Beyond Renewables:

Decarbonizing Latin America's Mines

BLACK & VEATCH

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Decarbonization is a global mining business imperative

The shift of energy intensive industries towards net-carbon neutrality is unstoppable. The change is part of the global drive for decarbonization, underpinned by the United Nations Paris Climate Agreement, in which 189 countries committed to limit global warming to 1.5 to 2 degrees Celsius from pre-industrial levels through economic and social adaptation.

Mining is an energy-intensive process and serves as a critical cog in the global clean energy supply chain. Significant amounts of metals and minerals are required to enable a sustainable future – from the copper and lithium essential for electric vehicle motors and batteries to the aluminum and steel for wind turbines and solar racks, and much more.

The International Energy Agency (IEA) estimates that a typical electric car requires six times the number of mineral inputs of a conventional car, while an onshore wind plant requires nine times more mineral resources than a similarly sized gas-fired power plant.

Minerals used in electric cars compared to conventional cars

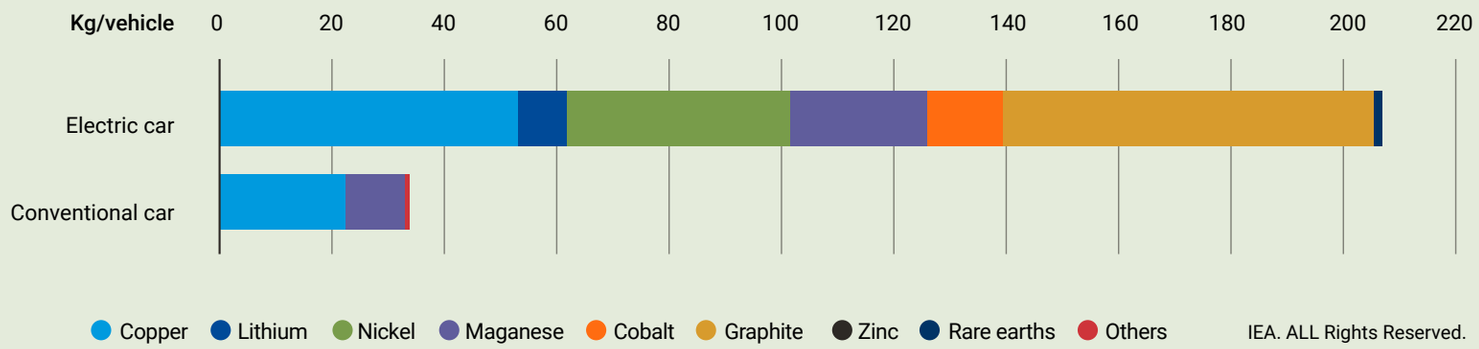
To support global decarbonization efforts, the energy intensive production of critical minerals – so called 'future-facing commodities' such as copper, lithium, nickel, cobalt and rare earth elements – will need to increase significantly. The IEA notes that, in order to meet the Paris Agreement's goals, mineral requirements for clean energy technologies would need to quadruple by 2040.

Responsible and sustainable production of mineral raw materials is critical to minimizing the impacts on the environment, climate and society throughout the value chain. Stakeholders, investors and communities are already demanding that responsible mining goes beyond safe operations, containing costs and deploying renewable energy on site.

To capture economic opportunities and address stakeholders' concerns, the mining industry has started its transformation journey, embracing sustainability commitments and playing a critical role in the world's shift to a carbon neutral future.

Moving forward, the industry must move beyond a focus on its social license to operate and drive deeper sustainability commitments that can be addressed through integrated infrastructure, power and water solutions.

Source: IEA



Pressure is on decarbonizing Latin America's mining sector

Latin America is critical for the global energy transition where much of the world's future-facing commodities can be found. Chile, Peru and Mexico alone account for approximately forty percent of the world's copper reserves. Large deposits of lithium can be found in Argentina, Bolivia and Chile with the region as a whole accounting for approximately two-thirds of global reserves. Plentiful nickel reserves too can be found in Brazil with others in Colombia and Cuba. Small amounts of cobalt are also located around the region.

This means that responsible mining in Latin America takes on an additional layer of complexity and urgency. The primacy of the social contract remains, where progress can be derailed by poorly designed projects that fail to adequately address social impacts; the industry must continue to develop projects that engage and consult meaningfully with all affected communities while promoting and delivering upon more equitable distribution of socioeconomic benefits. Local environmental impacts on water supply and biodiversity must also be addressed.

In addition, with Latin America poised to be a major raw materials supplier to assist in decarbonizing the planet, mining operations will be put under increasing pressure to decarbonize their own operations both from investors and customers. As technology improves, and international stakeholder demands heighten, supply chains will become increasingly transparent and mean mining operations that can demonstrate strong Environmental, Social and Governance (ESG) scores will be in better positions to attract more investment and attract more customers.

These external expectations are accelerating, with consistent warnings from the United Nations such as the publication of the Intergovernmental Panel on Climate Change (IPCC) reports in August 2021 and April 2022 moving from a "code red for humanity" to more recently "now or never". The latest report cautioned that greenhouse gas emissions must peak by 2025.

Taken together, this means the pressure and expectation is shifting to Latin America's mining industry. In a fiercely competitive environment, how do mining companies meaningfully and cost-effectively ramp up decarbonization efforts? And how do they plan and move beyond initial efforts that deployed renewable energy on site and produce carbon-neutral raw materials that meet new demands of customers for zero-emissions products?

You're not alone

Positioning for a low-carbon economy, adapting to climate change and mitigating impacts on community water resource is essential for miners to reduce risk and maintain a license to operate.

The societal pressures facing the industry will force miners to go beyond their initial embrace of renewable energy and carbon offsets and evaluate and deploy a variety of low and zero-carbon energy sources. Renewable energy strategies will include pairing large-scale solar and wind power with electric vehicles, low-carbon fuels and hydrogen – plus associated technologies such as battery storage and fuel cell technology.

Planning across the entire footprint of their mineral resource assets offers real opportunities for mining companies to not only achieve their sustainability goals and community license to operate, but to make significant inroads in improving efficiencies and reducing cost of production. These improvements are critical as the industry continues to battle economic uncertainty, cyclical commodity price challenges and fuel price volatility.

Miners are not alone. According to Black & Veatch's 2021 Corporate Sustainability, Goal Setting and Measurement Report, more than 80 percent of companies surveyed with revenues greater than US$250 million have set decarbonization goals, yet 25 percent have set goals at such a level that they are unsure how they will meet them.

However, prioritizing such investments in innovation that reduce carbon footprints is complex. Emerging technologies such as hydrogen power, direct air capture, electrification and advanced nuclear power must be considered while planning multidecade energy and resource strategies. Mining companies will need to evaluate the trade-offs of these technologies to ensure that a cost-effective, reliable pathway to net zero is achieved.

Where to start?

While mining companies have made substantial progress in recent years, many with long-established sustainability programs, more investment is needed to accelerate the impact of their decarbonization efforts.

To start this actionable zero-carbon journey, mining companies need to develop robust decarbonization roadmaps that help manage and understand limited budgets, technology timelines and complex regulations over potentially a 30-year time horizon – the kind of timeframe required when making major infrastructure investments.

Decarbonization roadmaps evaluate competing, commercially-ready and emerging technologies and present a de-risked pathway to zero emissions. Such roadmaps demonstrate to investors and communities that mining operators understand decarbonization opportunities and are systematically analyzing the economic and operational feasibility of each infrastructure investment along the timeline.

Integrating increasingly affordable and resilient mining infrastructure solutions available across power, water and many other critical technologies will give the mining industry opportunities to address sustainability challenges strategically at every stage of the mining process.

For example, when it comes to renewable energy, there is a clear opportunity to move past a reliance on green Power Purchase Agreements for grid-connected mines while remote mines could scale-up onsite solar and wind deployments. Strategic roadmaps covering longer time horizons would allow mining operators to consider the potential of renewable energy for green hydrogen production, long-term energy storage and future electricity production after mine closure. The powering of fleet vehicles and major equipment can be assessed across electric and alternative fuel options while other technologies such as direct air capture, net-zero water recycling, emissions-free explosives, small modular reactor, nuclear power and hydro energy storage can also come into consideration.

What is paramount is that mining companies need a toolbox and assessment framework to systematically evaluate the trade-offs of these technologies to ensure that a cost-effective, reliable pathway to net zero is achieved.

Mining industry commitments

In October 2021, members of the International Council on Mining and Metals (ICMM) collectively committed to a goal of net zero scope 1 and 2 greenhouse gas (GHG) emissions by 2050 or sooner, in line with the ambitions of the Paris Agreement. This is in addition to earlier commitments by companies like BHP and Vale which have since 2020 been targeting a 30 percent reduction in scope 1 and 2 emissions by 2030; Rio Tinto is targeting 15 percent.

ICMM is an international organization dedicated to a safe, fair and sustainable mining and metals industry. It brings together 28 mining and metals companies and over 35 regional and commodities associations to strengthen environmental and social performance and serve as a catalyst for change, enhancing mining's contribution to society.

Given the speed at which information is distributed globally, publicizing time-bound commitments that reflect the progress in the decarbonization efforts will help to enhance the transparency required to build trust with the global community as well as foster confidence among stakeholders and customers.

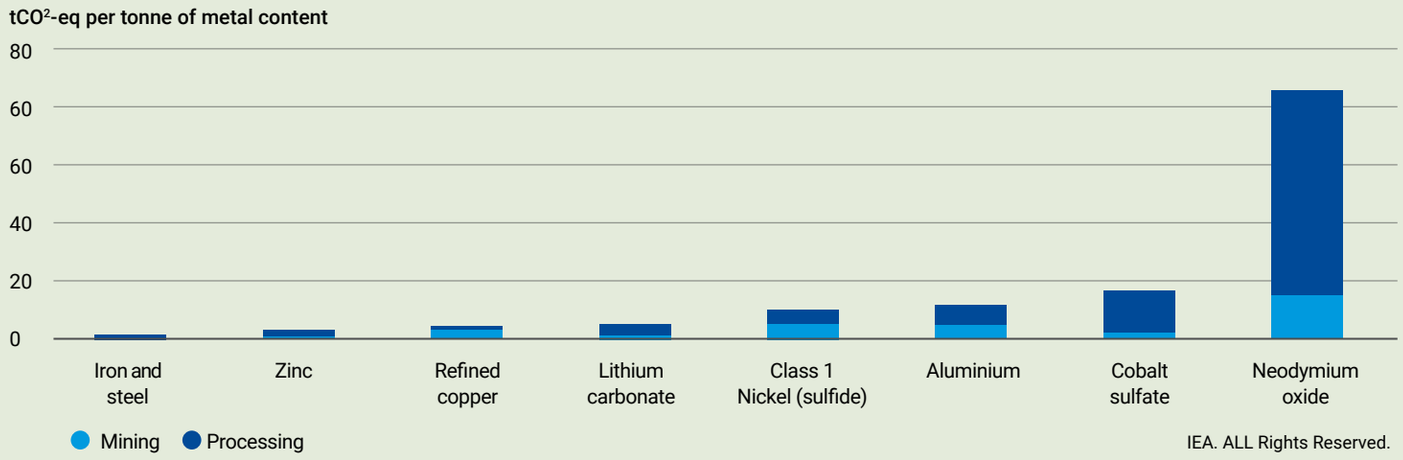
Average GHG emissions intensity for production of selected commodities

The burden created by energy costs is felt most acutely in remote areas where mines rely on diesel power generated on-site. Delivering diesel fuel to these remote sites can be expensive and delayed by weather conditions, leaving mines at risk of running low on fuel and potentially shutting down (while the delivery itself also adds to the organization's carbon footprint ledger).

Generating power at or near site is an attractive proposition to lower energy risk and operational costs. That option can help to reduce long term operational costs while also taking direct control in reducing emissions and other environment impacts.

Integrating renewable energy (through micro-grids, for example) into a traditional coal-fired or diesel power supply is a cost-containment opportunity that can be realized today as it can reduce coal or diesel consumption by generating electricity when renewable energy is available. The direct fuel cost savings and fewer fuel deliveries required will help the mining operation realize lower risk and more certain energy cost forecasting, offsetting the upfront capital cost.

Source: IEA



Today: Reduce the burden of fuel costs

Lowering energy costs and carbon emissions is underway across Latin America's mining industry and can be implemented and achieved quickly.

Energy is one of the biggest operational costs in the mining industry. Traditionally, energy demand is met using fossil fuels as a mine site's primary feedstock.

Due to its geographical characteristics and abundance of natural resources, Latin America has great renewable energy potential and much additional capacity deployed across the continent is renewable. According to the Latin American Energy Organization (OLADE), as of 2022, 81 percent of the new generation capacity installed in Latin America and the Caribbean comes from clean sources, either wind, photovoltaic, hydroelectric or renewable thermal plants (biogas and biomass).

Planning for and integrating renewable energy to power Latin American mining operations is a reasonable and achievable goal for the sector and represents good first steps to deeper operational transformation.

Hydrogen in mining

The mining industry relies on incredible amounts of energy to find, extract and process raw minerals from the earth. Traditionally, it has looked to fuel oil, electricity (purchased and produced on-site), coal and natural gas to power its energy intensive processes, but enthusiasm is building around hydrogen as a new fuel source that could redefine global approaches for hard-to-abate sectors.

Hydrogen is a fast-emerging alternative with great potential as an energy-dense and clean burning fuel.

Compelling mining applications for hydrogen

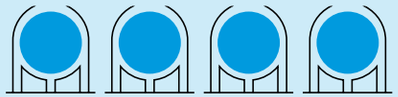
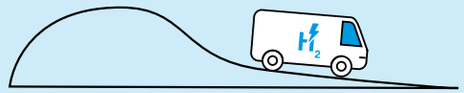
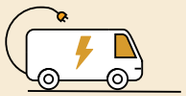
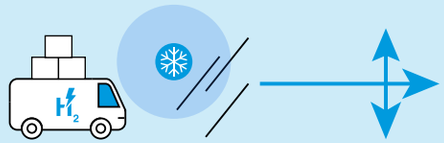
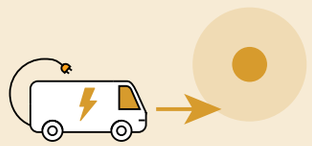
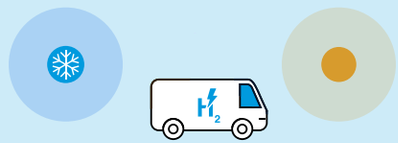
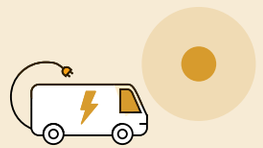
- Replacing fossil fuel for site vehicles and equipment
- On-site long-term energy storage
- Generating high-temperature heat
- Explosives

1. Hydrogen for heavy-duty site vehicles and equipment

Hydrogen fuel cell electric vehicles (FCEVs), for example, are gaining traction for commercial use. FCEVs have the same battery train as an electric vehicle but use hydrogen to produce electricity in addition to the battery. Benefits such as fast refueling time, long range performance, and lighter weight make FCEVs an attractive zero-emission option.

Importantly for the mining sector, other commercial applications include machinery and materials handling equipment, such as high-torque construction and excavation equipment for mining. Hydrogen-powered haulage is another possibility.

Refueling patterns on site are a key consideration with vehicles returning simultaneously to refuel at the end of shifts. Mine haulage fleets require rapid refueling speeds, which are harder to attain with electric battery alternatives.

	Hydrogen fuel-cell electric vehicles	Electric vehicles
Range	 Excel on long-distance routes or routes with frequent stops and heavy payload.	 Excel on shorter routes with fewer stops.
Power	 Require less electric power than EVs unless on-site hydrogen production is planned.	 Require power infrastructure and utility interconnection with adequate capacity.
Terrain	 Can climb hilly terrain, steep grades, and can traverse variable terrains depending on fleet profile, road conditions and route length.	 Perform best on flat roads. Can traverse variable terrains depending on fleet profile, road conditions and route length.
Predictability	 Perform best with variable routes, payload, harsh weather.	 Perform best with predictable duty cycles.
Climate	 Can handle all types of weather, hot or cold.	 Warm to moderate temperatures are ideal because batteries drain more quickly in cold climates.
Operational Efficiency	 Fast refill times, which increases operation uptime.	 Cost-efficiency increases when charging times and duty cycles are repetitive and predictable.

Black & Veatch is helping global operators create hybrid LNG and ammonia export and import infrastructure.

Given the remoteness of mine sites, production of hydrogen on site presents a more predictable supply chain for the operator, and would be competitive versus diesel supplies where remote delivery increases costs.

Chile's National Electromobility Strategy is an example of how emerging government policies across Latin America are beginning to seed development of zero emission transportation, impacting planning and operations of the mining industry. The strategy establishes that, by 2035, all new light and medium vehicles, public transport - including buses and taxis - and mining and construction machinery must be zero-emissions; this regulation will gradually progress across other categories, adding by 2040 the sale of minor mobile machinery (associated with construction, agriculture and forestry) and, by 2045, the sale of cargo transport and intercity buses.

2. Hydrogen as on-site energy storage

As an energy storage solution, hydrogen can be used together with battery energy storage systems (BESS) to maximize the value of electrons from green energy.

Lithium-ion batteries are ideal in daily cycling scenarios where charging and discharging rates provide four to eight hours of backup.

Hydrogen, on the other hand, can provide essentially infinite duration storage and backup power limited only by storage capacity. In tandem with batteries, hydrogen can be there when it is needed, much like the natural gas or diesel backups in use today.

Green hydrogen can serve as a reliable, low-cost alternative to batteries, particularly when considering the forecasted costs, with hydrogen prices becoming more competitive going forward. Mining sites are often located in regions with high renewable energy potential; this means surplus production is achievable for many operators and offers an additional long-term revenue opportunity whereby the site could be transformed to an electricity generation or hydrogen production center once the mine's resources have been exhausted.

During the lifecycle of the mine, making hydrogen from renewable electricity that would otherwise be wasted would allow the mining industry to shift supply for weeks or even months. For example, in the summer, excess energy from solar may be more readily available compared to winter. That energy can be stored for when it is needed most. Batteries do not offer the same option— to really be economical, they need to be charged and discharged on a daily cycle.

3. Other applications

Green hydrogen presents a compelling pathway for hard-to-abate sectors such as steel production. For activities such as smelting, where high temperatures are required, green hydrogen can serve as a feedstock, to replace coal and natural gas. When burning in air, hydrogen can reach 2,000-2,100 °C, similar to natural gas at circa 1,950 °C. When mixed with oxygen to create oxyhydrogen, maximum temperatures can reach 2,800 °C. This broad operating temperature range makes green hydrogen an attractive fuel option for many high temperature processes.

Ammonia (NH_3), a compound of nitrogen and hydrogen, is increasingly seen as a more stable way to transport hydrogen – especially over long distances. As existing LNG exporters assess the feasibility to convert LNG facilities to ammonia facilities, the mining industry has an opportunity to be an additional off-taker of green ammonia. Given ammonia's use (as ammonia nitrate) in explosives for mining, converting to green ammonia sources will also reduce the carbon footprint of mining sites.

Integrating water management and decarbonization efforts

Future-facing commodities, such as lithium and copper, is associated with high water requirements and, historically, challenges faced by mining developments in the region have had water issues – whether pollution or access/impact to community supplies. Much of the region faces at least medium water stress conditions.

Indicators for water use for selected minerals

With the frequency and intensity of storms and droughts expected to increase due to climate change, it is imperative that the mining sector plan for the long-term effects that such events will have on their operations and assets.

There is a huge opportunity for mining operations in Latin America to integrate long-term water planning with decarbonization planning across every stage of the mine lifecycle. This is particularly relevant as operations age because, as the quality of ore declines, increased amounts of water and energy are required to produce equivalent amounts of metal.

Water and wastewater treatment combined with conveyance can be energy intensive. The reduction of evaporation, leaks and waste can reduce energy requirements and correspondingly, GHG emissions.

Partnering to create holistic and resilient solutions that clean, move, control and protect water resources sustainably means governments, communities and mining companies can preserve water supplies and continue to create shared economic value.

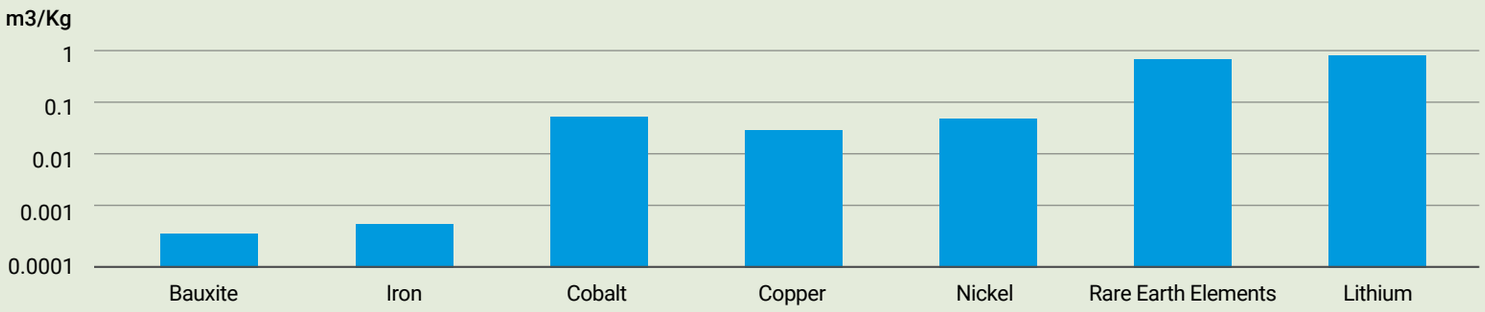
Integrating water planning with decarbonization planning will also create new sustainable pathways for mining operators and meet increasingly ambitious environmental targets.

Across many arid and water scarce mine locations, alternative means of supplies such as seawater or brackish desalination, water recycling or water reuse can be deployed alongside integrated energy solutions that reduce long-term operating costs and lower emissions in tandem. For example, sites could integrate renewable energy, pumped storage hydropower and desalination at grid scale. Combining these proven technologies would help deliver freshwater while providing renewable energy generation and low-cost energy storage.

Other approaches to optimizing water use in mining facilities include deploying closed loop recycling systems, using dry separation to eliminate water use in comminution of mining ore, minimizing water sent to tailings disposal and reducing evaporation losses.

The opportunity for Latin America's mining sector is to make sure that its water and wastewater experts, who fully understand the complexities of large site operations and their special water and environmental needs, are talking to and planning with their energy and decarbonization experts.

Source: IEA



The Escondida Water Supply Project located in the Atacama Desert of Chile's Antofagasta Region. Black & Veatch delivered the largest desalination plant in the Americas serving world's largest copper mine.

Digital decarbonization

This digitalization aspect of decarbonization is often overlooked, underestimated or not planned in conjunction with other decarbonization infrastructure investments. Integrating smart infrastructure to collect and monitor data that provides situational and operational awareness is critical to optimize the performance of mining assets.

Smart 'decarbonizing' infrastructure is a combination of automation, sensor technology and control devices paired with data analytics and increasingly, artificial intelligence (AI) and machine learning. Adopting these innovations helps mining companies optimize energy and water resources. By allowing mine operators to actively monitor and manage systems in real-time, these systems empower operators to make smarter operational decisions, preventing disruption, eliminating unnecessary waste, and saving time and money.

For example, digital applications can optimize the impact of individual technologies to enhance the performance of a mines' power systems. Operationally, the adoption of predictive asset maintenance monitors equipment performance in real-time, forecasting and optimizing maintenance schedules. Such advances will help mitigate costly outages and other equipment failures and extend the lifecycle of equipment. Further still, prescriptive analytics will enable autonomous management, where machines act on the information extracted by the AI, offering even further operational savings in the long term.

Digitizing power and water systems in mining will enable more efficient and flexible operations, reduce energy demand and emissions as well as guide long-range capital expenditure plans that focus on accelerating decarbonization efforts.

Let's Talk

To turn the energy, water and environmental challenges facing the mining sector into opportunities, mining companies need partners who specialize in integrating the many infrastructure components required for complex projects. From conventional and renewable energy, water supply and reuse, decarbonization solutions, and operational technology Black & Veatch's engineering, procurement and construction solutions help clients move farther, faster towards achieving their growth, resilience and sustainability goals.

Let's find ways for Black & Veatch to help you, too.

Contact us