

Building a Responsible Cobalt Supply Chain



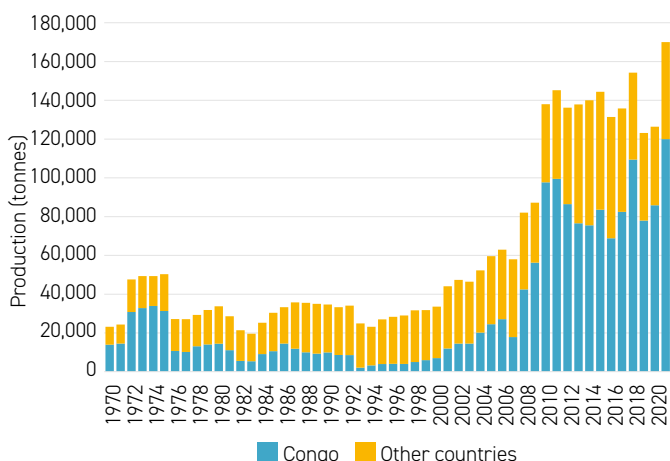
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A rapidly growing market for batteries across the globe has intensified pressures on suppliers of cobalt to meet surges in demand. Such pressures have impacted the livelihoods of miners – in particular, those working in the Democratic Republic of Congo’s artisanal and small-scale mines – in both beneficial and potentially deleterious ways. International efforts by businesses, governments, and NGOs to secure a responsible supply chain for cobalt have the potential to protect lives and livelihoods while ensuring corrupt practices are held in check.

Surging Demand for Cobalt

Global production of cobalt has experienced a growth spurt over the past few years, rising from an average global production of 38,000 tonnes per annum over the 1970-2010 period to around 140,000 tonnes per annum over the recent 2010-2021 period (Figure 1). The growth is largely driven by

Figure 1: Global cobalt production 1970-2021



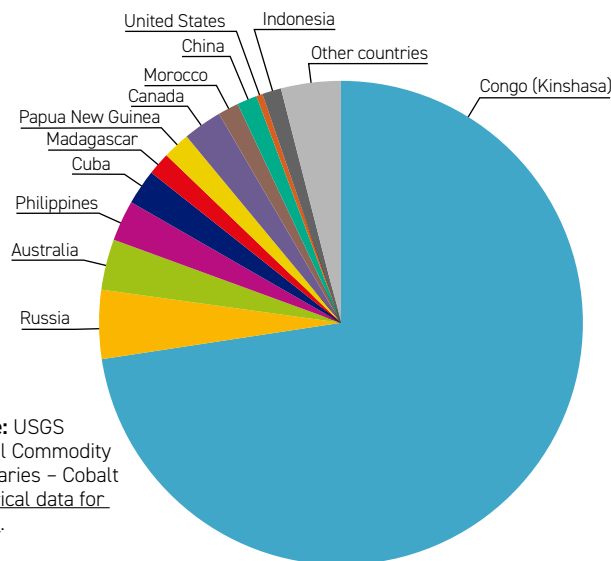
Source: USGS Mineral Commodity Summaries – Cobalt
[Numerical data for figures.](#)

Image courtesy of Katanga Mining Limited
* This Faraday Insight 7 is an update to the version first published in May 2020.
¹ Cobalt Institute (2021). 'State of the Cobalt' market report.

the market for batteries, which accounted for 57% of total cobalt consumption in 2021.¹

The Democratic Republic of the Congo (DRC) is by far the largest producer of cobalt, accounting for 62% of global production since 2010 and 70% in 2021 (Figure 2). Other large producers of cobalt include Russia, Australia, Philippines and Cuba. Going forward to 2030, cobalt production is expected

Figure 2: Global cobalt production by country 2021



Source: USGS Mineral Commodity Summaries – Cobalt
[Numerical data for figures.](#)

to grow to 14% of global demand in Australia and to 15% in Europe through additional mining activities and recycling.²

Demand for cobalt can be broken into two large categories: metallurgical and chemical. Cobalt for metallurgical use is primarily in high temperature alloys, for example, those used in aerospace rotators, defence and power generation, along with steel, carbide and diamond-based tools and magnets.

Cobalt for chemical applications is predominately used for rechargeable battery production. It serves as a key material in batteries for mobile phones, laptop computers and electric vehicles (EVs). Cobalt has properties that make it ideal for battery applications: thermal stability (which is important for battery safety) and high energy density (which allows energy to be stored and transferred at a scale suitable for vehicle applications).

With much of the world transitioning into full EVs, the demand for cobalt will increase, with 520,000 tonnes per annum of cobalt required for EV batteries and other products by 2040, compared to 170,000 tonnes in 2021.³

This increase in demand will continue even as scientists around the world, including those from the Faraday Institution, are developing alternative battery chemistries⁴ that require less of its use. Lithium nickel manganese cobalt (NMC) batteries are moving to higher nickel and lower cobalt chemistries such as NMC 811 (80% nickel, 10% manganese and 10% cobalt) and NMC9.5.5 (90% nickel, 5% manganese and 5% cobalt). Lithium iron phosphate (LFP), which does not use any cobalt, is also growing in popularity due to its use of lower cost materials. 25% of European-produced EVs are expected to be based on LFP chemistry by 2030.⁵ Longer-term options include lithium manganese nickel oxide and next generation technologies such as solid-state, sodium-ion and lithium-sulfur batteries.

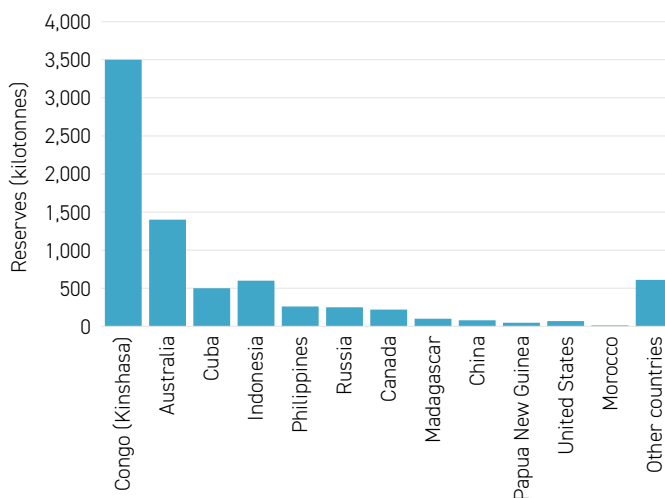
Despite these innovations, the demand for cobalt is still set to increase as EV sales escalate globally. Such an increase in demand leaves the cobalt supply chain very vulnerable to supply shortfalls. It is regarded as one of the most vulnerable raw material supply chains.⁶ Due to these factors, it is necessary to secure the supply chain and tackle the issues around cobalt's sourcing regardless of technological developments.

Concentration of Global Resources

Global cobalt reserves are currently around 7,600 kilotonnes. Similar to production, cobalt resources are concentrated in the DRC, which accounts for around 46% of global reserves. Important cobalt ore deposits are also found in Australia, Cuba, Philippines, Russia and Canada.

Most of the cobalt resources in DRC are in sediment-hosted stratiform and stratabound copper deposits.⁷ Around 98%

Figure 3: Global cobalt reserves, 2021



Source: USGS Mineral Commodity Summaries – Cobalt [Numerical data for figures](#).

of global cobalt is retrieved as a by-product of nickel and copper refining.⁸ Whilst DRC dominates production and reserves, most cobalt refining (i.e. purifying an impure metal) is done elsewhere. China accounts for 65% of global production of refined cobalt, largely obtained from DRC, followed by Finland (11%) Belgium (5%) and Canada (5%).⁹

Most DRC-mined cobalt is produced by large industrial firms, such as Glencore, which has interests in the Katanga and Mutanda mines,¹⁰ and China Molybdenum, which partially owns the Tenke Fungurume copper-cobalt mine. In August 2021, the Congolese government set up a commission aimed

The UK's Critical Minerals Strategy

In July 2022, the Department for Business, Energy and Industrial Strategy outlined a critical minerals strategy.¹¹ The strategy centres around aims to accelerate domestic production, collaborate with international partners and enhance international markets for critical minerals.

The strategy recognises the risk to the market's stability posed by the concentration of sourcing from a few countries and how illegal and unofficial mining projects often result in excess damage to the environment and exacerbation of social issues.

The strategy outlines the UK's commitment to working through its international networks, such as the G7, to promote a more fair and distributed market and to position London as the centre for responsible critical mineral financing.

² European Commission (2018). Cobalt: supply and demand balances in the transition to electric mobility.

³ Faraday Insight 6 (September 2022). Lithium, Cobalt and Nickel: The Gold Rush of the 21st Century.

⁴ See the Faraday Institution's research programme, including projects aiming to decrease cobalt use and develop a framework for full battery recycling.

⁵ Advanced Propulsion Centre (June 2022). Q1 2022 Automotive Industry Forecast.

⁶ Trafigura (May 2022). Accelerating transition: the case for formalising artisanal and small-scale mined cobalt in the DRC.

⁷ See Table 6 of Cobalt: demand-supply balances in the transition to electric mobility (2018).

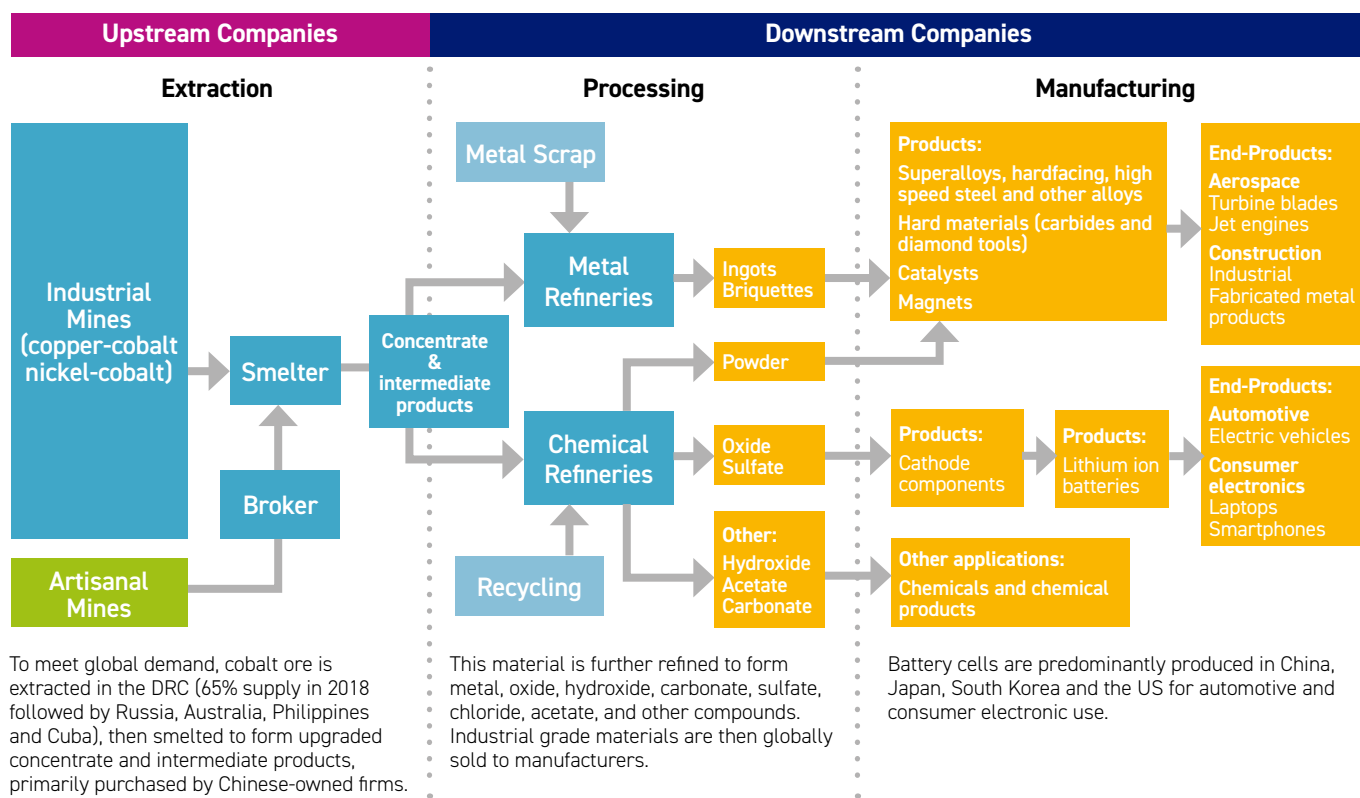
⁸ "Unlike most base metals, changes to global copper and nickel production are the main determinants of changes in cobalt production rather than the supply-demand dynamics and pricing of cobalt itself." Global Energy Metals Corp.

⁹ BGS Minerals UK. World Mineral Statistics Data, Production Data.

¹⁰ Glencore webpage on cobalt

¹¹ Resilience for the future: The UK's critical minerals strategy (July 2022).

Figure 4: The cobalt supply chain from mine to batteries and other applications



Sources: BMI, CRU International Ltd, British Geological Survey

at reducing the power of Chinese investors, who at the time controlled about 70% of the mining sector in the country.¹²

Artisanal and Small-scale Mining in the DRC

Artisanal and small-scale mines (ASM) – low-tech, labour-intensive mineral extraction and processing – in the DRC serve an essential part of the global cobalt supply, cover large swings in demand, provide a direct livelihood for 200,000 people and account for 20% to 40% of the DRC’s cobalt production.⁵

Benchmark Mineral Intelligence estimates that ASM in the DRC produce 7% of the world’s supply, though other estimates widely vary. Quantifying the amount of cobalt produced from ASM in the DRC is challenging in that the source of cobalt is hard to trace. Data-aggregating efforts like Delve¹³ are working on the challenge. While DRC cobalt is smelted in the country, it is not at a high enough quality for immediate industrial use. An estimated 90% of DRC-sourced cobalt is further refined and processed in China, which controls the majority of refined global cobalt output,¹⁴ supplying high-grade chemical cobalt to the international marketplace. Consequently, the Chinese refining industry remains a major entry point for DRC artisanal cobalt into the supply chain. The value chain for cobalt is illustrated above.

ASM, Child Labour and Modern Slavery

The DRC has received significant international attention on its human rights challenges, specifically around ASM child labour and modern slavery.¹⁵ For clarity, only a fraction of ASM cobalt from the DRC is informally extracted or linked to abuses.¹⁶ However, the unregulated and informal aspects of ASM in the DRC may exacerbate issues facing an impoverished people, whereby exploitation, violence, coercion and abuses of power go unchecked. Among many other countries who have adopted the UN Global Goals for Sustainable Development, the UK is committed to ending modern slavery, forced labour, and human trafficking worldwide by 2030, including the eradication of child labour.

The political and socioeconomic challenges in the DRC’s artisanal mining industry, however, are highly complex. To ensure international development and legal efforts do not cause harm to people, it is important to understand ASM dynamics in its local context. ASM is an important source of income for the DRC population on the extreme end of the poverty line. In countries where unemployment is high and public services are poor or non-existent, ASM employment is often the only option to feed, clothe, shelter and educate families. Simply removing ASM from mineral supply chains to address child labour and modern slavery may do harm and overlooks an opportunity to improve the lives of ASM

¹² Reuters (March 2022), Congo court appoints temporary administrator to run China Moly’s Tenke mine.

¹³ Delve, a global database for ASM data.

¹⁴ According to Benchmark Mineral Intelligence, 62% of all cobalt products (including metal) and over 80% of cobalt chemicals were refined in China (2018).

¹⁵ “Modern slavery” is an all-encompassing term for extreme forms of exploitation such that a person cannot refuse or leave because of threats, violence, coercion, deception, and/or abuse of power.

¹⁶ Benchmark Mineral Intelligence, “Cobalt and the DRC: a Reminder of the Salient Points,” December 2019.

operators and the communities in which they live. There is additional complexity here since ASM is integrated within major mining operations. This includes cases of unauthorised short-term incursions of ASM diggers onto formal mechanised mine sites, as well as the establishment of unregistered ASM digging communities on formal mine sites over the longer-term.⁵ Therefore, as demand for cobalt increases such human rights violations will continue unless directly addressed by the industry and downstream companies.

It is clear that the DRC and the cobalt supply chain must engage with workers to turn illegal, unregulated and dangerous operations into a safe, transparent, accountable and traceable source of cobalt supply. In 2019, the DRC established a state company – *Entreprise Generale du Cobalt (EGC)*, a new subsidiary of state-owned *Gecamines* – to purchase all ASM cobalt in the country for the market, in an attempt to boost revenue for the country and to address human rights abuses. EGC will have the exclusive right to buy ASM cobalt produced in the DRC. Through this power, the EGC can establish controls over the ASM cobalt supply and formalise the sector, introducing a standard of practice with the EGC Responsible Sourcing Practice.¹⁷ Despite this move, *Trafigura* have noted that buyers continue to purchase cobalt from the source, undermining the EGC's ability to ensure only responsible mines are accessing the market.⁵ Additionally, while the DRC's effort to formalise artisanal mining may prove beneficial, concerns have been raised about the concept and whether it will lead to transparency and accountability in practice. Further still, while the state-owned company could smooth out fluctuations in the supply chain by controlling the release of cobalt into the market, "the temptation to use its market power to support prices during periods of low-growth demand may prove irresistible."¹⁸

Other programmes have been designed and implemented to include the voice of ASM miners in the discussion and to help make real the development opportunity for the DRC and its ASM communities. According to the US-based organisation *Pact*,¹⁹ "the Mutoshi semi-mechanized, small-scale cobalt mining project is a unique responsible sourcing collaboration between concession-holders *Chemaf*, *Trafigura*, the cooperative *COMIAKOL* and *Pact*, with the support of DRC authorities." *Delve* has analysed the local economic impact of this responsible sourcing project, which seeks to "ensure the safe and secure delivery of cobalt to the market by working with artisanal miners."²⁰

International Efforts to Build a Responsible Cobalt Supply Chain

A range of international efforts and resources have been created to ensure the supply chain is responsible, legal, transparent and traceable, while protecting the livelihoods of workers.

Cobalt Industry Responsible Assessment Framework (CIRAF)

Led by the Cobalt Institute with its members, the CIRAF initiative aims to implement due diligence on responsibly sourcing practices. CIRAF launched in early 2019 to strengthen "the ability of cobalt producers and buyers to assess, mitigate, and report on responsible production and sourcing risks in their operations and supply chain. The CIRAF also enables a more coherent and consistent approach to cobalt due diligence and reporting by the cobalt industry."²¹

Delve

With an aim to help formalise the capture and dissemination of information on the sector, *Delve* is a resource for artisanal and small-scale mining data. Lack of quality data is "undermining the ASM sector, obscuring its contribution to development, and perpetuating a narrative that says ASM is dirty, chaotic and inherently bad for the environment and developing communities. We believe better data will reveal a different picture and lead to better decision-making, policies and interventions."¹³

Global Battery Alliance

Hosted by the World Economic Forum, the Global Battery Alliance is a global collaboration and public-private partnership. It seeks to catalyse, connect and scale-up efforts to ensure that the battery value chain is socially responsible, environmentally and economically sustainable and innovative. Among the GBA's strategic objectives is, "building stable and transparent raw material supply chains characterised by good working conditions and shared prosperity." Over 50 members support these efforts, including the Faraday Institution.

Pact's Mines to Markets (M2M)

A development programme run by *Pact*, *M2M*²² follows "an integrated, holistic approach to help resource-dependent communities improve their lives." Its approach is to bring together government, industry and miners in order to formalise ASM in order to make it safer for workers and ultimately more productive. *M2M* tackles areas of health and safety, human rights, traceability and transparency, economic empowerment among miners, mercury abatement, child labour reduction, mineral certification and ethical sourcing. *Pact's* 2021 Impact report predicts the *M2M* project to have improved the lives of more than 77,000 ASM workers.²³

Responsible Cobalt Initiative (RCI)

Reliant upon the OECD Due Diligence Guidance,²⁴ the RCI enables member companies to identify and address potential adverse impacts arising from their business. This includes calling on companies to trace cobalt extraction,

¹⁷ *Mining Magazine* (January 2022), *Pact Mines to Market Deputy Director Mickaël Daudin's op-ed on ASM cobalt and blockchain*.

¹⁸ *Reuters, Basic Materials: "Congo's move to control artisanal cobalt is double-edged"* Andy Home, (February 2020).

¹⁹ *Pact* (February 2020), *Confronting Modern Slavery in DRC-UK Mineral Supply Chains*.

²⁰ *The Mutoshi Pilot Project* (2019).

²¹ *Cobalt Institute: The Cobalt Industry Responsible Assessment Framework* (January 2019).

²² *Pact* (May 2018), *Mines to Markets (M2M)*.

²³ *Pact* (February 2021), *Measuring Pact's Mission 2021: Data, Evidence, Impact*.

²⁴ *OECD* (March 2013), *Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas*.

transportation, manufacture and sales. The development of the RCI was led by the Chinese Chamber of Commerce for Metals, Minerals & Chemicals Importers & Exporters (CCCME). Member companies include Apple, HP, Samsung SDI, and Sony. Notably, the RCI, CCCME and the RMI collaborated to develop the Pilot Cobalt Refiner Supply Chain Due Diligence Standard, an assurance process for cobalt refiners.

Responsible Minerals Initiative (RMI)

In early 2017, RMI members established a workgroup focused on the responsible sourcing of cobalt and, in particular, the risks related to instances of child labour in cobalt mining in the DRC. Through the workgroup, companies are working to increase transparency in cobalt supply chains and engage with supply chain actors to promote the responsible sourcing of this mineral. Specifically, the RMI works to create the enabling conditions for companies to exercise due diligence over cobalt supply chains, such as ensuring the downstream voice on responsible cobalt sourcing is heard, providing miners with tools and resources, conducting risk assessment and audits, and public reporting.

Establishing a Wholesale Raw Material UK Battery Supply Chain

Establishing a cobalt battery supply chain for the UK should be examined with respect to all critical materials used in EV batteries, such as lithium, cobalt and nickel for the cathode, graphite for anode, separators, electrolytes, and neodymium and dysprosium used for the high-powered magnets in electric motors.

There are a number of companies in the UK that have the capabilities or capacity to extract and refine the critical metals needed for the UK EV market. For example, Cornish Lithium is a privately-owned and well-funded company piloting the use of modern exploration techniques and digital technology to re-evaluate Cornwall's mineral potential. The Philips 66 refinery in Humber is the only coking refinery in the UK, the world's largest producer of specialty graphite cokes, and the largest anode coke producer in Europe. Despite such successful UK companies, UK capacity and the supply chain will still need to increase substantially to meet the growing demand for the materials used to manufacture EV batteries.

The UK Government is strengthening the trading relationship with Australia,²⁵ which has large reserves of battery metals, with a view to creating a sustainable and socially responsible materials partner for the UK. Having a battery supply chain with a resilient raw materials supply chain would be a key factor that could contribute to attracting cell manufacturers to the UK.

Korea and China initially relied on Japanese suppliers for cathodes, anodes and separators, but invested in their respective national clusters to reduce their dependence on

foreign supply. This allowed them to achieve lower prices and become globally competitive as cell producers became co-located with component suppliers.

A similar effort in the UK would likely yield the same results. With cell manufacturing consolidating in Europe in the next decades it is expected that electrode suppliers will also expand in the European market. Localising more of the battery supply chain in the UK will improve availability and affordability of key chemicals, materials and components. Without a robust UK supply chain, the industry would be exposed to supply chain disruption caused by the combination of an uneven spatial distribution in the supply and demand for raw material and the impact of shocks like natural disasters, pandemics, trade wars etc.²⁶

Creating the right ecosystem will be important to securing a viable and vibrant UK supply chain with substantial economic impact. Key actions to build a battery supply chain in the UK include:

- Attracting cell component (cathode, anode, electrolyte etc.) manufacturers
- Attracting and/or strategically partnering with manufacturers with capabilities in refining, processing and supplying materials for cathodes
- Continued involvement of the Faraday Institution in Battery 2030+, which is a long-term European research initiative focused on inventing the sustainable batteries of the future²⁷
- Establishing battery recycling facilities, including dismantling, pre-processing and materials recovery plants, to create a circular economy
- Exploring the supply chain requirements in more detail, including implementing the UK's Critical Minerals Strategy to collaborate with international partners and enhance international markets through improved data and traceability
- Encourage and support industry groups such as Battery in Focus to potentially simplify transport and storage rules and regulations

Global and UK supply chain issues are being driven by the massive increase in the purchase of EVs leading to a large increase in the raw materials needed for battery manufacturing. They are also driving the potential for a shift in the typical battery chemistry used in EVs, such as the move away from cobalt to other minerals, as well as the long-term opportunity for recycling. This is undoubtedly a massive long-term challenge but with the necessary preparations the UK chemical, battery and EV industries and supply chain should be able to respond to meet it.

Conclusion

To ensure the growing demand for cobalt does not exacerbate conditions for workers collective action will

²⁵ Australian Government (March 2022). 2022 Critical Minerals Strategy.

²⁶ B. Jones et al., EV revolution: The road ahead for critical raw materials demand, Applied Energy, Volume 280, 2020.

²⁷ Element Energy (2020). UK Energy Storage Lab Project - Public Report.

be required throughout the supply chain. Efforts to bring to light the perspectives and challenges of ASM workers – such as Pact's Mines to Markets programme – are necessary to ensure that international pressure to act does not inadvertently do harm to those whose livelihoods are already challenged. Transparency, traceability and accountability are needed throughout the supply chain and can be accomplished through building trust at all levels and between all stakeholders.

About the Faraday Institution and Faraday Insights

The Faraday Institution is the UK's independent institute for electrochemical energy storage research, skills development, market analysis, and early-stage commercialisation. We bring together academics and industry partners in a way that is fundamentally changing how basic research is carried out at scale to address industry-defined goals.

Our 'Faraday Insights' provide an evidence-based assessment of the market, economics, technology and capabilities for energy storage technologies and the transition to a fully electric UK. The insights are concise briefings that aim to help bridge knowledge gaps across industry, academia and government. If you would like to discuss any issues raised by this "Faraday Insight" or suggest a subject for a future Insight, please contact Stephen Gifford.

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