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Background document

Implications of the energy transition on the extractive industries in Asia and the Pacific

Energy Division

Implications of the energy transition on the extractive industries in Asia and the Pacific

This report is a background paper for the "Policy Dialogue on Extractive Industries and Sustainable Development in Asia and the Pacific", 19 May 2022, Bangkok, Thailand – Virtual". It was developed by Professor Xunpeng (Roc) Shi from the University of Technology Sydney and the International Society for Energy Transition Studies and Mr Matthew David Wittenstein from ESCAP. For comments and inquiries, please contact: xunpeng.shi@gmail.com.

Energy Division

Table of Contents

Executive Summary

Achieving net-zero carbon emissions will require a transformation of the global energy system toward low carbon, that is, the energy transition. This transition will increase the demand for non-hydrocarbon mineral resources because clean energy technologies are more mineral intensive than their fossil fuel counterparts and thus promote the supply security of critical minerals. The extractive industry thus again gains prominence during the energy transition process.

This report aims to inform debates and dialogue among the climate, energy and extractive industries in the Asia-Pacific region on the opportunities and challenges for the mining and metals industry in the transition to net-zero economies. This report focuses on the critical minerals that will have significant growth potential as a result of the energy transition, such as cobalt, copper, lithium, nickel, and rare earth metals as well as other relevant minerals such as aluminium (bauxite), manganese, the platinum group of metals, titanium and zinc.

Existing projections of the critical mineral also indicate a significant increase in their future demand. The IEA projects that to achieve net-zero emissions by 2050, the mineral demand will increase six times. Lithium will experience the fastest growth in demand, followed by graphite, cobalt and nickel. The World Bank has projected that under the 2-degree scenario (2DS), graphite, lithium, and cobalt production will need to increase by more than 450% by 2050 relative to 2018 production levels to meet demand from energy storage technologies.

The significant growth prospects of critical minerals will lead to the prosperity of extractive industries, which has a close and complicated relationship with sustainable development. The extraction process for critical minerals is generally more resource-intensive, and generates more social and environmental externalities, than that for hydrocarbons. From an Environmental, Social, and Governance (ESG) perspective, the future impact of the extractive industry on critical minerals includes:

Environmental sustainability. Emissions effects associated with the extraction of critical minerals are significant and could increase over time; and the development of critical minerals also has other environmental challenges, such as a large amount of waste rock movement and removal per unit of usable metal and water and biodiversity. The environmental legislation and other environmental performance enhancement will push up the prices of critical minerals and thus further undermine energy transition.

Social inclusion. The development history of minerals shows that extraction has the potential for social-economic development for mining communities. However, mineral development could have unexpected consequences, particularly the 'resource curse'. Public acceptance, or "Social License to Operate" (SLO), has become a key indicator for sustainable development of projects of all types, including mining and infrastructure projects.

Governance changes and challenges. The resource curse phenomenon is also often associated with increased geopolitical sensitivities, as a country is then prone to external interference which exacerbates local and regional political crises and increases instability. Moreover, the shortage of critical minerals promulgates supply security issues, leading to geopolitical concerns. The rapid development of critical minerals brings challenges to many developing countries that have rich resources but weak governance, in particular as it relates to environmental regulations, revenue management and social development.

The extraction of critical mineral issues is prominent in the Asia-Pacific region. The Asia-Pacific region has large reserves of critical mineral resources. ESCAP member States alone control about 30% of the world's Cobalt, Copper and Lithium reserve, 41% of Bauxite, 53% of Graphite, 59% of Nickel, 75% of Rare-Earth Elements (REEs) and 80% of Lead. The role of ESCAP member States in critical mineral production is even more prominent than in terms of reserves. In 2019, the region's share of the world's production of bauxite was 63%, lithium was 66%, graphite was 70%, nickel and lead ere, and REEs was were. The position of ESCAP member States in the production of critical minerals includes the uncomfortable fact that production is subject to a high degree of concentration and associated supply security. As the energy transition continues, resource-rich countries in the Asia-Pacific region will see significant opportunities and challenges and thus, further discussion, debate, deliberation and dialogue are required to ensure the extractive industry contributes to SDGs.

Resource-rich countries in the Asia-Pacific region, in particular developing countries, need to create effective plans to take advantage of the future mining revenue, and avoid "resource curse" -- the failure of many resource-rich countries to benefit fully from their natural resource development and better work towards the SDGs. This report presents some strategies that can inform policy development, dialogues and debates relevant to the sustainable development of the extractive industries.

Meeting demand for critical minerals: the role of circular economy

To avoid significant supply shortages in the period to 2050, strategies can be initiated across the value chain, including increased production, innovation to avoid or minimize the use, substitution, and recycling. A circular economy that involves reusing, recycling, repairing, and refurbishing existing materials and products can play a significant role and should be promoted. Policy certainty is conductive to promote the circular economy.

Align critical mineral extraction with sustainable economic development

Governments must ensure that mining revenues are invested into long-term savings, infrastructure, and economic development efforts. Good governance is critical for translating the economic benefits from the extractive industries into positive socio-economic and environmental outcomes. The recovery from COVID-19 offers an opportunity to reconsider the need for investments in critical minerals to support the energy transition.

Advocate inclusive social management of extractive industries

Ensuring that everyone benefits from the production of critical minerals may be challenging in some countries, and assistance from other countries may be necessary to fill these gaps. Increasing the social inclusiveness of the extractives industry requires cooperation between national governments, international organizations and private sector actors. Especially, civil society organizations should be included in the development and management of critical mineral extraction.

Promote preventive and holistic environmental management

To manage environmental impacts a more efficient systemwide, holistic and life-cycle approach is required. Producing countries must develop emissions mitigation plans for their critical mineral production as a part of the overall development plans. Government need interventions to reduce the negative environmental impacts of the extractives industry including the development and implementation of standards, regulations, and guidelines related to sustainable extractives processes. Additionally, scrutiny by consumers and investors is also required.

Strengthen regional coordination

While national governments are the key players, the international community can also promote sustainable investments by rewarding supplies from countries and companies that follow good environmental practices (such as through carbon footprint labelling and other standards and labels. Government and the private sector stakeholders must develop strategies to reduce geopolitical risks related to critical minerals and the extractives industry. The countries of the Asia-Pacific region should work together to support national efforts to improve legal and regulatory and other governance practices, adopt more sustainable operational practices, and manage risks. Coordination among various stakeholders can lead to more efficient governance at various levels.

While this report proposes some principles to ensure that future extractive activities contribute to SDGs, it intends to stimulate more questions than provide answers. Inclusive dialogues among key stakeholders, at community, subnational, regional and international levels are helpful to figure out what, how and when to take actions and by which stakeholders.

1. Introduction

Achieving net-zero carbon emissions by 2050 will require a transformation of the global energy system toward low carbon, that is, the energy transition. One implication of this transition is a significant increase in demand for non-hydrocarbon mineral resources (IPCC, 2018). Clean energy technologies generally require considerably more minerals[1] than their fossil fuel counterparts and thus minerals emerge as a critical topic in the energy transition (IEA, 2021a).

As the energy transition progresses, energy security discussions are increasingly focused on the availability and security of the supply of critical minerals. Many inputs that will play an increasingly important role in energy transitions are part of the "critical minerals" group. In general, critical minerals are defined as those metals and non-metals vital for the economic well-being of the world's major and emerging economies, but which face supply risks due to factors such as geological scarcity, geopolitical issues and trade policies.

On average, the level of mineral intensity of new power generation has increased by 50% since 2010 due to the increased share of renewables (IEA, 2021a). Moreover, material intensity is expected to increase with the level of decarbonization (World Bank, 2020). Up to 75% of future demand for critical minerals will come from investments in electricity networks, battery storage (in particular in electric vehicles), and renewable electricity generating capacity (Ali et al., 2017). For example, the mineral input in a typical electric car is six times that of a conventional car, and the

[1] For the sake of simplicity, flowing IEA (2021) practice, we use “minerals” as a representative term for the entire mineral and metal value chain from mining to processing operations.

mineral inputs in an onshore wind plant are nine times more than a gas-fired power plant (IEA, 2021a). The energy transition therefore implies a shift from a fuel-intensive to a material-intensive energy system, a fact that has profound implications for economies in general and for extractive industries in particular.

Extractive industries are those that are involved in the extraction, processing, and utilization of raw materials from the earth, including fossil fuels, minerals and rare earth metals.[2] In recent years, increasing attention has been paid to the implications of the energy transition, and in particular the rapid uptake of low carbon energy technologies, on commodity demand and mineral resources (IEA, 2021a; World Bank, 2020, 2017). This shift in focus reflects the asymmetric impact of energy transitions on mineral demand. Revenues from coal production are currently ten times larger than those from those critical minerals for low carbon technologies. Depending on the pace of the energy transition, however, combined revenues from minerals extraction and production will overtake those from coal well before 2040 (IEA, 2021a). While much has been written about this topic, relatively little of the discussion on the impact of the energy transitions on the critical minerals has focused explicitly on the perspective of the Asia-Pacific region as a whole.[3]

Building on the findings of ESCAP's high-level roundtable on the extractives industry organised in February 2021 and the associated report,[4] this report will discuss the production and reserve levels of key metals in the Asia-Pacific region with a focus on resource-rich countries, identify challenges and opportunities during the development of these resources, and suggest policy actions. The aim is to inform debates and dialogue among the climate, energy and extractive industries in the Asia-Pacific region on the opportunities and challenges for the mining and metals industry in the transition to net-zero economies. Suggested policy actions are focused on improving the environmental and economic sustainability of the extractive industries in producing

[2] https://unctad.org/en/PublicationsLibrary/suc2012d1_en.pdf
[3] In this report, the Asia-Pacific region is defined as the ESCAP member States https://www.unescap.org/about/member-states.
[4] https://www.unescap.org/events/2021/roundtable-extractive-industries-sustainable-development-and-2030-agenda

countries so that they can avoid environmental degradation and inequality that could result from increased demand for minerals.

2. Outlook for critical minerals: findings from the literature

Due to heterogeneity across nations and their industries, there is no universal definition of critical minerals (Glöser et al., 2015). The scope of critical minerals may differ among countries due to their relative resource advantage, level of domestic production, and demand situation.

For example, the United States (US), European Union (EU) and Japan identify 35, 27 and 31 critical minerals, respectively (Department of Industry Innovation and Science, 2019).[5] Renewable power generation, grid expansion, batteries and electric motors are the main drivers of critical materials demand (IRENA, 2021). However, despite the large diversity of low carbon technologies, existing studies – for example, the 2017 World Bank report "The Growing Role of Minerals and Metals for a Low Carbon Future" (World Bank, 2017) – have mainly focused on renewable power generation, electric vehicles and batteries. Electricity networks and batteries could drive three-fourths of the demand for critical minerals in 2050, half of which is for copper and a quarter is split between nickel and graphite, followed by lithium, manganese, and cobalt (IEA, 2021b). The IEA report further considered nuclear power, electricity networks and hydrogen-related technologies (electrolyzers and fuel cells) (IEA, 2021a)[6].

This report focuses on the critical minerals that will have significant growth potential due to the energy transition, what might be termed "energy transition minerals". This includes cobalt, copper,

[5] Those critical minerals that were identified by the world's major developed countries include Rare-earth elements (REE), gallium (Ga), indium (In), tungsten (W), platinum-group elements (PGE), including platinum (Pt) and palladium (Pd), cobalt (Co), niobium (Nb), magnesium (Mg), molybdenum (Mo), antimony (Sb), lithium (Li), vanadium (V), nickel (Ni), tantalum (Ta), tellurium (Te), chromium (Cr) and manganese (Mn), in ranked by Geoscience Australia in declining order.

[6] Despite of being widely used across a broad range of technologies, IEA did not assess the demand for steel and aluminium demand due to a lack of substantial security implications and the energy sector is not a dominant driver.

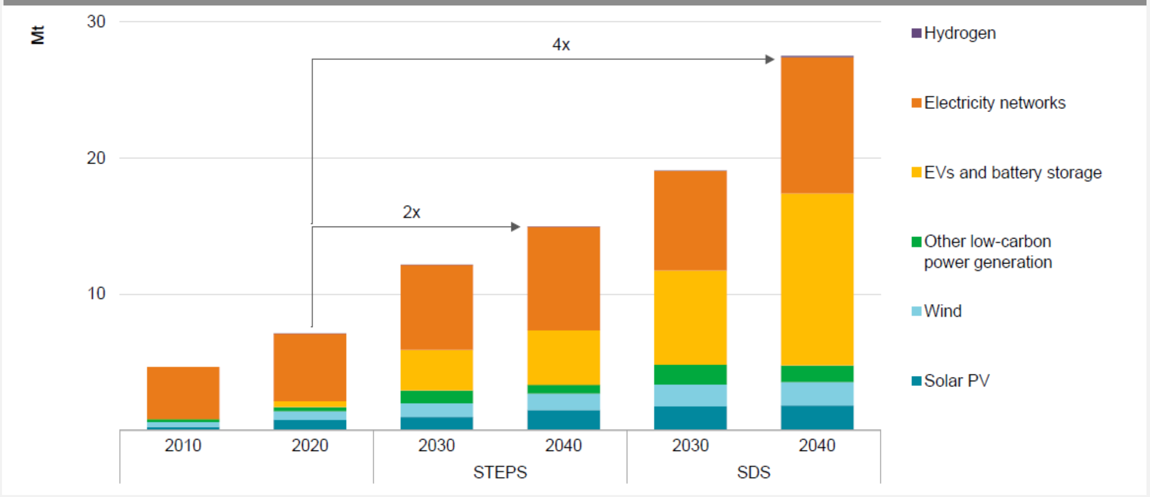
lithium, nickel, and rare earth metals (mainly neodymium and dysprosium) (IEA, 2021a; IRENA, 2021; World Bank, 2017). We also consider other critical minerals such as aluminium (bauxite), manganese, the platinum group of metals, titanium and zinc.

This section summarises projected outlooks for critical minerals by some well-regarded institutions.

International Energy Agency

In 2021, the International Energy Agency (IEA) published a bottom-up assessment of mineral demand to 2040 under various scenarios (Figure 1). It found that, compared to today, total mineral demand from clean energy technologies doubles by 2040 under the Stated Policies Scenario (STEPS, which assumes the implementation of current and planned policies) and quadruples under the Sustainable Development Scenario (SDS, which takes that countries meet the Paris Agreement goals [climate stabilization at "well below 2°C global temperature rise"]). To achieve net-zero emissions by 2050, the IEA projects that the mineral demand will increase six times (IEA, 2021a).

FIGURE 1: Total mineral demand for clean energy technologies by scenario



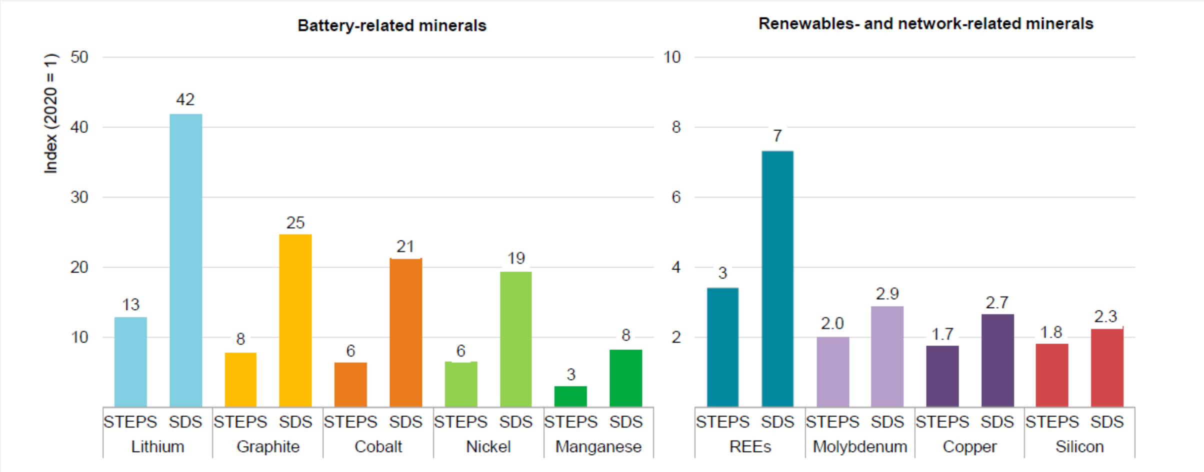
Source: IEA, 2021a.

Under the IEA's SDS, the primary driver for increased demand will be EVs and battery storage, which account for about half of the mineral demand growth from clean energy technologies by 2040. Mineral demand for EVs and battery storage will grow nearly tenfold under STEPS and around 30 times under the SDS. Also under the SDS, copper demand from the power sector will double while mineral demand will triple. The IEA, however, explicitly states that its projections are subject to large technology and policy uncertainties (IEA, 2021a).

By mineral, lithium will experience the fastest growth in demand (over 40 times in the SDS by 2040), followed by graphite, cobalt and nickel (around 20 to 25 times) (Figure 2). Nickel and zirconium for electrolyzers and platinum-group metals for fuel cell electric vehicles (FCEVs) may also experience significant growth in demand due to the fast development of hydrogen.

The demand for Rare Earth Elements (REEs)[7] – mainly used for EV motors and wind turbines – will grow threefold under STEPS and around sevenfold under the SDS (IEA, 2021a).

FIGURE 2: Growth in demand for selected minerals from clean energy technologies in 2040 relative to 2020 levels

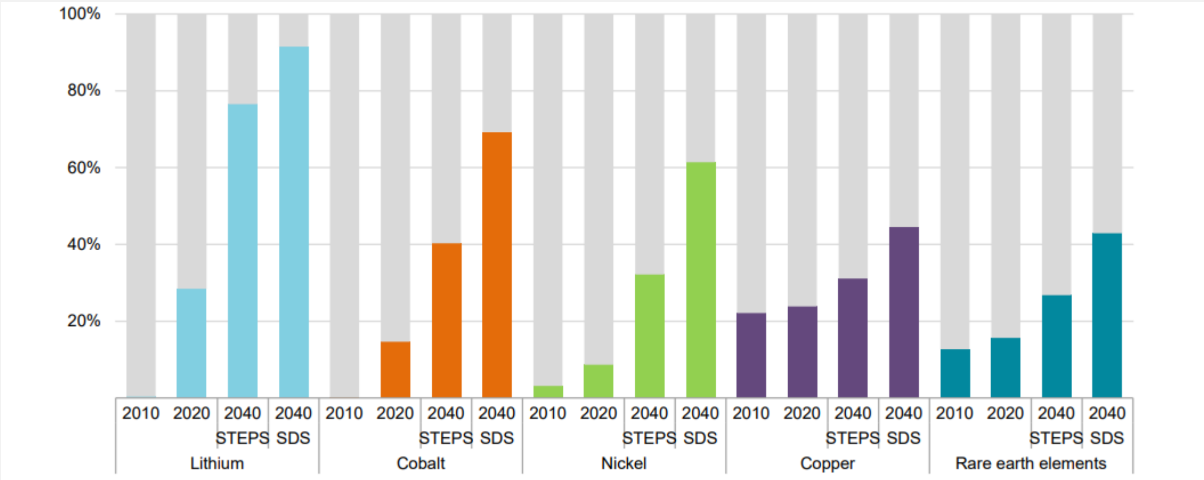


Source: IEA, 2021a.

[7] The IEA defines REEs as "a family of 17 elements comprising 15 elements in the lanthanides group (ranging from lanthanum to lutetium), plus scandium and yttrium."

To put these outlooks into perspective, under the SDS scenarios by 2040, the share of energy transition related demand out of total demand for these minerals will rise from today's relatively marginal levels to over 40% for copper and rare earth elements, 60 to 70% for nickel and cobalt, and almost 90% for lithium (Figure 3). The current largest consumer of lithium – EVs and battery storage – will become the largest consumer of nickel by 2040 (IEA, 2021a). By weight, mineral demand in 2040 is dominated by copper, graphite and nickel (IEA, 2021a).

FIGURE 3: Share of clean energy technologies in total demand for selected minerals



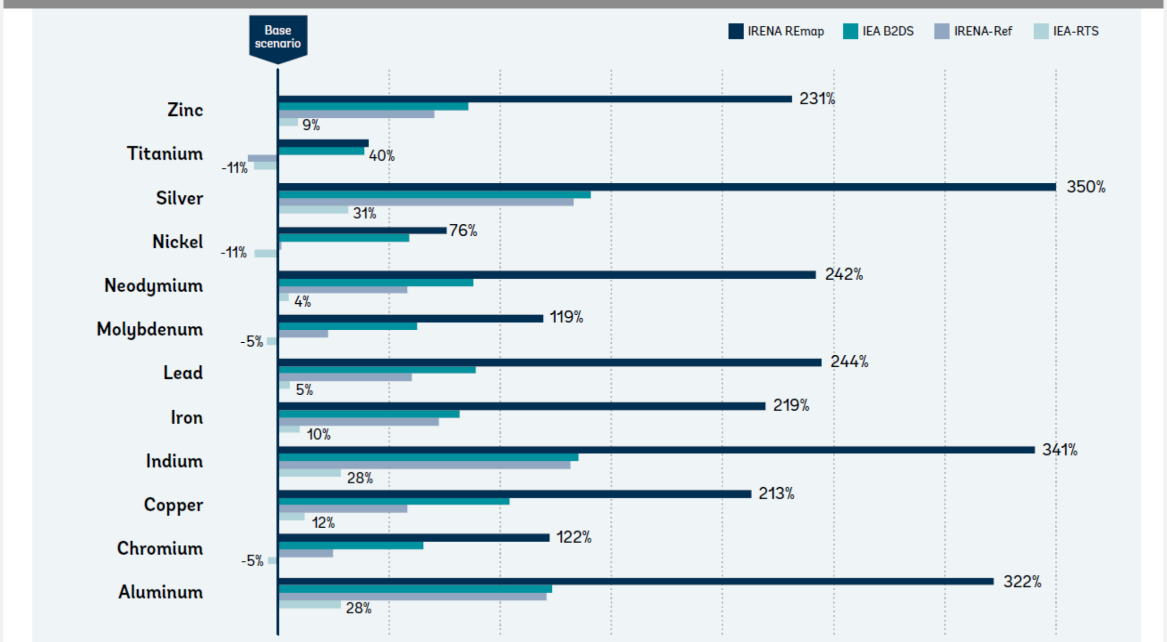
Source: (IEA, 2021a).

World Bank

In 2017, the World Bank published a set of commodities demand scenarios up to 2050. Notably, these scenarios were based in turn on the IEA's climate and technology scenarios (World Bank, 2017). The World Bank projections consider three technologies – wind, solar and batteries – under 2, 4, and 6 degree global temperature increase scenarios (2,4, and 6 DS). They found that renewable energy generation (including hydropower and biomass) in the energy mix would increase from 14% to a low of 18% under 6DS and a high of 44% under 2DS. Furthermore, the report found that low carbon technology requirements, and relevant metals demand, would increase rapidly between 4DS and 2DS. Batteries alone drive demand for aluminium, cobalt, iron, lead, lithium, manganese, by more than ten times under the 2DS compared to the 4DS (World Bank, 2017).

More recently, the World Bank has projected that under 2DS, graphite, lithium, and cobalt production will need to increase by more than 450% by 2050 relative to 2018 production levels to meet demand from energy storage technologies (Figure 4). The projected demand for some base minerals is relatively small in percentage but large in absolute terms: aluminium and copper will be 103 million tons and 29 million tons by 2050, respectively (World Bank, 2020).

FIGURE 4: Relative change in demand for minerals from energy technologies (without storage) through 2050 under different scenarios

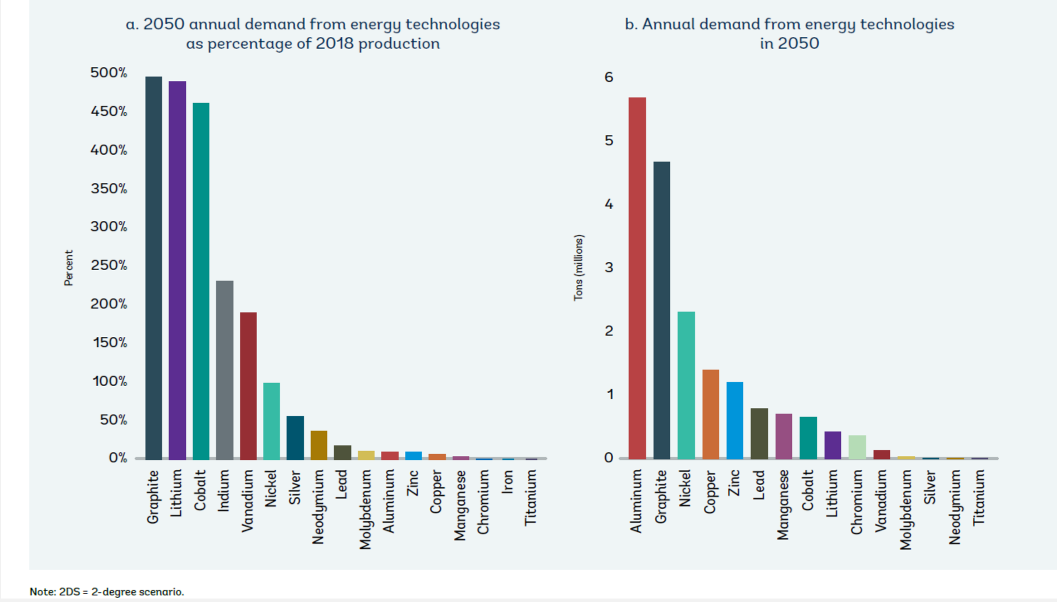


Source: World Bank (2020).

Notes: Base scenario = 4-degree scenario, B2DS = beyond 2-degree scenario, IEA = International Energy Agency, IRENA = International Renewable Energy Agency, Ref = reference scenario, REmap =renewable energy roadmap scenario; RTS = reference technology scenario.

The World Bank projected that, compared with 2018, the annal demand for graphite, lithium, and cobalt will increase by up to five times by 2050 (Figure 5). In terms of value, the increase is dominated by aluminum, graphite, and nickel, which have broad applications. Graphite demand is at the top in terms of both absolute and percentage increase due to its primary uses – for example, in anodes (commonly deployed in cars), and grid-integrated and decentralized storage (Figure 5). According to the World Bank (2020), about 103 million tons of aluminum, 68 million tons of graphite, 60 million tons of nickel, and 30 million tons of copper will be required over the period 2020-2050, to manufacture the clean energy and storage technologies required to put the global energy sector on a low-carbon pathway.

FIGURE 5*: Projected annual mineral demand under 2DS from energy technologies, 2050 vs. 2018 production levels scenarios*



Source: (World Bank, 2020)

The demand patterns for critical minerals vary significantly across technologies. Under 2DS, solar PV will account for 87 % of demand for aluminium from energy technologies, while wind and geothermal will account for at 98 percent of zinc and 64 percent of titanium demand, respectively. Solar PV and wind combined would account for 74.2 % of all generation technology copper demand, while graphite and lithium demand depend entirely on the level of deployment of battery storage (World Bank, 2020).

International Renewable Energy Agency

The third projection comes from the International Renewable Energy Agency (IRENA), which examined the potential demand for a few critical minerals in 2050 under a 1.5°C scenario (Table 1). The projection reveals the diversity in supply and demand among the critical minerals, and differs significantly from, for example, the earlier World Bank estimates. By value in 2050, copper has the highest share of about a third, followed by lithium and nickel (a quarter each), graphite (10%), and cobalt (7%) (IRENA, 2021).

Table 1 Current supply and projected demand in 2050 in a 1.5°C scenario, Metric Ton per year (Mt/yr)

	Current supply	2050	Comment
Copper	30 (2020)	50 - 70	Energy is only part of the demand
Nickel	2.54 (2019)	5 - 8	Currently mainly for stainless steel
Lithium (LCE)	0.41 (2019)	2 - 4	Mainly for batteries
Cobalt	0.14 (2020)	0.5 - 0.6	Mainly for batteries
Neodymium	0.03	0.2 - 0.5	Mainly for permanent magnets

Source: (IRENA, 2021)

These three projections differ in terms of the scale of demand for the same critical minerals, but, given that they have different starting points and different assumptions about the pace and scale of the energy transition, this is to be expected. The important point is they all show significant growth potential of demand due to the energy transition. They also reveal significant heterogeneity across minerals, with inputs such as lithium, cobalt and neodymium – which are predominantly used for energy applications – logically more impacted by the energy transition than inputs with more general uses such as copper and nickel. However, even in the case of these more generally utilized inputs, the energy sector becomes a significant driver of total demand. Therefore, the energy transition has sweeping implications for the entire extractives industry sector.

3. Environmental, social and governance factors in the extractives sector impacted by increased demand for critical minerals

The significant growth prospects of critical minerals will lead to the a prosperity of extractive industries, which has a close and complicated relationship with sustainable development. The World Bank has pointed out that the mining sector has an important role to play in supporting the achievement of several Sustainable Development Goals (SGDs), including SDG 7 (Energy), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (climate change) (World Bank, 2020). However, mining activities also pose challenges to land (SDG15), water (SDG14), and the general ecological system and may also have adverse socio-economic and cultural impacts, including population displacement, inequality (SDG10), and armed conflicts (UNDP et al., 2017). According to Lèbre et al. (2020), potential externalities from the extraction of critical minerals include the waste that impacts the downstream ecosystems, hydromorphological changes and transformation of water catchments and water competitions, biodiversity, land use changes, community impacts, social impacts (including poverty, inequalities and demographic imbalance), and adequacy and effectiveness of national political and regulatory institutions. In addition, the burning of fossil fuels has been the main contributor to climate change (SDG13).

The extraction process for critical minerals is generally more resource-intensive, and generates more social and environmental externalities, than that for hydrocarbons. While increasing commodity prices and improvement in extraction technologies will boost the economic viability of minerals, stringent social and environmental mechanisms and measures could make resource development more difficult (Ali et al., 2017).

The following sections focuses on impacts that are closely related to the extraction of critical minerals using an Environmental, Social, and Governance (ESG) perspective (S&P Global Ratings: RatingsDirect, 2019).

3.1 Environmental sustainability

The extractives industry for critical minerals and climate change are inextricably linked (Ali et al., 2017). This extends even to the beginning of the supply chain.

Emissions associated with the extraction of critical minerals are significant. Despite being crucial inputs into low carbon technologies, the methods of extraction of critical minerals are not themselves necessarily low carbon. In fact, the extraction of critical minerals has a higher emissions intensity relative to other commodities due to their lower concentration in ore – meaning, more ore must be extracted in order to extract an equivalent quantity of critical minerals. For example, compared with steel production, extracting the same amount of lithium carbonate and Class 1 nickel generates three and ten times more emissions, respectively (IEA, 2021a). According to World Bank estimates, under the 2DS, cumulative emissions to 2050 from aluminum, graphite and nickel production for energy technologies add up to 1.4 GtCO2e (World Bank, 2020).

Left unchecked, the emissions effects of critical mineral extraction could increase overtime. Emission intensity effects are exacerbated by deteriorating ore quality, which, for example, resulted in a 130% and 32% increase in fuel and electricity consumption, respectively, per unit of mined copper during the period 2001-2017 (Azadi et al., 2020). It is also likely that future production will shift toward more energy-intensive producers. For example, lithium production has been moving from brine-based recovery methods (mostly utilised in Chile) to mineral concentrate production from hardrock, which is three-times more emissions-intensive (mostly in Australia, including emissions from refining that is mainly carried out in coal-dominated China) (IEA, 2021a).

The development of critical minerals also has other environmental challenges, such as a large amount of waste rock movement and removal per unit of usable metal, which both consumes energy and produces radiative waste materials. Water scarcity will pose a significant challenge to copper and lithium production, which require significant water inputs, and more than half of current production is in regions with high water stress levels (IEA, 2021a). Major Asia-Pacific mineral producers, such as Australia and China, are also exposed to extreme heat or flooding risks (IEA, 2021a). Loss of biodiversity as mining activities is a common problem in the extractive industry.

Tailing disposal is another environmental challenge. Indonesia, for example, is considering replacing the prevailing land-based tailings storage facilities with deep-sea tailings placement due to the country's unique geographical conditions (e.g. high precipitation and frequent seismic activities) and lower cost (IEA, 2021a), which could result in severe marine environmental issues.

These environmental impacts prompt a need for strong environmental legislation, which remains a key factor affecting the extraction of renewable energy mineral resources. Growing momentum to improve environmental performance could also lead to a higher cost of critical minerals, which will undermine the paces of energy transitions (IEA, 2021a). A policy framework that balances the environment and the critical mineral supply will be required.

3.2 Social inclusion

The development history of minerals shows that extraction has the potential for social-economic development for mining communities. UN ESCAP's previous background paper for the United Nations Roundtable on Extractive Industries, Sustainable Development, and the 2030 Agenda in Asia and the Pacific (ESCAP, 2021) highlighted the fact that, in addition to contributing to efforts to meet SDG7, the extractive industries can foster economic and social development by generating jobs and revenue, fuelling economic growth (SDG8), and indirectly providing access to healthcare (SDG3), education (SDG4), and water (SDG6) and supporting related industries.

However, mineral development could have unexpected consequences, in particular the 'resource curse'. Countries that rely too heavily on the extractives industry, and in particular countries with large deposits and where mineral resources dominate the country's export revenues, could fall into the infamous 'resource curse' trap. The resource curse is a phenomenon whereby an economy, lacking the mechanisms and institutions to indigenously develop industries and retain national control over their extractives industry and export revenues, grant mining concessions to foreign entities on disadvantageous terms in order to incentivize investment in the mining industries and related infrastructure. Countries trapped by the ‘resource curse’ suffer from perpetually weak institutions, inadequate financial management and capital control mechanisms, and run the risk of underinvestment in other sectors of their economy, locking them deeper into poverty over the medium and long term (Auty, 1993; Badeeb et al., 2017).

More narrowly, an essential factor for a timely and adequate growth of primary materials supply is local acceptance (IRENA, 2021). Increasing awareness of social and environmental impacts has put mining activities under increasing scrutiny, and social licences issued by the mining community are considered a standard requirement for mining projects to operate (Lacey and Lamont, 2014). Public acceptance, or “Social License to Operate” (SLO) (Prno, 2013), has become a key indicator for sustainable development of projects of all types, including mining and infrastructure projects (Kamenopoulos and Agioutantis, 2021).

3.3 Governance changes and challenges

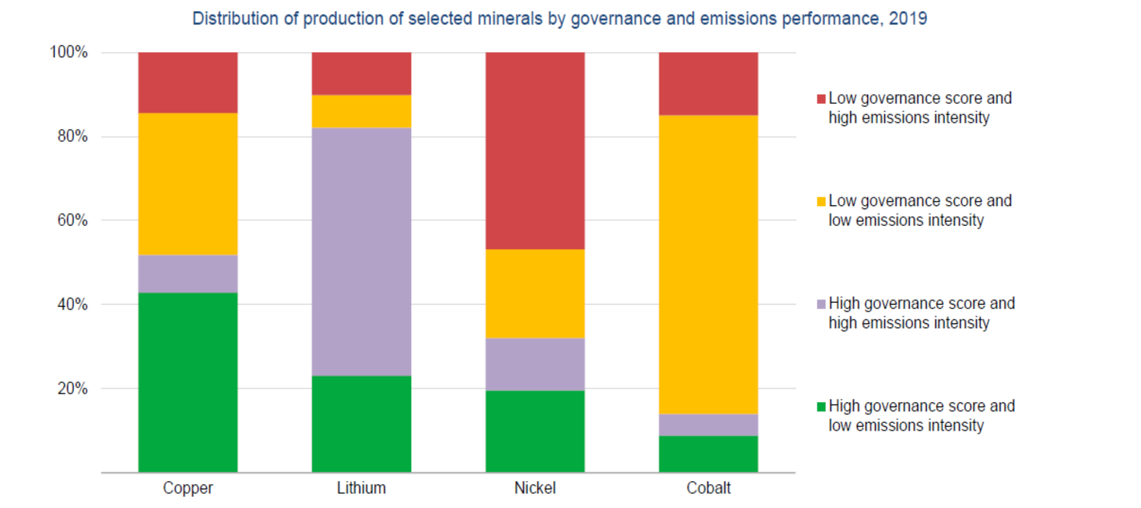
The resource curse phenomenon is also often associated with increased geopolitical sensitivities, as a country is then prone to external interference which exacerbates local and regional political crises and increases instability. As the history of oil and gas industry development shows, resource development has caused intensive tension between sovereign nations and mining companies. Resource-rich countries want to capture the benefits of the resources they hold, leading to tensions in cases where the extractives industry is owned and managed by multinational companies, as was the case in, for example, Serbia, Chile, Peru, and Indonesia (Tsafos, 2022).

Moreover, the shortage of critical minerals promulgates supply security issues, leading to geopolitical concerns. The supply chains of critical minerals are less transparent and more concentrated than fossil fuels. Many countries in the Asia-Pacific region have significant roles in the production and processing of critical minerals, as well as significant reserves. China, for example, has a global dominance in the production and domestic reserves of many base minerals and rare earth elements (REES). India is a dominant player in the production of iron, steel and titanium; Indonesia is rich in bauxite and nickel; Malaysia and the Philippines have significant opportunities with cobalt; and New Caledonia has massive reserves of nickel (World Bank, 2017).

The rapid development of critical minerals brings challenges to many developing countries that have rich resources but weak governance, in particular as it relates to environmental regulations, revenue management and social development. Producer countries with well-developed regulatory systems, strong enforcement and institutionalized transparency practices can lead to good environmental and social performance. But in reality, as in 2019, around 10-15% of copper, lithium and cobalt production and almost half of the nickel production came from regions with low governance scores and high emissions intensity (Figure 6). Further development of the critical minerals add more governance challenges. Many countries are expected to play a more important role in the future supply of critical minerals (Gillies et al., 2021). An earlier study finds that more than one-quarter of known copper resources are in countries with unsatisfactory governance, and it is therefore inevitable that some products will come from countries with poor levels of governance (Ali et al., 2017).

Source: (IEA, 2021a)

FIGURE 6: Distribution of production of selected minerals by governance and emissions performance (2019)



These combined factors of high concentration and a lack of transparency make critical minerals more vulnerable to physical disruption, trade restrictions or other developments in major producing countries than fossil fuels (IEA, 2021a). Some, mainly developed, countries, have focused on boosting supply through a national security agenda from sources that are politically more feasible to access. Clear and high standards for extraction transparency along the extractive industry value chain are conducive to lessen such conflicts (Tsafos, 2022).

4. Critical mineral production and reserves in the Asia-Pacific region

4.1 Overview

Table 2: Reserve of key critical minerals in top countries in 2020 (kiloton)

(ESCAP member States in **bold**)

Bauxite		**Cobalt**		**Copper**		**Graphite (Natural)**	
Guinea	7,400,000	The Democratic Republic of the Congo	3,600	Chile	200,000	**Turkey**	90,000
Australia	5,100,000	**Australia**	1,400	Peru	92,000	**China**	73,000
Viet Nam	3,700,000	Cuba	500	**Australia**	88,000	Brazil	70,000
Brazil	2,700,000	**The Philippines**	260	**The Russia Federation**	61,000	Madagascar	26,000
Jamaica	2,000,000	**The Russia Federation**	250	Mexico	53,000	Mozambique	25,000
Indonesia	1,200,000	Madagascar	100	**The United States of America**	48,000	Tanzania	17,000
China	1,000,000	**China**	80	Poland	32,000	**India**	8,000
India	660,000	**The United States of America**	53	**China**	26,000		
The Russia Federation	500,000	**Papua New Guinea**	51	Zambia	21,000		
Saudi Arabia	190,000	South Africa	40	**Kazakhstan**	20,000		
RoW	5,550,000	RoW	766	RoW	229,000	RoW	11,000
Total	30,000,000	Total	7,100	Total	870,000	Total	320,000
ESCAP	41%	**ESCAP**	29%	**ESCAP**	28%	**ESCAP**	53%

Lithium (mined)		**Nickel**		**REE**		**Lead**	
Chile	9,200	**Indonesia**	21,000	**China**	44,000	**Australia**	36000
Australia	4,700	**Australia**	20,000	**Viet Nam**	22,000	**China**	18000
Argentina	1,900	Brazil	16,000	Brazil	21,000	Peru	6000
China	1,500	**The Russia Federation**	6,900	**The Russia Federation**	12,000	Mexico	5600
The United States of America	750	Cuba	5,500	**India**	6,900	**The United States of America**	5000
Canada	530	**The Philippines**	4,800	**Australia**	4,100	**The Russia Federation**	4000

Zimbabwe	220	**China**	2,800	**The United States of America**	1,500	**India**	2500
		Canada	2,800	Greenland	1,500	**Kazakhstan**	2000
						Bolivia	1600
						Sweden	1100
RoW	2,200	RoW	14,200	RoW	7,000	Row	6,200
Total	21,000	Total	94,000	Total	120,000	Total	88,000
ESCAP	33%	**ESCAP**	59%	**ESCAP**	75%	**ESCAP**	80%

Source: Courtesy of the International Energy Agency.

The extraction of critical mineral issues is prominent in the Asia-Pacific region. The Asia-Pacific region has large reserves of critical mineral resources. ESCAP member States alone control about 30% of the world's Cobalt, Copper and Lithium reserve, 41% of Bauxite, 53% of Graphite, 59% of Nickel, 75% of REEs and 80% of Lead (Table 2).

The role of ESCAP member States in critical mineral production is even more prominent than in terms of reserves. In 2019, the region's share of the world's production of bauxite was 63%, lithium was 66%, graphite was 70%, nickel and lead were 74%, and REEs was 96% (Table 3).

The position of ESCAP member States in the production of critical minerals includes the uncomfortable fact that show is subject to a high degree of concentration and associated supply security. Several countries in the region are among the top producers of more than one key critical minerals, including Australia, China, India, Kazakhstan, Papua New Guinea, the Russian Federation, and the US. Australia is among the top list of six of the seven critical minerals, the lone exception being graphite. China is also on the top list for six of the seven key critical minerals, except cobalt (Table 3). In 2019, Australia was the world's largest producer of bauxite, lithium and the second-largest producer of cobalt, while China is the world's no. 1 producer of graphite, and REEs. In 2020, China produced 58% of the world's output of REEs and 43% of Lead. In the same year, the Russia Federation produced 43% of Palladium, and Indonesia produced 32% of lead (U.S. Geological Survey, 2021).

As the energy transition continues, resource-rich countries in the Asia-Pacific region will see significant opportunities and challenges that have been experienced in the past resource development. This includes Australia, Canada and the United States of America, selected

ASEAN countries (Indonesia, Malaysia and the Philippines), China and India, and New Caledonia (World Bank, 2017). Several developing countries, such as China, Indonesia, India, Kazakhstan, Myanmar, the Philippines, Papua New Guinea, and Viet Nam, are top the list of key critical minerals (Table 2). Further discussion, debate, deliberation and dialogue are required to ensure the extractive industry contributes to SDGs.

Table 3 Production of key critical minerals in top countries in 2019 (ESCAP member States in bold)

Bauxite		**Cobalt**		**Copper**		**Graphite (Natural)**	
kiloton	2019	kiloton	2019	kiloton	2019	ton	2019
Australia	105,000	The Democratic Republic of the Congo	111.4	Chile	5,787.4	**China**	700,000
China	70,000	**Australia**	5.9	Peru	2,455.3	Mozambique	107,000
Guinea	67,000	**The Philippines**	3.9	**China**	1,818.8	Brazil	96,000
Brazil	34,000	Cuba	4.0	The Democratic Republic of the Congo	1,388.4	Madagascar	48,000
India	23,000	**The Russia Federation**	3.7	**The United States of America**	1,318.3	**India**	35,000
Indonesia	17,000	Zambia	4.2	**Australia**	934.1	**The Russia Federation**	25,100
Jamaica	9,020	**Papua New Guinea**	2.9	**The Russia Federation**	792.2	Ukraine	20,000
Kazakhstan	5,800	Madagascar	2.9	Zambia	804.9	Norway	16,000
The Russia Federation	5,570	Canada	3.4	Mexico	768.5	**Pakistan**	14,000
Saudi Arabia	4,050	**New Caledonia**	2.0	**Kazakhstan**	701.4	Canada	11,000
RoW	17,560	RoW	10.8	RoW	4,195.1	RoW	27,900
Total	358,000	Total	155.1	Total	20,964.4	Total	1,100,000
ESCAP	63%	**ESCAP**	12%	**ESCAP**	27%	**ESCAP**	70%

Lithium (mined)		**Nickel**		**REE**		**Lead**	

kiloton	2019	kiloton	2019	ton of REO*	2019	kiloton	2019
Australia	46.8	**Indonesia**	855	**China**	132,000	**China**	2,000
Chile	18.8	**The Philippines**	303	**The United States of America**	28,000	**Australia**	509
China	9.1	**The Russia Federation**	232	**Myanmar**	25,000	**The United States of America**	274
Argentina	6.3	**New Caledonia**	208	**Australia**	20,000	Mexico	259
Zimbabwe	1.6	**Australia**	160	Madagascar	4,000	Peru	308
		Canada	188	**The Russia Federation**	2,700	**The Russia Federation**	230
		China	107	**Thailand**	1,900	**India**	200
		Brazil	60	**Viet Nam**	1,300	Turkey	71
		Guatemala	41			Sweden	69
		Cuba	53			Bolivia	88
						Tajikistan	65
						Kazakhstan	56
RoW	2.2	RoW	321	RoW	5,100	RoW	591
Total	84.7	Total	2,529	Total	220,000	Total	4,720
ESCAP	66%	**ESCAP**	74%	**ESCAP**	96%	**ESCAP**	74%

* REO = Rare-Earth-Oxide equivalent content

Source: U.S. Geological Survey, 2021.

The following sections will take a closer look at aspects of the extractives industry and relevant policy frameworks in some of these countries.

4.2 Australia

Australia's resources industries play a vital part in the national economy, with resource and energy commodity exports accounting for more two-thirds of its goods exports in 2018-19. Australia is the world's largest producer of lithium and zirconium concentrate and the fourth-largest producer of REEs. Australia is also well known for its status as a globally leading supplier of iron ore, coal, gold, bauxite, copper, zinc, lead, manganese, and several other commodities, many of which are closely related to the energy transition.

Australia is the world's largest producer, and has the third-largest reserves of, lithium; it is ranked sixth in terms of reserves and second for production of REEs; and has considerable resources of cobalt, manganese, tantalum, tungsten, and zirconium (Department of Industry Innovation and Science, 2019). Despite being a major producer of many critical minerals, however, and in contrast to the world's other major industrial economies, Australia's domestic demand for most critical minerals is relatively small. Domestic demand is high for phosphate and potash, which are used in fertilizers and which are essential for Australia's agricultural industries. At present, however, Australia is not self-sufficient in these commodities.

The Australian government is considering further development of some critical minerals with high geological potential, such as cobalt and REEs, and is working to develop supporting policy frameworks to develop domestic potential to meet increasing global demand (Department of Industry Innovation and Science, 2019).

Table 4: Critical minerals in Australia (kiloton)

	Critical Mineral	Australia's Geological Potential	Australia's Economic Demonstrated Resource	Australia's Production	Global Production	Market Value (Global) (million United States dollars)
1	Cobalt	High	1221	5	110	$541.80
2	Graphite	Moderate	7140	0	1200	$1,076.10
3	Lithium	High	2803	14.4	43	$1,430.60
4	Magnesium	Moderate	-	0	1100	$716.40
5	Manganese	High	231 000	3200	16 000	$5,443.70
6	Platinum-group elements	High	24.9 ton	2.6 ton	200	$19,316.60
7	Rare-earth elements	High	3270	14	130	$415.413
8	Tantalum	High	55.4	-	1.3	$1,552.90

9	Titanium	High	Ilmenite: 276 500 Rutile: 32 900	Ilmenite: 1400 Rutile: 300	Ilmenite: 6700 Rutile: 750	$1,609.90

Note: the Australian statistics uses term resources, which has a broader scope than reserve.

Source: extracted from 2019 Critical Minerals Strategy (Department of Industry Innovation and Science, 2019)

To leverage its leading resource advantage, Australia is positioning itself to be a reliable and responsible world leader in the supply of critical minerals necessary for the global clean energy transition (Department of Industry Innovation and Science, 2019). For example, nickel produced in Western Australia is considered one of the most sustainable sources for the metal, with the lowest carbon emissions associated with its production. BHP and Telstra, both Australian companies, are collaborating to make the battery supply chain more sustainable using blockchain and lowering emissions in their respective operations (BHP, 2021). Australia is also planning to extend its domestic value chain from exploration and extraction to processing, separation, refining and niche manufacturing.

4.3 China

China has a dominant position globally in terms of reserves and production of metals—both base and rare earth, dwarfing even resource-rich developed countries such as Canada, the United States, and Australia (World Bank, 2017).

China emerged as a major producer of REEs in the mid-1990s, when it surpassed the previous leader, the United States. China's share of global production peaked at 95% in 2010, but has since fallen to just over 60% as of 2019, as the United States and other countries increased production (USGS, 2021).

For example, in the case of REEs, and despite substantial efforts made by the global community to diversify supply portfolios, China remains the dominant global processor of many critical raw materials (Minerals Council of Australia, 2021). China currently accounts for almost 90% of REE processing, and from 40 to 70% of global copper, lithium and cobalt refining. Chinese companies also have a substantial equity investment in overseas assets in Australia, Chile, the DRC and Indonesia (IEA, 2021).

Despite its strong position in both the up- and down-stream of the critical minerals, China is still significantly dependent on global markets, and is looking to introduce policies to manage potential supply security risks. China's National Mineral Resource Plan for 2016–2020 specified 24 minerals as critical, and has called for the development of a warning mechanism to safeguard their supply security (NDRC, 2017). China already has a law in place to control the exports of these critical minerals. In December 2021, the Chinese government consolidated several REE producers into a central-government owned company, which will enhance the state's control of the REE production and exports (Bloomberg, 2021).

Table 5 China's catalogue of 24 strategic minerals

Energy	Oil, Gas, Shale Gas, Coal, Coal Seam Methane, Uranium
Metals	Iron, Chromium, Copper, Aluminium, Gold, Nickel, Tungsten, Tin, Molybdenum, Antimuonium, Cobalt, Lithium, Rare earth, Zirconium
Non-metal	Phosphor, Potash, Crystal graphite, Fluorite

Source: (NDRC, 2017)

While China is a major producer of REEs and a few other minerals, a large part of its significance comes from the processing part of the value chain. This industrial strategy could be replicated by the United States and its allies over time. The US-China trade war and the COVID-19 pandemic exposed the vulnerability of depending on China for critical supplies. Therefore, the United States, Europe, Japan, Australia and developing countries such as India have actively implemented strategies to reduce supply chain dependency on China, though these efforts have been impeded by the COVID-19 pandemic (Shi et al., 2021).

4.4 Indonesia and the Philippines

Indonesia is an important producer of copper, nickel and tin. Indonesia and the Philippines account for 45% of global nickel output, and as a result the Asia-Pacific region is the key driver of the over 20% increase in global nickel production over the past five years. Indonesia and the Philippines are anticipated to be responsible for around 70% of global production growth over the period to 2025 (IEA, 2021).

Since Indonesia alone accounts for around half of that growth, the future of the global nickel supply is highly likely to be driven by progress there. With the development of new projects that are mainly invested by Chinese investors, Indonesia's share of nickel is expected to increase from 28% to 60% of global output later this decade (Treadgold, 2021). However, Indonesia has limited capacity in further processing nickel. China has been the main processor for Indonesian nickel, and Chinese companies have invested a combined amount of USD 30 billion in the Indonesian nickel supply chain (IEA, 2021). At the start of 2020, to incentivise the development of downstream processing industry, Indonesia banned the export of nickel to develop its downstream processing industry (IEA, 2021). Currently, Indonesia is planning to ban exports of unprocessed minerals -- including tin, bauxite, gold and copper, in the middle of 2023 (Tani, 2022).

In 2020, the Philippines was the world's second-largest nickel producer after Indonesia, when its annual nickel output was about 320,000 tonnes. The ban on export unprocessed nickel in Indonesia was expected to return the world's no. 1 producer status to the Philippines. Nickel resources in the Philippines, which are estimated to be 4.8 million tonnes, are only ranked the sixth in the world and 23% of the world's largest—Indonesia[8] (U.S. Geological Survey, 2021).

4.5 New Caledonia

New Caledonia is the world's fourth-largest nickel producer. The Goro mine may hold up to one-quarter of the world's nickel reserves, and New Caledonia therefore has the potential to be one of the world's biggest nickel producers (BBC, 2021). The environmental impact of the nickel industry there is significant, however, and as a result New Caledonia has one of the world's largest per capita carbon emissions (NY Times, 2021).

However, New Caledonia has the potential to become a model for a sustainable extractives industry. As a French overseas territory the country is subject to rigorous European environmental and labour standards (NY Times, 2021). Tesla, which purchases up to one-third of New Caledonia's nickel, is considering directly investing in the nickel supply chain in order to ensure environmental and socially responsible mining for the mineral (NY Times, 2021). As the major buyer, Tesla is forming a "technical and industrial partnership" to ensure sustainability in production (BBC, 2021). Ensuring these environmental and labour standards are met, however, means the supply of nickel from New Caledonia could be more expensive than that from the world's top suppliers, namely Indonesia and the Philippines (NY Times, 2021).

[8] Half of the world's 94 million tons of known nickel reserves are in Indonesia (21 Million tons) and Australia (20 Million tons). Brazil (16 Million tons), the Russia Federation (6.9 Million tons) and Cube (5.5 Million tons) also have large reserves than the Philippines.

4.6 The United States of America

After China's export embargo of REEs in 2010, critical minerals have increasingly become a prominent feature in US national security and defence strategies, indicating the interdependence of economic security with national security (IEA, 2021a).

Despite the presence of significant deposits of certain minerals that are vital to the Nation's security and economic prosperity, the United States is heavily reliant on imports of some of these mineral commodities due to the underdevelopment of domestic reserves for lack of data, permitting delays; and potentially protracted litigation. The US perceives the dependency on foreign sources as a strategic vulnerability for both its economy and military to adverse foreign government action, natural disasters, and other events that can disrupt the supply of these key minerals. To ensure secure and reliable supplies of critical minerals, in 2017, the President Executive Order 13817 encouraged identifying new sources, increasing activity along the supply chain, guaranteeing electronic access to data, and streaming leasing and permitting process (US Gov., 2017). Based on this order, the United States has designated 35 mineral commodities as critical to the country's economic and national security (Department of the Interior of the US, 2018). The list includes both common elements such as aluminum, tin and magnesium, and specialized materials like REEs and vanadium[9].

In 2019, the United States. Department of Commerce (2019) described specific steps the Federal Government will take to revitalize domestic production and processing operations, including 24 goals, and 61 recommendations under the six major "calls to action". These actions include research, development and deployment (RD&D), supply chain resilience, international trade and cooperation, domestic resources data, access to domestic resources and the Workforce. The Energy Resource Governance Initiative (ERGI), launched by the Bureau of Energy Resources of the United States Department of State in June 2019, brings countries together to engage in

[9] The final list includes: Aluminum (bauxite), antimony, arsenic, barite, beryllium, bismuth, cesium, chromium, cobalt, fluorspar, gallium, germanium, graphite (natural), hafnium, helium, indium, lithium, magnesium, manganese, niobium, platinum group metals, potash, the rare earth elements group, rhenium, rubidium, scandium, strontium, tantalum, tellurium, tin, titanium, tungsten, uranium, vanadium, and zirconium.

advancing governance principles, sharing best practices and encouraging a level playing field for investment aims to promote sound mining sector governance and resilient global supply chains for critical minerals (IEA, 2021a). The founding partners – Australia, Botswana, Canada, Peru and the United States – released the ERGI Toolkit to share and reinforce best practices.[10]

4.7 Japan

Due to its geographic circumstances and highly industrialized economy, Japan has long practiced foreign engagement and emergency preparedness activities to meet its demand for natural resources. Japan has operated a strategic stockpiling programme since 1983, through the Japan Oil, Gas and Metals National Corporation (JOGMEC), a state-backed company was only after China's embargo of REEs in 2010 promoted the shift of JOGMEC's attention to rare earths. After the Chinese export ban in 2010, Japan introduced a comprehensive policy package (the so-called "ABCD+R" initiative) that seeks to reduce the risk of REE supply disruption. Through JOGMEC, the Japanese government provides financial support to Japanese companies working to develop overseas critical mineral resources. JOGMEC also directly conducts exploration activities in cooperation with foreign companies (IEA, 2021a).

In the decade after China's export ban, Japan reduced rare earth supplies from China from over 90% of imports to 58%, according to UN Comtrade data and it aims to bring that below 50% by 2025 (Hui, 2021). Despite of been resource-poor, Japan does maintain a significant REE processing and refining industry, including 15% of global permanent magnet production (CSIS, 2021).

Japan plans to increase the self-sufficiency rate of mineral resources (base metals) to more than 80% by 2030 (IEA, 2021a). In order to achieve this ambitious role, Japan has been taking action on both the demand and supply sides. On the supply side, besides its traditional stockpiling program, Japan also starts to exploit mineral resources on the seabed from 2017. On the demand side, the Japanese government also supports R&D for recycling, material efficiency and substitution technologies to reduce the primary supply requirements (IEA, 2021a).

[10] https://ergi.tools/

5. Critical minerals development and SDGs in the Asia Pacific region: Policy implications

Resource-rich countries in the Asia-Pacific region, in particular developing countries, need to create effective plans to take advantage of the future mining revenue, and avoid the "resource curse" -- the failure of many resource-rich countries to benefit fully from their natural resource development and better work towards the SDGs. Managing the risks that the extractive sector faces for developing critical minerals can be done from several different dimensions, including technology innovation, improvement of regulatory and other institutions, investment promotion and environmental performance disclosure. ESG performance would, for example, benefit from inclusive measures, such as dialogues among stakeholders, including the various level of governments, development partners, industries, and civil society organizations in resource-producing countries. This report presents some strategies that can inform policy development, dialogues and debates relevant to the sustainable development of the extractive industries.

5.1 Meeting demand for critical minerals: the role of circular economy

Supply security is an immediate challenge for the global community. The IEA estimates that the expected supply from existing mines and projects under construction can meet only half of projected lithium and cobalt requirements and 80% of copper needs by 2030 (IEA, 2021a). A case study of copper mines, for example suggests that the mining industry may not be able to boost their production quickly enough to meet anticipated demand as the average lead-time between discovery and development is 13 to 23 years (Ali et al., 2017). This projected supply shortage will delay energy transitions and push up their cost. This issue is exacerbated by the fact that the quality of ore has been declining for many commodities.

To avoid significant supply shortage in the period to 2050, strategies can be initiated across the value chain, including increased production, innovation to avoid or minimize use, substation, and recycling (IRENA, 2021). Expanding production and ensuring diversity of supply of critical minerals is essential but challenging. While reserve and resource data are necessary to ramp up supply, institutional factors, such as social acceptance of mining projects and the consideration of the geopolitical implications of critical mineral supply, are also needed to ensure a secure supply of critical minerals (IRENA, 2021). Ensuring a sufficient supply of these critical minerals will reduce energy security concerns and lead to lower prices, which can then help accelerate the energy transition.

Substitution may help increase materials available for the energy transition by **reducing** demand for inputs that are difficult or expensive to obtain. For example, battery cathode materials can be adjusted to avoid or minimize the use of cobalt, copper cabling can be replaced with aluminium, and copper water pipes can be replaced with several other materials (IRENA, 2021).

Innovation can play a critical role in reducing demand for them. For example, design innovation can eliminate the need for permanent magnets in wind turbines and EVs, and can substantially reduce the demand for cobalt in batteries (IRENA, 2021). It has recently been reported that the US Department of Energy (DOE) has developed a plan to "eliminate cobalt and nickel in lithium-ion batteries" by 2030, and DOE has supported research and development efforts to reduce the consumption of critical minerals, including REEs (Tsafos, 2022).

A circular economy that involves reusing, recycling, repairing, and refurbishing existing materials and products can play a significant role and should be promoted. The two highlights are recycling and reusing.

Breaking down the material and re-forming it for alternative use (recycling) can reduce the need for extraction. While recycling is regularly practised for bulk metals, such as steel, equivalent practices have not been established for many energy transition metals such as lithium and rare earth elements (World Bank, 2017). The current recovery rate of cobalt, copper, and nickel, is

around 28.5%, 32%, and 35%, respectively (World Bank, 2020). The current recovery rate of lithium is close to zero, although its medium and high recycling rates are 40% and 80%, respectively (World Bank, 2020). The low recycling rates, however, imply significant potential. However, while recycling can reduce the need for mining and therefore associated environmental impacts like carbon emissions, it could also increase energy use and water footprints.

In addition to recycling, many low carbon technologies, such as batteries, can be **reused** for other purposes without changing their original components. For example, For example, Li-ion batteries that are retired from electric vehicles could potentially be used in other types of energy storage applications, thus extending their life (World Bank, 2020).

National governments can play critical active roles in promoting investment in recycling by providing policy certainty, a conducive institutional environment, and fiscal and financial assistance, etc (World Bank, 2017). For example, incentives and awareness of the economic and environmental challenges of recycling are required to stimulate recycling actions (World Bank, 2020).

5.2 Align critical mineral extraction with sustainable economic development

Governments must learn from the past management of mining revenues and ensure that they are invested into long-term savings, infrastructure, and economic development efforts that can stabilize and diversify economies in impacted communities and regions (Haggerty et al., 2018) .

Good governance is critical for translating the economic benefits from the extractive industries, including those for the critical minerals, into positive socio-economic and environmental outcomes, as elaborated by (Addison and Roe, 2018). Ensuring that the benefits from the extractions of transition minerals will be fairly distributed across stakeholders, in particular, among disadvantaged groups and across generations, requires the presence of effective institutions. These institutions include a transparent revenue management regime and socio-environmental regulations and legislations. This topic is discussed further in ESCAP's earlier background paper on effective resource governance discussions (ESCAP, 2021).

The recovery from COVID-19 offers an opportunity to reconsider the need for investments in critical minerals to support the energy transition. While the pandemic has demonstrated the vulnerability of global supply chains, including those for minerals, its full impact is still unfolding and is yet to be fully understood. How to effectively use COVID-19 recovery packages, and how to adapt the extraction and supply/trade of critical minerals to the post-COVID-19 world is a question for the international community and national governments. With this in mind, the United Nations has developed the Financing for Development in the Era of COVID-19 and Beyond Initiative (FfDI).

5.3 Advocate inclusive social management of extractive industries

Ensuring that everyone benefits from the production of critical minerals may be challenging in some countries, and assistance from other countries may be necessary to fill these gaps. Ensuring local communities benefit from mineral wealth is essential, but also a long-lasting challenge, particularly in counties with a significant amount of informal mining activities (World Bank, 2017).

Increasing the social inclusiveness of the extractives industry requires cooperation between national governments, international organizations and private sector actors. Different actors have different perspectives on the need for and potential impacts (positive and negative) of developing mineral resources, and inconsistent or conflicting interests among relevant stakeholders – in particular national governments, local interests, and project developers – are often the norm. However, currently, there is no overarching international governance framework for critical minerals and coordinated policy action (IEA, 2021a). A lack of coordination across sectors and stakeholders is in particular disadvantageous to impacted communities, which often do not have sufficient voice in the development or management of extractives industry projects, and which therefore are unable to benefit fully from local development. Lack of coordination may also hinder the process of economic diversification (United Nations, 2020). Reconciling the contradictory goals requires governments to create enabling and inclusive environments while still allowing the private sector to drive investments (ESCAP, 2021). There is therefore a need for dialogue to address concerns and find mutually agreeable solutions (IRENA, 2021).

Especially, civil society organizations should be included in the development and management of critical mineral extraction. Those organizations can monitor the performance of extractive industries, raise concerns on behalf of underrepresented segments of society, inform the public, and facilitate multi-stakeholder partnerships and dialogue (UNDP et al., 2017). For example, members of the climate community need to work closely with mineral producers—including resource-rich developing countries and the mining industry (World Bank, 2020).

5.4 Promote preventive and holistic environmental management

To manage environmental impacts a more efficient systemwide, holistic and life-cycle approach is required. Such an approach must be applied across all mining activities from planning, and production to decommissioning, and consider both the mining activities themselves and the broader social-economic context (ESCAP, 2021).

Producing countries must develop emissions mitigation plans for their critical mineral production as a part of the overall development plans. One key method of improving the environmental impact of the extractives industry is to promote the low emission production of critical minerals. The fact that there are already significant variations in the emissions footprint of different producers suggests that there are already technical and process solutions to reduce the emissions intensity of critical mineral production – for example, by switching to clean fuels and low-carbon electricity, and by improving efficiency (World Bank, 2017). The potential for increased critical minerals production to increase emissions means that producing countries must develop emissions mitigation plans, and that these plans be integrated into development plans.

Government need interventions to reduce the negative environmental impacts of the extractives industry including the development and implementation of standards, regulations, and guidelines related to sustainable extractives processes. Reducing the extractive industries' carbon footprint requires well-designed and enforced regulatory frameworks from mineral extraction to end of life. These regulatory frameworks should include environmental impact assessments in the planning phase of a mining project, minimum performance standards during its operational phase, and decommissioning plans (United Nations, 2020). Since many mining activities for critical minerals have not yet started, now is the time to establish such overarching frameworks, and to improve capacity among government agencies to make sure these frameworks can be implemented and enforced.

Scrutiny by consumers and investors is also required. Mineral production is already facing increasing scrutiny by consumers and investors to ensure practices are sustainable and responsible. Increased public scrutiny can incentivise companies and communities to properly manage the environmental and social issues of mineral production. Environmental and social performance is a key factor in gaining public acceptance for project development, and can help minimize supply disruptions due to environmental damage, regulations, and legal actions (IEA, 2021a). Innovative instruments should be introduced to both secure investments for critical minerals and incentivise environmental sustainability. For example, Environmental Financial Assurance (EFA), commonly referred to as environmental bonds, are increasingly been introduced (UNDP, 2018), and their use should be encouraged.

5.5 Strengthen regional coordination

While national governments are the key players, the international community can also promote sustainable development by rewarding supplies from countries and companies that follow good environmental practices (such as through carbon footprint labelling and other standards and labels (Shi, 2013)), formulating regional guidelines for investment and operations, and implementing recycling practices that fully consider environmental and safety costs (World Bank, 2020). Effective and innovative recycling practices are global public goods, as other countries can learn from the frontrunners. International organizations therefore should promote and aid in the adoption of these emerging practices at their nascent stage.

Government and the private sector stakeholders must develop strategies to reduce geopolitical risks related to critical minerals and the extractives industry more generally. As the role of critical minerals in global supply chains increases, relevant geopolitical concerns are emerging. Broadly speaking, governments should address potential supply risks due to the long-term geopolitical issues, while the private sector manages market fluctuations (IRENA, 2021). Governments should coordinate their policies to ensure a free market for critical minerals. Free international markets can ensure a sustainable and secure critical mineral supply. However, as in the case of fossil fuel markets, governmental interventions are the prevailing norm, resulting in distortions and even supply risks. Therefore, international institutions should work together to create norms and other arrangements to promote free markets for critical minerals.

The countries of the Asia-Pacific region should work together to support national efforts to improve legal and regulatory and other governance practices, adopt more sustainable operational practices, and manage risks. Building the capacity of resource-rich developing countries in resource management and other governance will help both those countries and the global community as a whole achieve the SDGs. Many international initiatives, such as the Extractive Industries Transparency Initiative (EITI) (Marques, 2020), could be promoted to safeguard the sustainable development of the extractive industry.

Coordination among various stakeholders can lead to more efficient governance at various levels. Some international organizations, such as United Nations Environment Programme, and the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development and civil organizations such as World Resources Forum and Future Earth have existing knowledge generation and sharing programs, but more is needed to improve policymaking (Ali et al., 2017). Other relevant efforts include the World Bank's Climate-Smart Mining Initiative, could be adopted to support the responsible extraction and processing of minerals and metals for clean energy transition and sustainable development (World Bank, 2020). An international agreement to mitigate the impact of supply disruptions and promote sustainable use of scarce mineral resources should also be explored (Henckens et al., 2016).

6. Conclusion

As the energy transition and sustainable development more broadly continue, demand for many critical minerals is expected to grow rapidly. However, the increased extraction of critical minerals faces not only challenges common to the extractive industry as a whole, but also some challenges specific to those materials – high and increasing emissions, ensuring broad and equitable economic growth, and obtaining social acceptance for new projects, to name but a few.

The countries of the Asia-Pacific region will have an important role in the future supply of critical minerals, due not only to their resource advantages, but also because of the growing demand for these resources within the region. Many countries in the region which already well developed extractives industries will benefit, but in some cases countries will be seeking to develop a significant extractives industry for the first time. The decisions made by Asia-Pacific countries in the coming years as to how to develop and utilise critical minerals will have global implications.

To meet the increasing demand for critical minerals sustainably, stakeholders should develop 3R strategies (reduce, reuse and recycle). More efforts should be made to manage the environmental, social and governance (ESG) challenges and regional cooperation based on the principles of inclusive social management and preventative and holistic environmental management. National government and international organizations in Asia and the Pacific should work together to provide better policy support to member countries.

While this report proposes some principles to ensure that future extractive activities will contribute to SDGs, it intends to stimulate more questions than provide answers. Inclusive dialogues among key stakeholders, at community, subnational, regional and international levels are helpful to figure out what, how and when to take actions and by which stakeholders.

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