and nickel exceeds current production rates by around 2030.

The more rapid increase for these metals is owing to the predicted rapid electrification of the transport system and expansion of battery storage that has only begun to accelerate in the last few years, compared to established technologies of solar PV and wind.

Supply risks:

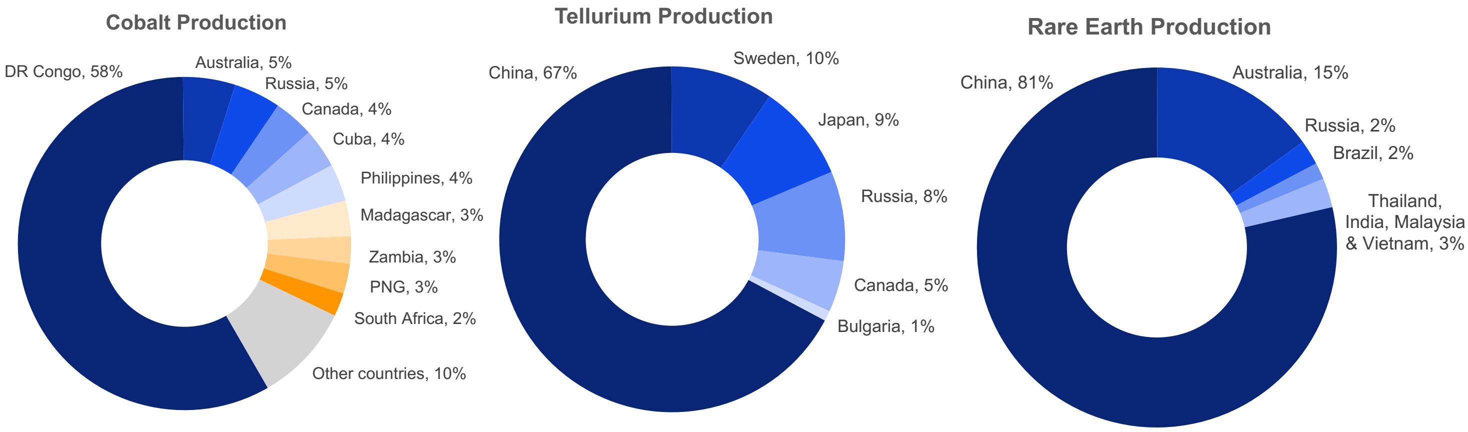
To review the risks of security of supply of the metals in renewable energy supply chains, the geographical distribution of producers and reserves, and the renewable energy share of end-use was examined. Cobalt is the metal of most concern for supply risks as it has highly concentrated production and reserves, and batteries for EVs are expected to be the main end-use of cobalt in only a few years.

The supply chains for renewable energy technologies are opaque and involve a vast number of countries and companies. Chinese companies have significant control of supply chains, including mining, processing and manufacturing, and China is also the largest end-market.

- **Concentration of production and reserves:**

The concentration of supply in a single or very few countries is a risk for manufacturers to secure ongoing supply and make the metal more vulnerable to price fluctuations. The metals for which supply is concentrated in a single country are cobalt, rare earths and tellurium (Figure B). Australia, Chile, DR Congo and South Africa have large shares of the production of metals for lithium-ion batteries and Japan, Korea, Canada and Russia have significant production levels of metals for PV, in addition to China. Although DR Congo is the major producer of cobalt and Australia of lithium, the majority of both of these metals is shipped to China for processing. China dominates the manufacturing of solar PV and lithium-ion batteries, as well as being the largest market for these technologies.

Figure B: Concentration of production



Cobalt has the highest concentration of potential supply, with nearly 50% of reserves in DR Congo. The majority of other metals are found in many regions across the globe, with Australia, Chile, Brazil and China having significant shares of many metals. Rare earths are found in many countries, but are not always economically viable to mine. Despite rare earth production being highly concentrated in China, countries in including Brazil, Vietnam and Russia, have a significant share of global reserves, but currently only a very small share of production.

- **Renewable energy share of end-use:**

The metals for which renewable energy is a significant share of end-use are cobalt, lithium, rare earths and tellurium. Lithium-ion batteries for EVs and storage are currently responsible for between 4-8% of demand for cobalt and lithium, and this could be up to 43% of demand for cobalt in 2020. For lithium this could be even higher, with EVs and storage expected to consume 50% of lithium by 2020. Permanent magnets for wind turbines and EVs are the current end market for approximately 32% of neodymium and dysprosium. Solar PV is already a large end market for tellurium (40%), gallium (17%), indium (8%) and silver (9%), and is expected to remain so.

Supply impacts:

If not managed responsibly, there are significant environmental and social impacts associated with the mining and processing of metals. These include:

- **Cobalt:** Heavy metal contamination of air, water and soil has led to severe health impacts for miners and surrounding communities in DR Congo, and the cobalt mining area is one of the top ten most polluted places in the world. Around 20% of cobalt from DR Congo is from artisanal and small-scale miners who work in dangerous conditions in hand-dug mines and there is extensive child labour. New cobalt mines are proposed in DR Congo, as well as in Australia, Canada, Indonesia, the US, Panama and Vietnam.
- **Copper:** Copper mining can lead to heavy metal contamination, as seen in Chile, China, India and Brazil, has led to environmental pollution from a major tailings dam spills in the US and there are health impacts for workers in China and Zambia.
- **Lithium:** The major concern over lithium mining is water contamination and shortages in the lithium triangle of Argentina, Bolivia and Chile, and the inadequate compensation for affected local communities.
- **Nickel:** Damage to freshwater and marine ecosystems has been observed in Canada, Russia, Australia, Philippines, Indonesia and New Caledonia.
- **Rare earths:** Rare earth processing requires large amounts of harmful chemicals and produces large volumes of solid waste, gas and wastewater. There have been impacts in China, Malaysia and historically in the US, and new mines are proposed for Canada, Greenland, Malawi, South Africa and Uganda.
- **Silver:** There has been heavy metal contamination of soil and water from recent and historical mines in the US, Mexico, Peru and Bolivia, and social conflicts in Guatemala.

Although recycling is generally environmentally preferable to mining, it needs to be done responsibly. The informal recycling of e-waste in many parts of the world is done in hazardous working conditions, that only ends up recovering a fraction of what could otherwise be recovered, and emits dangerous toxins, heavy metals and acid fumes into the surrounding environment, leading to severe illnesses.

With the growing demand for these metals from renewable energy, responsible operations are necessary to avoid negative environmental health impacts for workers and local communities, and to ensure the respect of human rights and guarantee an equitable sharing of benefits.

Industry awareness and responses:

The renewable energy, EV and battery manufacturing industries are very aware of issues around supply risks for key metals. The main concern of the industry is the ability to guarantee long-term supply of key metals at a stable price, particularly for cobalt and lithium.

The renewable energy and battery industries have made significant improvements to the efficiency of technologies, to improve performance, minimise demand for materials and reduce production costs. Current recycling infrastructure remains underdeveloped and/or not optimised for high value metal recovery, with the exception of recycling of wind turbines which relies on existing scrap recycling. The wider application of lithium-ion batteries is driving advances in recycling and the industry is very aware of the looming volumes from EV. PV recycling is demonstrated but not optimised for high value metal recovery. Policy to ensure take-back and recycling at end-of-life of batteries and solar PV will be needed if the industry does not establish effective voluntary schemes.

EV companies are beginning to engage in responsible sourcing and certification, but they are concerned about the ability to secure adequate volumes of supply from responsibly sourced mines. If the auto industry makes public commitments to responsible sourcing, it will encourage more mines to engage with responsible practices and certification schemes.

There are a large number of responsible sourcing initiatives, that promote environmental stewardship and the respect of human rights in the supply chain, most of which are voluntary and industry-led. If these initiatives are harmonised and widely adopted, it may lead to more responsible supply chains. Responsible sourcing initiatives need to ensure that they do not lead to unintended negative consequences, such as increasing poverty, by avoiding sourcing from countries with poorer governance.