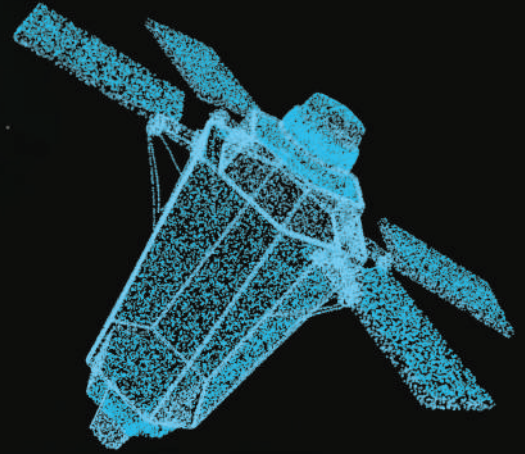




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From Contention to Collaboration: How to Strike Mining's Sweet Spot for Esg and The Energy Transition

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ABSTRACT

In 2021, Amazon-backed Rivian became the sixth most valuable car company as it hit a valuation of more than \$120 billion on its U.S. debut. While this feat is worth celebrating, there is a great need to address the strain on the minerals ecosystem. Also, blind spots are abundant among stakeholders because they lack a complete view of the entire minerals ecosystem. As a result, miners will face a world of contention as they pursue responsibly sourced materials, creating a dual challenge: how to produce the volume of minerals necessary for decarbonization and electrification, and how to produce the volume of minerals with ESG requirements in mind. A primary example of this tension is copper. The energy and water intensity of current processes, coupled with current miners' capital discipline and the challenges presented by the 15- to 20-year permitting and development cycles, makes the feat to mine millions of tons of copper highly unlikely. The most alarming consideration is the upstream impact is likely to wipe out any downstream gains if miners continue to apply current methods for extraction and processing. One impediment is mining's persistent underinvestment in innovation. This innovation deficit creates instability in the industry as the world shifts its energy systems from being fuel-intensive to materials-intensive. The good news is a growing awareness exists about the inadequate supply of key minerals to satisfy the rapid demand for transport electrification and the growth of renewable energy. To overcome the contention within the minerals ecosystem, the mining industry cannot forge it alone; the magnitude of these complex challenges is beyond any single company or industry. In order for miners to strike a sweet spot at the intersection of ESG and the energy transition, they have to tackle two challenges. First, miners must address an innovation challenge to shift from miners to materials providers. Second, miners must address an engagement challenge, expanding the universe of inputs by taking a multi-sector, multi-stakeholder approach to increase understanding and collaboration.

KEYWORDS

Stakeholder engagement, collaboration, cross-sector collaboration, innovation, critical metals, climate change, copper

1. INTRODUCTION: SOCIETY AWAKENS TO METALS-SUPPLY OBSTACLES – AND THE MINER’S DUAL CHALLENGE

Consumers, governments, and markets have begun to demand a transition to low-carbon energy sources as result of climate change. For years the emphasis of climate advocates has been the *adoption* of renewable energy generation. Advocates and energy companies alike realized that enablers of adoption, such as energy storage, electric vehicles, or grid upgrades, represented a potential bottleneck; and, consequently, advocates, governments, and industry players began to address these bottlenecks. However, it appears that a major enabler of the energy transition—the production of metals used in renewable energy assets—went largely unaddressed until conversations taking place around the 2021 United Nations Climate Change Conference (COP26) brought attention to it.

The energy transition requires a shift from a fuels-intensive energy system (depending fundamentally on the production of fossil fuels to pass through traditional energy generation plants) to, as the International Energy Agency (IEA) puts it, a materials-intensive one (depending critically on the production of metals and materials to build renewable generation assets) (IEA 2022). Since COP26, key stakeholders have become increasingly aware that the mining sector will be challenged to meet demand for copper and other minerals central to the production of renewable energy generation and enabling technologies (IEA 2022; S&P Global 2022, a).

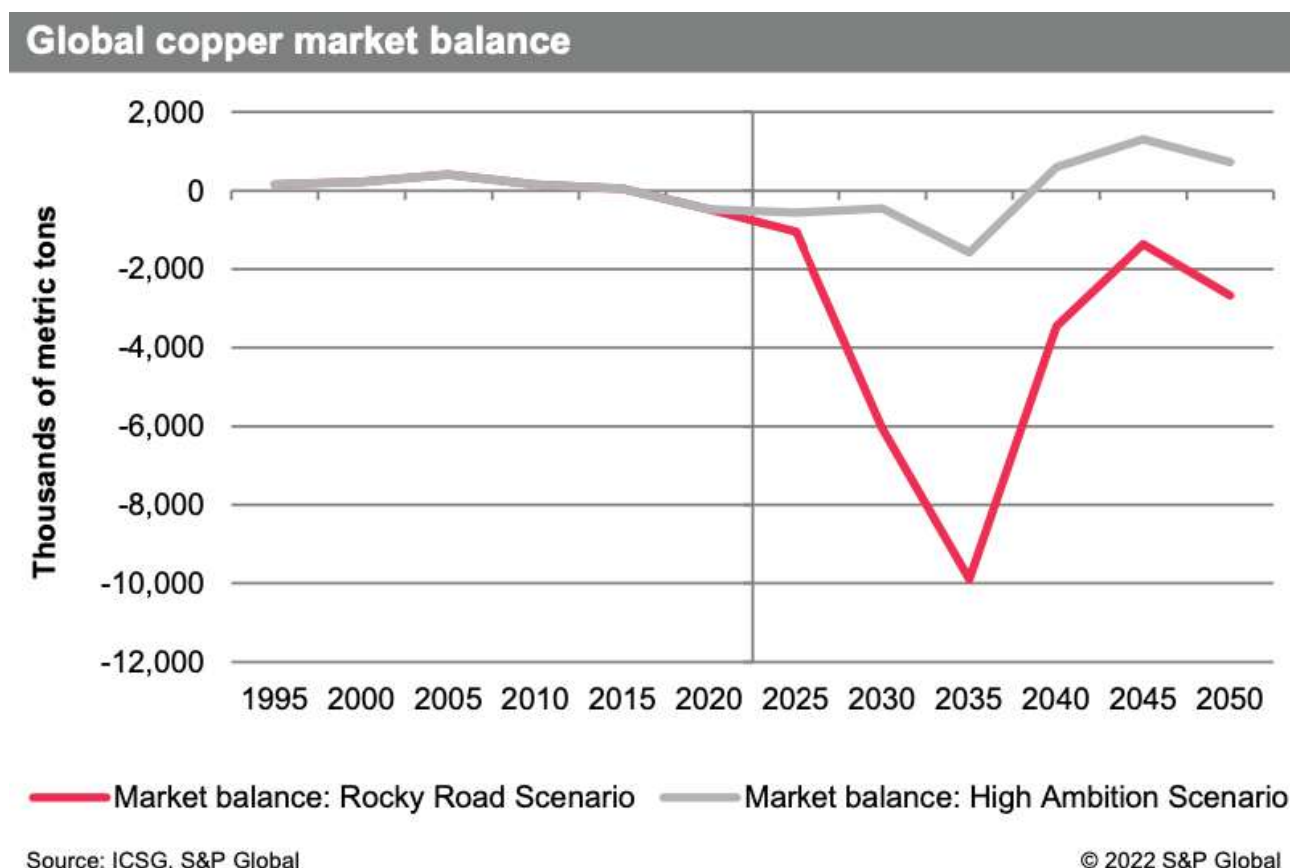


Figure 1 – Copper shortfall through 2050, according to S&P projections (S&P Global 2022, a)

However, despite awareness of the copper shortfall, a deeper understanding of the challenge eludes many of the players that will need to contribute to the solution. For instance, consumer-facing companies do not fully understand the challenge facing companies in their supply chain. Equally, suppliers of metals and other inputs do not fully understand the Environmental, Social, and Governance (ESG)-related requirements of their customers and other partners upstream of them in the value chain. Few downstream companies understand the aspirations, needs, and pains of communities affected by the industry's operations. This disconnect makes it more difficult to devise innovative solutions and accelerate necessary transformation. This will be one of society's grand challenges in the coming decades.

In addition to demanding action around climate and the energy transition, society has also demanded that companies (not just energy and mining companies but all companies) produce goods in a responsible way. Indigenous communities have become empowered to strongly advocate for themselves and ensure mining acts as a catalyst to grow their prosperity. Miners, along with other resource sectors (for example, rubber, even coffee), acknowledge the need to respect and partner with communities; going forward, mining needs to drive change to meet the growing expectations of indigenous communities and positively contribute to the future prosperity of these communities.

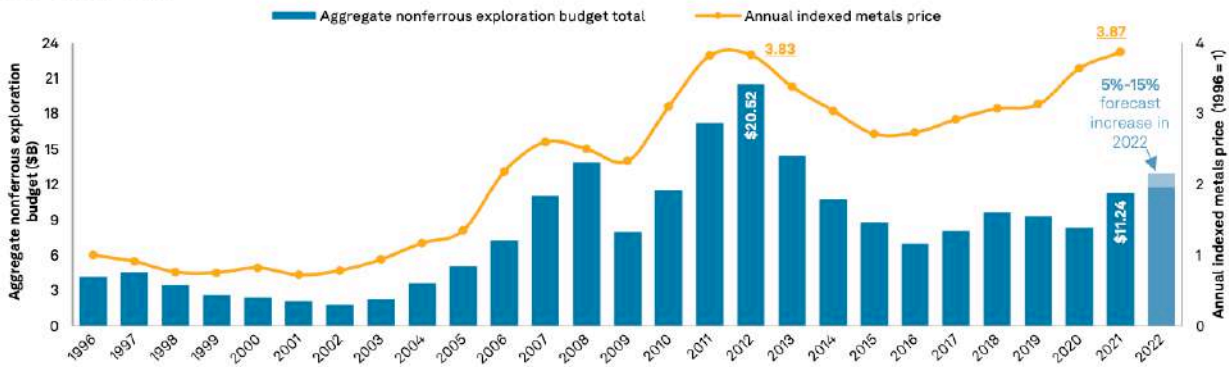
These complications, obstacles, and constraints have the potential to further slow the approval of new mines, thereby constraining or delaying future supply. Miners and downstream companies face a dual challenge: produce metals faster than ever (for an adequate, affordable, and secure supply of metals) – and do so responsibly. What is required to deliver on this dual challenge? The *innovation* challenge that requires an innovation-driven solution, with mining shifting to become materials providers. And, it is also an *engagement* challenge that demands multi-sector and multi-stakeholder engagement, understanding and collaboration.

2. INNOVATION DESERT: THE STORY OF COPPER'S FUTURE CENTRALITY AND SCARCITY

The energy transition requires significant increases in copper production (among other critical minerals, such as nickel and lithium) for the electrification of transportation, electric grid upgrades, battery storage, and deployment of renewable energy generation. Specifically, annual copper production must increase nearly 50% from the current 21 million tons to 30 million tons by 2030 and double by 2050 to 42 million tons (IEA 2022); some analysts estimate an even faster ramp up, with virgin metal production peaking in 2035 not 2050 (S&P Global 2022, a).

Production increases of this scale are not simple to accomplish. They require the discovery of new major, mineable mineral deposits, expansion of existing mines, and transformation of how minerals are extracted and processed. Such operational expansions will be hampered by constrained investment before any operational constraints are applied. That is, capital markets have incentivized miners to apply capital discipline in reaction to previous cyclical overinvestment that led to a supply glut, coupled with downward price pressure and losses in the 2000s and early 2010s. Therefore, miners' primary focus is shareholder returns via dividends, share buy backs, and debt pay downs.

Indexed metals price exceeds 2012 high but 2021 exploration budget only 50% of 2012 high



Data as of Feb. 3, 2022.
Source: S&P Global Market Intelligence

Figure 2 – Exploration budgets have not kept pace with metals pricing (S&P Global 2022, b)

Even when market signals are able to incentivize miners to invest in additional projects (either through price/profit signals or regulation), operational challenges exist. Assuming the global average copper ore grade remains stable at the current 0.5%, which is unlikely given Chilean grades have declined 30% in the last 15 years (COCHILCO 2017), to achieve copper production of 42 million tons annually, more than 4 billion additional tons of rock must be extracted, transported, crushed, and processed annually (21 million additional tons of copper *divided by* 0.5% grade).

This expansion is a challenge in and of itself, but it is further exacerbated by the constraints of energy and water conservation in these mining and processing activities. Take energy as a constraint, for example: the energy required to produce metals needed for batteries, renewables, and grids is immense, and it must be reduced to avoid the erosion of the greenhouse gas (GHG)-abatement benefits of these technologies.

Finally, mining companies need to shift from acting as only miners of virgin minerals to become providers of materials – meeting the needs of society by incorporating recycled metals into their offering, reducing the need for metals in key energy-transition technologies, and developing substitute materials. This transformation is an important ingredient to remaining a valuable mining company in the future. Glencore, for instance, harvested 30,000 tons of copper in 2020 from recycled materials (Glencore 2021). Rio Tinto has recently put into production waste-to-value technology extracting lithium from borates waste rock at its borate mine in Boron, California, USA (Rio Tinto 2021). And, investments in startups like the Urban Mining Company can push the envelope of recycling in the mining sector (Forbes 2020).

Innovation is required to overcome these challenges—capital constraints, operational challenges, climate constraints, and business model transformation. But, importantly, the mining sector continues to underinvest in innovation when compared to other industrial sectors, such as manufacturing and oil & gas. In the 2010s, the mining sector spent less than 1% of revenue on research and development (R&D) (Filippou & King 2011). In 2021, the sector’s R&D investment fell by 2.1% after falling 17.5% the year before (Institute of Materials, Minerals, and Mining 2022). The sector needs to turbo-charge innovation efforts to keep parity with other sectors under business as usual, let alone once one adds all the challenges mentioned above.

The underinvestment in R&D and innovation in mining should be resolved with a combination of measures, including increased spending, incentives, and capital. Those specific measures may include:

- 1) Better collaboration within the industry amongst mining companies to tackle common intractable issues, e.g., the elimination of tailing dams. Consortium efforts like the Oil & Gas Climate Initiative's (OGCI) climate initiative offer examples of such collaboration. OGCI sourced financing from and built collaboration among 12 of the world's largest oil & gas companies to eliminate emissions from oil & gas operations, accelerate carbon capture and storage technologies, and support government policies focused on valuing carbon (OGCI 2022).
- 2) Harmonization of investment across initiatives and across national and provincial boundaries. Currently, fragmented investment and effort slows down innovation. Again, OGCI represents an example to be emulated in mining. The initiative has pooled investment from 12 majors and focused it in a single investment vehicle aimed at funding climate solutions. This has avoided duplication of efforts and synergistic collaboration.
- 3) Expanded venture capital and corporate venture capital activity in mining. Often, valuable and impactful technology is stranded in university R&D centers or mining tech companies that remain small, starved for growth capital that would normally be supplied by venture capital (VC) and corporate venture capital (CVC).
- 4) Increasing corporate budgets for exploration, technology transfer, and process innovation.
- 5) Government incentives for exploration and collaborations. Such incentives increase the availability and speed-to-market of technology in mining operations by providing guardrails to allow the other measures described above (collaboration, harmonization, growth capital, and corporate R&D budgets) to flourish. These incentives are relevant for developed economies but especially for emerging markets.

In addition to addressing underinvestment, cross-sector collaboration and investment can assist miners in becoming materials providers (versus pure virgin-metals miners). For instance, Shell recently launched a consortium to accelerate the switch to electric haul trucks in mining, working with eight collaborators in EVs, charging, and renewables to “launch an end-to-end, interoperable electrification system pilot” (Canada Mining 2022). Nascent collaborations between automakers and miners have also begun to address circular economy and the percentage of metals supply provided via recycling (about one-third of copper is sourced from recycling in a given year, according to the United States Geological Survey (USGS) (USGS 2020), and the vast majority of all copper ever mined is still in use, in large part thanks to the metal's infinite recyclability (Copper Development Association)). For instance, Toyota has launched an initiative that could source 1,000 tons of copper from scrap annually via extracting the metal from vehicle wiring harnesses without it being contaminated by impurities (Reuters 2017). Renault has built a “refactory” – a 915,000-square-foot facility dedicated entirely to remaking and refurbishing cars (New York Times 2022). Miners should proactively drive or at least be open to innovative collaborations that aim to lower the amount of minerals needed in energy transition technologies via substitutions where possible. Forward-thinking miners could even consider how to support efforts to lower overall demand for metals in applications like electric vehicles (EVs). Approaches such as incentivizing more shared rides (which lowers demand for EVs) or providing consumers with a selection of battery ranges for EVs (which reduces the average size of EV batteries) are possibilities. On the surface, some of these approaches may seem counter to the profit equation of mining; however, they may translate into stronger market valuations. Therefore, rewarding companies who support these kinds of initiatives will require transformational changes to revenue models and business model innovations. Those that resist this kind of change will eventually find themselves on the sidelines. Innovative miners or innovators from other sectors will adapt to meet the changing needs of a market that focuses less on procuring commodities and more on delivering solutions in a manner consistent with climate and societal constraints of the ultimate end users, e.g., auto original equipment manufacturers (OEMs).

Each of these important levers need transformative innovation and whole-of-value-chain collaboration to both accelerate the change and increase the chance of success. Business as usual—even with incremental change—will not get the job done. Radical transformation is needed.

3. THE POWER OF ENGAGEMENT: HOW COLLABORATION, TRANSPARENCY, AND PARTICIPATION STRENGTHEN EFFORTS TO EXPAND MINERAL PRODUCTION

Another hurdle on the mining sector’s path to meeting global demand for copper will be the approximately 20-year timeline for new mine permitting and construction. The permitting process for a major mine currently takes 7 to 10 years and construction/development can be 10 years or more, depending on the complexity of the jurisdiction and the deposit. This scenario represents a significant delay in new production coming online, especially relative to the 2050 timeframe in which global climate solutions have been suggested to be implemented.

Adding to that lengthy process, miners must engage stakeholders and owners in more involved and robust ways. This engagement is essential for Indigenous communities and owners to ensure mining adds to their long-term prosperity (and also strengthens the permitting, approvals, and stakeholder engagement process); while it may potentially lengthen an already long mine-building process, it results in a more just outcome.

Essentially, downstream players, civil society, and consumers are asking miners to accelerate the creation of a mineral value chain shaped by community values, delivering long-term prosperity to communities. Up until now, miners have often focused on a jurisdiction’s legal requirements for consultation; instead, they should proactively build towards prosperity and partnership with local communities, regardless of the local laws. Initiatives like the Development Partner Institute’s Responsible Sourcing Coalition (RESCO) have already begun to engage communities in dialogue about what their values are and what prosperity means to them (Development Partner Institute 2022). On the ground level, this reality includes the following key traits:

- 1) Attentive listening and patient dialogues with local and “downstream” communities about what is important (unmet needs, fears, aspirations), working towards a match between community and miner priorities
- 2) Collaboration with knowledgeable governments, multilaterals, and civil society to co-create a vision for sustainable development and shared prosperity, contributing to non-mining and post-closure objectives
- 3) Co-creation of the approach to community engagement with a trusted and knowledgeable civil society and community-representative allies; followed by engaging community leaders in patient dialogue to understand what they seek from a new mine
- 4) Ongoing dialogues with Indigenous people about growing prosperity while respecting Indigenous rights and culture
- 5) Ongoing local summits to identify risks to communities, especially those who are more vulnerable to the effects of climate change or economic changes
- 6) Upskilling through labor unions and workforce development programs to prepare workers in communities for a low-emission economy

Many of these measures come from an emerging concept called a “just transition” – referring to an energy transition that is co-designed, avoiding the uneven distribution of the burdens to those who can least afford it, and the benefits to a chosen few. Co-creating an inclusive vision through multistakeholder conversations makes hitting copper production goals more realistic, because it de-risks projects and creates more effective coalitions. For instance, New Zealand is enacting a just transition roadmap in the region known as Taranaki,

which was heavily dependent on oil & gas. After the government elected to discontinue offshore oil drilling, this region needed new sources of employment and revenue. To address this need, the New Zealand Just Transition Team developed Transition Pathway Action Plans for the region that laid out development programs and plans for 11 varied economic sectors and activities such as energy, food, tourism, the arts, infrastructure, and so on (Taranaki Regional Government 2020).

Elements of this approach can be seen in South Africa's Impact Catalyst. In partnership with the government of South Africa, this is a cross-sectoral, multi-partner development initiative between Anglo American, the South African Council of Scientific & Industrial Research (CSIR), Exxaro, Zutari, and World Vision South Africa, who all share a vision of creating enhanced social impact in the mining communities in Limpopo and other provinces. Its aim is to establish inclusive, collaborative, cross-sectoral platforms, initiatives, and partnerships to achieve systemic socio-economic impact through public-private partnerships.

4. COMBINING INNOVATION WITH STAKEHOLDER ENGAGEMENT: IMPROVING THE CHANCE OF SUCCESS

Strong engagement is required not only with communities, but also with other stakeholders in the value chains mining serves: consumer-facing companies (automakers, for instance), intermediate manufacturing and heavy industry (steelmaking, for instance), suppliers, regulators, investors, and so on. An entire-value-chain approach represents for the best chance for mining's success in meeting future demand and doing so responsibly. But, as it currently stands, very few miners understand the needs and aspirations of these value-chain stakeholders—and vice versa—and cross-value-chain-node collaboration is minimal.

For instance, miners should collaborate with their suppliers to strengthen innovation capabilities of suppliers and better integrate with the startup ecosystem. This allows for exponentially more innovation (and, thereby, production expansion) by mobilizing a node in the mining value chain (technology suppliers and engineering firms) to solve mining's grand challenges and, in effect, unleash some of the most sophisticated and capable technical minds in the entire value chain.

Another, more fundamental, philosophical issue underlying successful value-chain collaboration exists, as well: the need for miners to better understand their customers' *definitions of* and *ambitions for* responsible sourcing. Standards abound (from IRMA, to ICMM's Responsible Gold Standards to "The Fairmined Standard" to EITI and many more) aiming to create definitions for responsible sourcing grounded in a company's performance against environment, social, and governance (ESG) operational benchmarks. However, these standards are not, for lack of a better term, standardized; they are not *harmonized*. Different standards exist across sectors and across geographies; and even within a given sector and geography, there are competing standards. While a harmonization of such varied standards is one part of the solution, another key element is communication and partnership between miners and their customers – and their customers' customers. For an auto company, what – specifically – qualifies as responsibly sourced copper? What makes a steel company's operations responsible? And so on. Communication and partnership can help illuminate these complex questions.

Unpacking the nuances of investors' ambitions around ESG, returns, and capital discipline can unlock pathways to more capital that is also more affordable. As with customers, miners need to understand investors' definitions of responsible sourcing in order to unlock the significant sums going toward ESG investing and avoid disruptive shareholder activism. Beyond responsible sourcing, it will be critical to

communicate explicitly about investors' appetite for more aggressive investment in the expansion of mineral production. From exploration to throughput at existing mines, meeting energy-transition-related demand requires significant investment. But investors are currently reticent to fund such expansion. Therefore, miners need open dialogue with investors about what is driving that fear and what demand signals, profitability metrics, operational benchmarks, etc. could convince an investor of the viability of investments in production expansion.

Government and miners also need to collaborate more closely and learn from each other. One example of better understanding that is needed is distinguishing between the many varied actors in mine exploration and production. In mining, there is no one single ubiquitous challenge. A one-size-fits-all approach will inevitably fail, as each commodity critical to electrification has different dynamics and players. (Some governments, like the US, have a single policy and approach to all critical minerals.) Taking copper and lithium as examples:

- 1) Different kinds of mining companies run operations: Junior miners tend to deploy and operate lithium mines, whereas the scale of copper mines requires the capital and engineering know-how of majors
- 2) Different jurisdictions are involved: the bulk of lithium processing goes to China, whereas copper processing is more dispersed
 - a. Another example: 90% of cobalt is mined in the DRC, while 95% of cobalt is processed in China
- 3) Different capital sources are available: lithium's price is too volatile for traditional financiers to tolerate such risk, whereas copper returns are more stable and therefore friendly to capital allocators
- 4) Different innovation challenges exist: for example, one type of lithium is extracted from brine via evaporation, making water usage a key constraint, whereas for copper (and nickel, among others), the primary constraint is energy used to move rock and smelt the copper, along with the massive accruals of waste due to low grades and increasing depth of underground mines
- 5) Different community and indigenous challenges arise: lithium is largely present in remote desert, where communities are not impacted as much (but "downstream" water can become broader concern elsewhere in the country), whereas copper is often found in areas with significant indigenous populations. Nevertheless, SQM, a lithium miner operating in the Chilean desert has been the subject of recent indigenous opposition that lead to significant delays due to their view that they see all the downside and none of the benefits (Reuters 2022)
- 6) Different substitution issues exist, too: copper is very difficult to thrift or substitute because of its unparalleled conductive properties, whereas lithium (and cobalt) may be substituted more easily because of the many different battery models that are being developed (e.g., Tesla has developed a battery free of cobalt (Electrek 2022))

Given the myriad idiosyncrasies of the mining sector, it will be critical to provide education, as well, in order to develop understanding and trust, with governments who seek to support and regulate the sector but are currently underinformed. This task can be accomplished via trust-building efforts on the part of miners and trade associations, government, and local communities. National governments would like to develop their economies, and companies would like to develop the resources in those countries. Furthermore, communities would like to see their longer-term social and economic prosperity grow. However, local Indigenous communities need to be brought into the conversation to complete a "triangle of trust". Respectful listening (on the part of both miners *and* government) drives deeper trust and alignment around a shared vision of development.

5. CONCLUSION: A FOCUS ON GOALS AND TOOLS FOR THE MINER'S DUAL CHALLENGE

Miners face a dual challenge: produce metals faster than ever to meet demand for the energy transition – and do so responsibly. Elements of a responsible approach to metals production (environmental studies, community consultation, deployment of renewable energy on the mine site, minimizing water use, and so on) complicate efforts to scale up production in the required timeframe of the next 10 to 25 years.

So, what is required to deliver on this dual challenge? It is an *innovation* challenge that requires an innovation-driven solution, with mining shifting to become materials providers. It is also an *engagement* challenge that demands multi-sector and multi-stakeholder engagement, understanding and collaboration.

The measures and actions described in this paper lay out a roadmap to meet each of those challenges. The innovation challenge requires increased innovation investment (corporate R&D budgets, government incentives, and capital); concentration and coordination of efforts and investment; more robust mining sector and cross-sector innovation collaboration, and miners evolving from commodity-producers to materials-solutions-providers. The collaboration challenge requires attentive listening and deep empathy for communities and open dialogue with value-chain stakeholders, from customers, to suppliers, to investors. With these goals in mind and tools in hand, the mining sector dramatically improves its chances of meeting the dual challenge society has given it.

REFERENCES

Canadian Mining. Shell launches consortium to speed up electrification of mining vehicles. October 12, 2022. <https://www.canadianminingjournal.com/news/shell-launches-consortium-to-speed-up-electrification-of-mining-vehicles/> Accessed on October 20, 2022.

COCHILCO—Chilean Copper Commission. Chilean Copper Mining Costs. December 2017. <https://www.cochilco.cl/Presentaciones%20Inglis/Chilean%20Copper%20Mining%20Costs.pdf> Accessed on October 25, 2022.

Copper Development Association. Copper - the World's Most Reusable Resource. https://www.copper.org/environment/lifecycle/g_recycl.html#:~:text=Known%20worldwide%20copper%20resources%20are,of%20any%20other%20engineering%20metal. Accessed on October 25, 2022.

Development Partner Institute. RESCO's official debut is a call for companies to move beyond risk management in mineral sourcing. September 29, 2021. <https://www.dpimining.org/news/news/rescos-official-debut-today-is-a-call-for-companies-to-move-beyond-risk-management-in-their-mineral-sourcing> Accessed on October 20, 2022.

Electrek. Tesla is already using cobalt-free LFP batteries in half of its new cars produced. April 22, 2022. <https://electrek.co/2022/04/22/tesla-using-cobalt-free-lfp-batteries-in-half-new-cars-produced/> Accessed on October 12, 2022.

Filippou, D., King, M., (2011). R&D prospects in the mining and metals industry. *Resources Policy*. Volume 36, Issue 3. 276-284. ISSN 0301-4207. September 2011.
<https://www.sciencedirect.com/science/article/pii/S0301420711000237> Accessed on October 12, 2022.

Forbes. Urban Mining Company's Rare Earths Recycling Helps Us Tackle Chinese Dominance. June 11, 2020.
<https://www.forbes.com/sites/jimvinoski/2020/06/11/urban-mining-companys-rare-earths-recycling-helps-us-tackle-chinese-dominance/?sh=306f55f325ea> Accessed on Monday, October 10, 2022.

Glencore. Pathway to Net Zero 2021 Progress Report. <https://www.glencore.com/dam/jcr:ad341247-c81e-45b4-899d-a7f32a9d69a0/2021-Climate-Change-Report-.pdf> Accessed October 10, 2022.

Institute of Materials, Minerals, and Mining. New figures show mining R&D spend fell 2.1% in 2021. April 5, 2022. <https://www.iom3.org/resource/new-figures-show-mining-r-d-spend-fell-2-1-in-2021.html>, Accessed October 12, 2022.

International Energy Association. The Role of Critical Minerals in Clean Energy Transitions: The state of play. April 2022. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/the-state-of-play> Accessed on Monday, October 10, 2022.

New York Times. Roy Furchgott. Some Carmakers Say Recycling Car Parts Is the Future. But Is It Realistic? August 31, 2022. <https://www.nytimes.com/2022/08/31/business/cars-recycling-circular-manufacturing.html> Accessed October 12, 2022.

OGCI (Oil & Gas Climate Initiative). <https://www.ogci.com/who-we-are/> Accessed on October 20, 2022.

Reuters. Chile lithium producer SQM gets green light on environmental plan. August 30, 2022.
<https://www.reuters.com/business/sustainable-business/chile-lithium-producer-sqm-gets-green-light-environmental-plan-2022-08-30/> Accessed on October 12, 2022.

Reuters. Toyota and Jaguar show zero-waste metal. April 27, 2017.
<https://www.reutersevents.com/sustainability/toyota-and-jaguar-show-zero-waste-metal> Accessed on October 12, 2022.

Rio Tinto. Rio Tinto achieves battery grade lithium production at Boron plant. April 7, 2021.
<https://www.riotinto.com/en/news/releases/2021/Rio-Tinto-achieves-battery-grade-lithium-production-at-Boron-plant> Accessed on October 25, 2022.

S&P Global. The Future of Copper: Will the looming supply gap short-circuit the energy transition? July 2022. <https://ihsmarkit.com/info/0722/futureofcopper.html> Accessed on Monday October 10, 2022.

S&P Global. World Exploration Trends, PDAC Special Edition. April 2022.
https://pages.marketintelligence.spglobal.com/World-Exploration-Trends-2022-EMC1705.html?utm_source=MIWebsite Accessed on Monday October 10, 2022.

Taranaki Regional Government. Transition Pathway Action Plans. June 2020.
<https://www.taranaki.co.nz/vision-and-strategy/taranaki-2050-and-tapuae-roa/taranaki-2050/transition-pathway-action-plans/> Accessed on October 12, 2022.

USGS (United States Geological Survey). Mineral Commodity Summaries 2020.
<https://pubs.usgs.gov/periodicals/mcs2020/mcs2020.pdf> Accessed on October 25, 2022.