JOINT VIRTUAL WORKSHOP:
MINERALS CRITICALITY & THE ENERGY TRANSITION

SUMMARY OF KEY INSIGHTS FROM THE DISCUSSIONS

EVENT OVERVIEW

On **2 June 2020,** the virtual workshop **'Minerals Criticality and the Energy Transition'**, which was organized jointly by the U.S. Department of State Bureau of Energy Resources and the International Renewable Energy Agency (IRENA) attracted a diverse global audience representing public and private industry, as well as academia, international organisations and NGOs, which underpinned the importance of minerals' criticality in the clean energy transition and the need for responsible concerted actions by everyone.

3 sessions	11 expert speakers	Over 500 participants	Participants from 79 countries

Following the establishment of the Energy Resource Governance Initiative (ERGI) by the United States alongside other founding partner countries of Australia, Botswana, Canada and Peru, and building on the IRENA's 2019 report 'A New World: The Geopolitics of the Energy Transformation', this virtual workshop aimed to **raise awareness of the dependence of the global energy transition on supplies of specific critical minerals** for renewable energy technologies **and to call** on countries and the international community **to develop strategies** to ensure reliable access to these minerals.

The workshop emphasised that **the energy transition is going to be mineral intensive** by illustrating how current designs of key clean energy technologies require specific minerals that are critical to their operation. The World Bank report 'Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition' published in March 2020 indicates we would need over 3 billion tonnes of such minerals and metals by 2050 in a 2-degree scenario. Therefore, how we manage the supply of critical minerals could either accelerate or hamper the progress of the energy transition. The virtual workshop discussed what needs to be further addressed in terms of challenges and opportunities for scaling up the supply of minerals in a socially and environmentally responsible manner, and whether we can mine minerals and process, recycle and repurpose their products or find substitutes at an acceptable price with social and environmental externalities factored in.

KEY-NOTE WELCOMING ADDRESSES

The US Assistant Secretary of State Fannon and the IRENA DG La Camera framed the discussion within the broader context of the energy transition together with the challenges posed by COVID pandemic, whilst Dr. Bazilian provided an overview of the current state of minerals criticality in the energy transition.

Key-note speakers:

- **Frank Fannon**, the US Assistant Secretary of State for Energy Resources
- **Francesco La Camera**, the Director General of the International Renewable Energy Agency
- **Dr. Morgan Bazilian**, Director of the Payne Institute, Professor of Public Policy at the Colorado School of Mines

Highlights from the speeches:

» **Falling oil prices have not translated into a lack of interest in exploring alternative pathways for the clean energy transition**. The post-COVID recovery and discussions have yet again pointed out the risks of volatility of the fossil fuel prices and have stressed how much the energy transition needs to be clean and sustainable with fair and just environmental, economic, and social considerations.

» **Compelling economic reasons for post-COVID recovery prioritise renewables and energy efficiency.** The year 2019 showed a continued strong business case for renewables that currently account for one-third of global power capacity with the trend even more positive when looking forward.

- **Wind and solar would cut annual system costs by up to USD 23 billion and yield a stimulus of USD 940 billion by replacing the costliest 500 GW of coal-fired capacity.** IRENA's new 2019 Renewable Power Generation Costs report shows more than half of the renewable capacity added in 2019 achieved lower power costs than the cheapest new coal plants. It showcases that continued investments in fossil fuels are risky as they lead to an even greater number of stranded assets.
- **Jobs in the renewable energy sector projected to employ 42 million jobs by 2050, which is four times more than today.** Delivering the energy transformation would require total energy system investment to reach USD 110 trillion by 2050 compared to the over USD 95 trillion of investment needed for current plans as indicated by the IRENA Global Renewable Energy Outlook report. That investment would create much needed work, particularly critical in the context of the current crisis.
- **Prospects of higher GDP growth of 2.4% more by mid-century compared to current plans brought by the energy system transformation.** The cumulative gain between now and 2050 amounts to USD 98 trillion putting the additional investments needed for transforming the energy system into a more positive light.

» **Many analogies exist between minerals' criticality and energy security.** Some of the commonalities are a need for social license to operate, countries' exposure to the security of supply in terms of both price and quantity, public and private elements that require strong cooperation with a forward-looking and stable policy outlook with developing and emerging economies put in the centre.

» **The development of national and global strategies that ensure reliable and responsible access to critical minerals has been long overdue.** Geopolitics of the global energy system transformation points out to the dependency on critical minerals in key clean energy technologies. IRENA 2019 report 'A New World, Geopolitics of Energy Transformation' outlines that key minerals and particularly rare earth elements are not geologically rare but rather abundant and widely disperse, although expensive and very polluting to mine and process, with mining and processing being concentrated in a handful number of countries. The report calls on governments and the international community to prepare for the changes and develop strategies to enhance prospects of a smooth transition with responsible and resilient access to minerals.

» **Grouping all minerals into one category does not help policy makers to design impactful strategies.** Each mineral has its own set of origins, properties, market conditions, processing type and recycling rates. Each mineral's supply chain has several uncertainties and a very different 'market' profile. They are however all interconnected and not independent. Several minerals are traded on the London Metals Exchange (implying more transparent prices), the rest are bilateral or smaller markets with opaque contracts. All this underlines a need for a multi-faceted approach.

» **Integrated multi-pronged national and global strategies that address all parts of the supply chain of various minerals simultaneously are key**. Strategies should focus on expanding and diversifying the supply of critical minerals through mining and sourcing, which require countries' cooperation and trust, and a strong commitment to doing so socially and environmentally responsibly. Despite an immature market, early policies (including standards, regulations, etc.) and RD&D programmes for recycling, reuse/repurposing as well as seeking for substitutes should be developed simultaneously.

» **Cooperation and collective experience sharing are key to ensure a resilient and responsible supply chain of critical minerals and their products.** In response to the limited attention paid to this area, the US alongside Australia, Botswana, Canada, and Peru launched the Energy Resource Governance Initiative at the 2019 UN General Assembly, which membership has since grown to include Argentina, Brazil, DRC, Namibia, the Philippines, the Holy See, and Zambia. ERGI aims to create the above-ground conditions to encourage

private investment in and beyond the mining industry, engage countries to advance governance principles, share best practices and encourage a level playing field.

» **Based on geography and availability of domestic supply, countries are developing lists of critical minerals where they define criticality either as an economic issue or as an export opportunity.** The European Union (EU) published its first List of Critical Raw Materials in 2011 and has since updated it three times with the next update coming up later this year. The EU lists raw materials as critical due to risks of supply shortage and their impact on the economy. The list currently contains 27 critical raw materials, with approximately half of them relevant to the clean energy technologies. The same national security risks considerations apply to the List of Critical Minerals in the US that has also been updated since 2011 and currently lists 35 minerals, whilst the 2018 Japan List of Critical Minerals contains 31 key metals minerals. On the other hand, countries such as Australia or Canada with large deposits of several critical minerals consider the list of critical minerals through the optics of export and business opportunities.

» **Many minerals have few or no alternatives given their particular properties, which creates a tremendous opportunity for the mining industry.** But the mining industry is experiencing immense public pressure and critique, as their operation involves sensitive issues of land rights of local communities, as well as environmental considerations. The mining companies are slowly assuming responsibilities towards climate change, respect for human rights, labour and environmental standards, but the efforts to do it across their whole supply chain are not entirely explored and reported.

» **Governments call for responsible environmental and social practices in the critical minerals supply chain and consider subjecting their public finance to their adherence.** To send a strong signal to the mining industry, governments are exploring ways to condition the eligibility of accessing public finance to the adherence to good governance principles on social and environmental responsibility. For example, the US Development Finance Corporation that leverages US government finance to catalyse private sector capital to developing and emerging economies will condition access to its finance to the adoption of ERGI principles, which in turn will make companies enhancing ERGI principles a preferred option of countries' investment choice.

» **Investment in education and training is essential and should be high on the priority list.** To develop a mine, or create a successful mineral processing or manufacturing activity require an educated and trained workforce and should be an integral part of any national and global roadmaps.

Panel 1: Governance - Laying the Institutional Framework to Attract Competitive and Transparent Investment

Discussions explored the importance of the mining sector to adopt and implement good governance principles including socially and environmentally sound approaches to encourage private responsible investment and create value and economic opportunities.

The panel was **moderated by Jenna Schroeder**, Global Energy Programs Manager from the US State Department's Bureau of Energy Resources, who was joined by the following **panellists**:

- **Shawn Tupper**, Associate Deputy Minister, Natural Resource Canada
- **Augusto Cauti**, Vice Minister of Mines, Peru
- **Tyler Gillard**, Head of Sector Projects & Legal Adviser, OECD

Highlights from the panellists:

» **Global standards and initiatives that promote increased transparency are bringing transformative effects and drive the development of the mining industry and host economies.** The mining industry holds great potential for generating income, sustaining livelihoods, and fostering local development. A large share of these resources is however located in conflict-affected and high-risk areas where exploitation of natural mineral resources is significant and may contribute, directly or indirectly, to armed conflict, gross human

rights violations and hinder economic and social development. Examples of global standards and initiatives that tackle it:

- The Energy Resource Governance Initiative (ERGI) helps create value and economic opportunity throughout the entire mine development lifecycle by outlining universal considerations important for any country to consider when developing its energy mineral sector. It aims to ensure that countries with mineral resources are empowered to advocate for their citizens and that human rights are respected throughout the entire clean technology supply chain.
- OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas provides recommendations for global responsible supply chains of all minerals, in order for any company potentially sourcing minerals or metals from conflict-affected and high-risk areas to cultivate transparent, conflict-free supply chains and sustainable corporate engagement.
- Extractive Industries Transparency Initiative (EITI) establishes a global standard to promote open and accountable management of mineral resources by requiring disclosure of information along the mining industry value chain including how revenues make their way through the government.

» **The mining sector can drive countries' economic development if done responsibly.**

- **Canada's** mining sector has access to over 60 minerals and metals incl. lithium, cobalt, nickel, graphite, and its approximately 700 companies operating in mining with the assets of over USD 174 billion in 100 foreign countries represent half of the global mining sector. The government plays a vital role in creating a **predictable regulatory environment, that integrates environmental, social, and economic considerations** into its regulations and policies, and **supports R&D**. In 2019, Canada adopted a 'Minerals and metals action plan' outlining roles, responsibilities, and priorities of its federal, provincial and territorial governments, to be implemented **in collaboration with its stakeholders including industry, and local communities**. Following clarification of domestic strategies, at the beginning of 2020 Canada and the US finalized The Joint Action Plan on Critical Minerals Collaboration.
- **Peru** with its enormous geological potential of copper, zinc, silver, gold and molybdenum is a leader in mining with extensive expertise based on its mining history and represents a great opportunity for investors. Only in 2019, more than USD 600 million was invested in the mining sector, with mining activities representing 10% of Peru's GDP and 60% of its total exports. Peru has **showcased the possibility to transform the mining industry into a sustainable one with significant welfare created for large parts of its population by taking drastic measures through taxes, responsibilities, inclusion**, among others. Peru has also set up a forward-looking outlook based on shared responsibility for the post-COVID recovery, including regional governments' responsibility to transfer technical capabilities to small artisanal mines, and large mining companies' responsibility to continue supporting their workers and local communities. To shape **an ecosystem of governance, open innovation, international cooperation, knowledge base, and competitiveness**, the Mining Cluster of Southern Peru is funded by CAF, the Development Bank of Latin America. Peru also works with the US and Canada's governments to seek assistance with attracting sustainable private finance through policies and regulations.

» **Artisanal small-scale mining, whilst a particularly vulnerable, offers a large potential to local communities.** Sourcing of artisanal mines is often informal making it vulnerable to abusive practices that are hardly enforceable by environmental and labour laws. But it is also the largest source of jobs in the sector amounting to 85% of the workforce, mostly in poor areas. To avoid abusive practices, artisanal mining must be formalized via the establishment of cooperatives, associations, and other structures.

» **Governments must promote and innovate policies that create shared value through social, economic, and environmental outcomes and maximize the value from mining activities without harming people or the environment**. The government of Canada develops standards, shares best practices, invests in public education and workforce training, and puts a strong focus on R&D on mining but also extracting value from the waste, cleaning up and accessing bi-products. It works closely with the mining and oil and gas

sectors and communities to introduce an enabling regulatory framework with social and environmental considerations and commitment to multilateralism.

» **If harmonised by governments, the auditing schemes across the world will be strengthened.** Financial institutions are adopting various auditing schemes against illegal sourcing. For example, London Metal Exchange requires that any producer must comply with the OECD Due Diligence Guidance to be accepted to the London Metal Exchange. Banks as well as the private sector are also introducing their own auditing schemes against illegal sourcing. This offers an opportunity for governments to harmonise these schemes which will only strengthen them.

» **Adherence to good governance principles has significant implications on the overall reputation of the mining sector.** Sound governance or a lack of it can either make or break the mining sector and decide whether countries can attract sustainable investment, which has significant implications on the overall reputation of this sector. The OECD has been collecting reports on risks that are being associated with mining operations that may expose companies to not only reputation damage but also legal liabilities. They have noticed several higher risks including child labour, bribery and corruption, forcing compulsory labour or direct and indirect support to non-state armed groups and sanctioned entities particularly in connection to cobalt, but also lithium and nickel mining activities.

» **Reputation is increasingly seen as a way to sustain companies' competitive advantage.** Corporate reputation is driven by social, environmental, and economic outcomes of the mining activities, but also the quality and the structure of the relationships between the company and its stakeholders. Particularly reputation with host communities facilitates better access to capital, planning permission, and skilled labour. This in turn creates cost advantage, leads to improved financial performance, and contributes to considerable stability over time.

» **Consumers exercise immense pressure on companies to offer products with ethically sourced minerals.** Information flow has become faster, and any incidents of environmental misconduct, human rights violations or unethical business behaviour are immediately known. Meanwhile, consumers alter their beliefs, attitudes and buying behaviour and scrutinise companies accordingly to their reputation. Regulators and civic society are creating pressure on companies to certify minerals they source, purchase or use are conflict-free. Companies are taking note, and are exploring solutions, such as blockchain to track conflict minerals, to help them with their due diligence requirements.

» **Policies aiming to increase midstream value must include measures on infrastructure and workforce to attract investment.** Mining countries in Africa and Asia have been seeking to increase their midstream value-added share for some time, mostly through bans on exports of raw unprocessed minerals. To attract investment, countries need to develop a good and predictable business environment through sound policies and regulations, ensure a skilled workforce, acquire know-how, and build infrastructure.

» **Advice from old mining countries to the new ones: transparency, the stable and predictable legal system, and adherence to global governance principles are key to developing the mining industry and attract sustainable investment.** The first steps for a 'new' mining country is to adopt regulations addressing environmental, social and economic concerns in a multi-stakeholder, inclusive, and transparent manner. Equally important is to join global initiatives such as ERGI to learn from more experienced countries and jointly invest in R&D.

PANEL 2: STEWARDSHIP – SUPPORTING THE FULL VALUE CHAIN FROM MINERALS TO ENERGY TECHNOLOGIES

Discussions explored alternative strategies to reduce supply risks including recycling and reuse/repurpose critical minerals in the context of the circular economy; and reduction in demand for specific critical minerals through alternatives technological designs that reduce the need for or substitute for those minerals.

The session was **moderated by Dr. Dolf Gielen**, the Director of the IRENA Innovation and Technology Center, who was joined by the following **panellists**:

- **Christopher Sheldon**, Practice Manager for Extractives, World Bank
- **Peter Handley**, Head of Energy Intensive Industries & Raw Materials, DG Grow, European Commission
- **Jeffrey Spangenberger**, ReCell Center Director, Argonne National Laboratory

Highlights from the panellists:

» **More than 3 billion tons of minerals and metals will be needed by 2050 under the 2-degree scenario.** The World Bank 2020 report 'Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition' compares that amount of minerals to the third of all plastics produced between 1950-2015. For certain minerals, the projection shows a 500% increase, for the others show a much lower %-increase, but still with large volumes. These estimations are based on the existing technologies, and it is important to consider that technologies, their design as well as energy scenarios may all change, which will impact the demand for minerals and metals up or downwards.

» **The world needs to plan for a massive increase in demand for critical minerals by diversifying the supply chain through recycling, repurposing, and seeking substitutions.** Given current technological and economic limitations, the scarcity of minerals is less about depleting existing stock, and more about whether we can mine these minerals as quickly as our energy transition models would demand and whether we can produce these materials at an acceptable price with environmental and social externalities factored in. Circular economy (recycling and repurposing) and seeking substitutes offer an alternative, environmentally and socially conscious forward-looking options.

» **Positions towards recycling, recovery, and substitution are driven by policy objectives**. For example, the EU Green Deal and the EU post-COVID recovery plan both acknowledge dependencies and vulnerabilities of the EU vis-a-vis specific critical minerals and stress the importance of developing a strategic autonomy and resilience. The EU is, therefore, evaluating its dependencies in individual renewable energy technologies particularly onshore and offshore wind, solar PVs and batteries for a while. It has invested into R&D to develop substitutes, and for the critical minerals without current substitutes has assessed the technical and economic feasibility of minerals' recycling and reuse/repurpose, ways to engage supply chain actors and the public, and develop strategies, policies and legislation to create a market that ensures the availability of recyclable items and the infrastructure.

» **Recycling rates differ in their availability of scrap.** There are two commonly reported rates for recycling: **end of life (EOL)**, on how much of a mineral is recycled at the end of its use in a product; and **recycled content (RC)**, on the percentage of secondary material that goes into end-use demand for a mineral. EOL and RC rates are not equal, and the former is higher than the latter. The primary reason for this difference is the availability of scrap. For example, in the case of cobalt, around 68% of cobalt is recycled EOL, yet the RC of new cobalt products has been estimated at around 32%. Nickel on the other hand has below 1% EOL and RC recycling rates.

» **Recycling rates data spur improvements in recycling economics, technology, and other factors.** Recycling data have the potential to demonstrate how efficiently metals are being reused and can help to determine the influence of recycling on resource sustainability, provide information for R&D on improving recycling efficiency, and enhance informed recycling policies.

» **Scaled-up deployment of EVs and home storage systems drives the need for recycling of their minerals but lacks sufficient investment into RD&D.** The EU has been investing in exploring economic recycling processes through its R&D programme Horizon 2020, accompanied by regulatory frameworks (one will be launch in fall 2020). The US Department of Energy's Vehicle Technologies Office's established the ReCell Centre earlier in 2020 to explore cost-effective, flexible techniques to extract as much value as possible from current and future batteries chemistries to make recycling economically viable.

» **Not all lithium-ion batteries are created equal**. There are different chemistries for different applications. Each application is particular and has its own recycling challenges. Consumer electronics use high cobalt

chemistries that are worth but have very low collection rates and batteries are hard to remove, cordless tools contain no cobalt, whilst plug-in vehicles, on the other hand, use lower cobalt chemistries, and their collection is not expected to be an issue, but they are expensive to recycle.

» **By comparing different recycling methods, existing challenges are identified and suggestions for improving the recycling effectiveness can be proposed.** There are various recycling methods currently in use: pyrometallurgical (using high temperatures) and hydrometallurgical (use of acid leachant agents to dissolve battery metals) are both cost not-competitive and have environmental implications, therefore a new method of a direct cathode recycling is being explored.

» **To further improve the overall economics of batteries, batteries can benefit from the recovery of other materials and a better battery design**. Research centres, including ReCell Centre, are improving methods to recover other materials from batteries including anode materials (graphite), plastics, and electrolyte components. Batteries are currently characterised by a large number of battery-pack designs that vary in size, electrode chemistry, and format with each designed by a different manufacturer. Better battery design needs to allow extended lifetime, use less or less frequent critical minerals, make disassembly and material separation easier to significantly improve batteries' economics and this can be also accomplished through international standardisation.

» **Time lags should not stop improving recycling processes.** A product can only be recycled once it is no longer in use. The "time lag" between the manufacture of a product and its availability for recycling varies, and in terms of EVs amounts to 12- 15 years. There is therefore a time lag between now and 2035 when EV batteries come back for treatment. Only around the year 2035 the impact of recycling will start to be realised, but it will also depend on the recovery rates, and whether there are improved recycling processes and an enabling environment for it.

» **Consumers have a role to play in increasing recycling rates.** Despite numerous recycling programmes globally, there is limited awareness of their existence. The public sector should foster mineral recycling by raising awareness of these programmes, enhancing transparency along the supply chain, developing business models to increase consumers' participation in these programmes, whilst clearly designating actors responsible for recycling materials.

» **Recycling and primary production are complementary not competing approaches.** With a massive increase in demand for critical minerals, even 100% EOL recycling cannot meet demand under a 2-degree scenario and primary production will still be needed. But the mining needs to be assessed from various aspects, including its carbon footprint, use of water, energy, impact on forests as well as the transport of minerals.

» **Substitutions should remain an essential part of global strategies to reduce dependencies on critical minerals**. Substitution has been considered from reducing the use of critical minerals through improved material efficiency to substitution at material and component levels. The EU's dependence on several critical minerals in applications and technologies translated into the research programme that made considerable progress in reducing or even eliminating the amount of some rare earth in wind turbines, and platinum group elements in PVs by 80%. However, the research on substitution of rare earth in permanent magnets for offshore wind applications and electric vehicles advances slowly due to a need to replace them with minerals of the same efficiency and same functionalities.

CONCLUSIONS

With the global COVID-19 pandemic, the world has been experiencing the largest economic shockwave in decades. The International Labour Organisation (ILO) calculated that over 300 million people around the world have lost their job this year, and data reveals devastating effects on workers in the informal economy such as artisanal small-scale mining. This is being accompanied by declines in GDP.

Renewables, although affected along with the rest of the economy, appear more resilient than other parts of the energy sector and bring compelling economic benefits, calling on **post-COVID recovery plans of many**

countries to prioritise renewable energy and energy efficiency. IRENA projections show that each million dollars invested in renewables or energy flexibility would create at least 25 jobs, while each million invested in efficiency would create about 10 jobs.

Whilst there is a considerable scale-up on the use of renewables across economy, this event pointed out to another dimension to the energy transition. The large-scale deployment of renewables is expected to cause increased demand for critical mineral resources. Discussions underlined that mining and processing of these minerals is polluting and expensive and is concentrated in a handful of countries. Speakers stressed that our response to it would be decisive for the success of the energy transition with multiple aspects to be considered.

In addition to ensuring the resilient supply of minerals, the responsibility of the mining industry towards the environment and host communities needs to be scaled up just as ambitiously as the net-zero emissions energy transition. Panellists from across all sessions recognised that doing so will require concerted commitments from both the mining industry and governments to ensure the adoption and adherence to good governance principles by requiring not only mining operations but also the whole supply chain to adhere to stringent, independent environmental and human rights standards. Discussions pointed out to several ongoing efforts. The OECD, EITI or London Metal Exchange are active in introducing standards to increase transparency on ensuring resilient and responsible access to minerals or their products along the supply chain. In turn, adherence to these standards is becoming a condition to access public and private finance.

But more needs to be done.

Recycling, repurposing, and substitutions of minerals are becoming key as COVID adds disruption to the mining supply chain. There are still many economic considerations in these areas. The recycling and repurposing sectors are immature, with low recycling rates, cost-ineffective processes, and no international standards. The scale-up of EVs and storage systems is slowly driving investments into RD&D to spur the improvements in recycling economics and technology, comparing different recycling methods and identifying further challenges. Research is also clear on the need to develop new or improve existing methods to cost-effectively recover other minerals from batteries (plastics, graphite from anodes, or electrolytes) and look into a better design of these technologies that would use less critical minerals without sacrificing its effectiveness and functionalities. Researchers are calling on policy makers to equally explore substitutes and include this research activity into global strategies that seek reduced dependencies on critical minerals.

Discussions however stressed on multiple occasions that with a massive increase in demand for critical minerals, even 100% EOL recycling cannot meet demand under a 2-degree scenario alone and primary production will therefore still be needed. Therefore, the discussion emphasizes that it is not primary production versus recycling, repurposing, or substitution. It is both.

In addition, participants emphasised the importance of organising these types of events to create an opportunity for policy makers, industry and civic society to gather, discuss challenges, share the experience but also explore partnerships and collaborations between national and international, private and public stakeholders to ensure resilient and responsible supply chain of critical minerals.

To conclude, the energy transition is going to be mineral intensive and requires countries and the international community to scale-up their concerted efforts to ensure the supply of minerals is resilient, actors adhere to environmental and human rights standards, governments introduce policies, standards and regulations, attract sustainable investment and invest in RD&D in recycling, repurposing and substitution as ambitiously as the net-zero emissions energy transition.