DECARBONISATION PATHWAYS

Beyond Renewables:

Impactful Decarbonisation of Australia's Mining Sector

BLACK & VEATCH

More goes into infrastructure than most might think, but you can't miss the difference it makes in the world. Our Decarbonisation Pathways eBooks help our clients stay ahead of the curve so they can progress relevant and effective Decarbonisation strategies and help the world transition to net zero.

About this eBook

When it comes to sustainable mining, Australia's mining operators can go beyond existing renewable energy power purchasing agreements and small-scale technology deployments. The industry can go further, faster and stay ahead of global customers' expectations for sustainable, zero-emissions products. This eBook explores emerging opportunities and provides insights into decarbonising Australia's mining operations.

Decarbonisation is a Global Mining Business Imperative

The shift of energy intensive industries towards net-carbon neutrality is unstoppable. This focus is led by the global drive for decarbonisation, underpinned by the United Nations Paris Climate Agreement, where 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 essential for electric vehicle motors 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

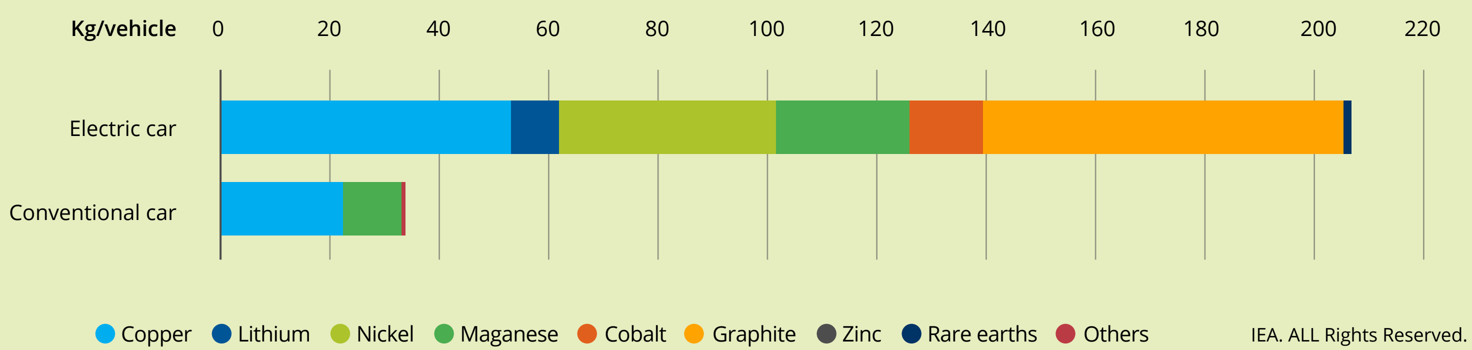
To support global decarbonisation efforts, the energy intensive production of critical minerals, including copper, lithium, nickel, cobalt and rare earth elements, will need to increase significantly.

Responsible and sustainable production of mineral raw materials is critical to minimising 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 to Decarbonise Australia's Mining Sector

Dating back to the gold rushes of the 1850s, the mining industry is one of Australia's most well-established and financially significant sectors. It typically accounts for around 10 percent of the country's total Gross Domestic Product (GDP) and recorded AU$350 billion (US$243 billion) in exports in 2021, according to the Australia Bureau of Statistics. Recognised as a global top-five producer of aluminum, gold, iron ore, lead, zinc, and nickel, Australia has the world's largest uranium and fourth largest black coal resources.

With the rise of ESG (Environmental, Social, and Governance) investments and the growing demand for globally sustainable supply chains, the Australia mining industry needs to continue to align with the future expectations of international and domestic customers and stakeholders. And these expectations are accelerating, with warnings from the United Nations and 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. Once hesitant to commit, the Australian government as recently as October 2021 also publicly committed to targeting net zero emissions by 2050, while falling short on legislating these targets as of now.

This means the pressure and expectation has been shifted to Australia's private sector. In a fiercely competitive environment, how do Australian mining companies meaningfully and cost-effectively ramp up decarbonisation efforts, 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 resources are essential for miners to reduce risk and maintain a license to operate.

The societal pressures facing the industry are compelling 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 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 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 decarbonisation goals, yet 25 percent have set goals at such a level that they are unsure how they will meet them.

However, prioritising 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 multi-decade 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 decarbonisation efforts.

To start this actionable zero-carbon journey, mining companies need to develop robust decarbonisation 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.

Decarbonisation roadmaps evaluate competing commercially-ready and emerging technologies and present a de-risked pathway to zero emissions. Complementing other studies evaluating opportunities to decarbonise across the mining stage gates, such roadmaps demonstrate to investors and communities that mining operators understand decarbonisation opportunities and are systematically analysing 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.

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 decarbonisation 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

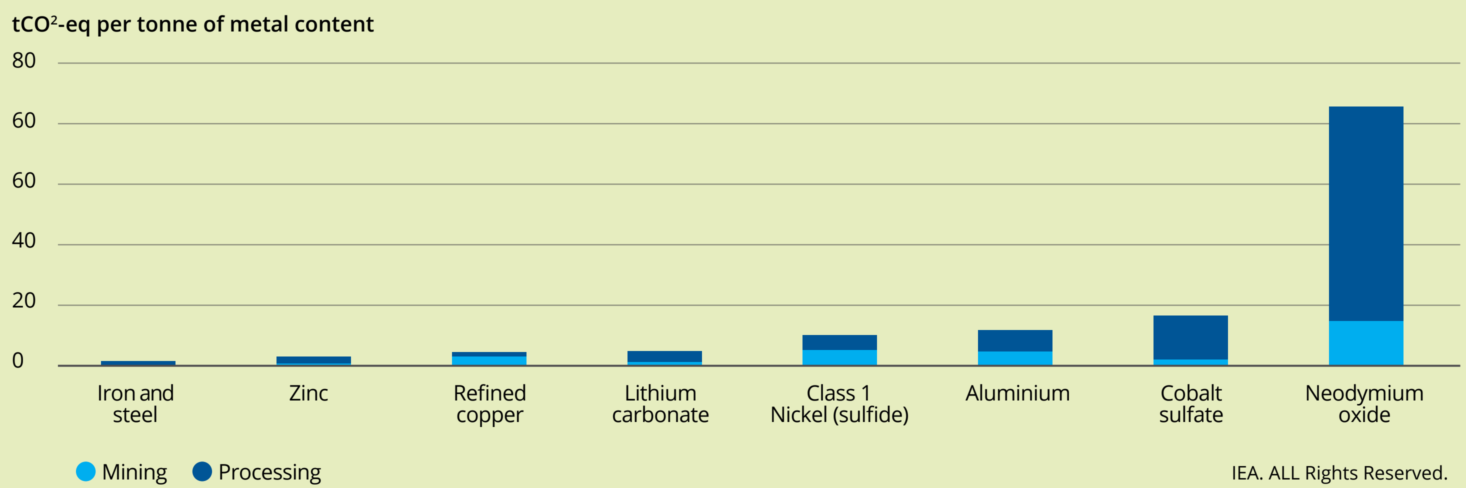
The burden created by energy costs is felt most acutely in remote areas where mines rely on diesel power generated on-site. Delivering diesel fuel to these remote sites can be expensive and delayed by weather conditions, leaving mines at risk of running low on fuel and potentially shutting down.

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 realised 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.

Such decarbonisation efforts are good first steps to approaching deeper operational transformation.

Source: IEA



Today: Reduce the Burden of Fuel Costs

Lowering energy costs and carbon emissions is well underway across Australia'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. This leaves miners exposed to volatile gas, oil and coal prices.

Decarbonising Australia's mining sector

Innovation in decarbonisation is well underway in Australia. Fortescue Metals Group has designed and built a hydrogen-powered haul truck. Hyzon Motors is preparing to deliver five, 154-ton zero-emission trucks to Ark Energy by the end of 2022 to be deployed at the Sun Metals zinc refinery. BHP Group is developing zero-emissions mining trucks.

Mining companies continue to actively study possibilities to electrify their mines, motivated by the potential to reduce costs, boost their license to operate and contribute to a more sustainable industry.

Key initiatives in Australia include the "Charge On" innovation challenge organized by BHP, Rio Tinto and Vale. The challenge is a global initiative to develop concepts for large-scale haul truck electrification systems. The objective of the challenge is to find a safe solution that can be applied across various mines, mine infrastructure and truck manufacturers. One challenge is to uncover innovative ways to safely charge mining truck fleets without losing productivity.

Another industry initiative is led by The Electric Mine Consortium, where leading mining companies are collaborating to achieve the fully electrified zero carbon dioxide and zero particulates mine.

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 to hard-to-abate sectors.

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

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.

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

	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.

2. Hydrogen as on-site energy storage

As an energy storage solution, hydrogen can be used together with battery energy storage systems (BESS) to maximise 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 hit 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, a compound of nitrogen and hydrogen, is increasingly seen as a stable, more transportable way to transport hydrogen to overseas markets, replacing Australia's liquified natural gas (LNG) exports over time. 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 Decarbonisation Efforts

The fragility and variability of Australia's water supply — either too much or too little water — is fresh in the minds of the nation whether experiencing first hand or witnessing scenes of devastation and disruption through local media broadcasts.

Responsible mining companies have an opportunity to take greater control in minimising their water acquisition and consumption, and to do so as part of their transformed and decarbonised operations.

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 Australia's mining industry to integrate long-term water planning with decarbonisation 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.

As water and wastewater treatment and conveyance is energy intensive, comprehensive water management plans that cut levels of consumption, treatment and conveyance — reducing evaporation, leaks and waste, for example — reduces 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.

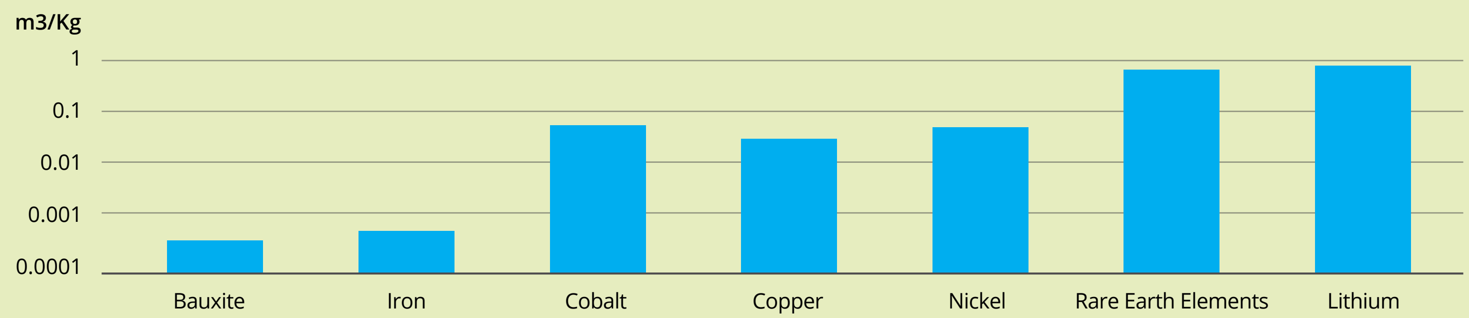
Integrating water planning with decarbonisation planning will also create new sustainable pathways for mining operators and meet increasingly ambitious environmental targets.

Across many arid and water scarce mine locations in Australia, 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 optimising water use in mining facilities include deploying closed loop recycling systems, using dry separation to eliminate water use in comminution of mining ore, minimising water sent to tailings disposal and reducing evaporation losses.

The opportunity for the Australia 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 decarbonisation experts.

Source: IEA



Technology spotlight: Pumped storage hydropower

Hydroelectric dams rely on water flowing through a turbine to create electricity to be used on the grid. To store energy for use later, pumped storage hydropower (PSH) facilities use pumps to elevate water into a retained reservoir behind a dam — creating an on-demand energy source that can be unleashed rapidly. When more energy is needed on the grid, water from that reservoir is run through turbines to produce electricity.

PSH is a type of hydroelectric energy storage. It is a configuration of two water reservoirs at different elevations that can generate power as water is discharge from one to the other, passing through a turbine.

PSH facilities store energy in the form of water in an upper reservoir, pumped from another reservoir at a lower elevation. During periods of high electricity demand, power is generated by releasing the stored water through turbines in the same manner as a conventional hydropower station.

During periods of low energy demand (usually nights or weekends when electricity is also lower cost), the upper reservoir is recharged by using lower-cost electricity from the grid to pump the water back to the upper reservoir.

Pumped storage projects around the globe are increasingly used to stabilise the grid because of the strong influx of variable power sources such as wind and solar.

When renewable energy from wind and solar is available, the energy can be used to pump water from the lower reservoir to the upper reservoir. When renewable energy is unavailable, water can be released from the upper reservoir through a hydroelectric turbine to produce renewable energy.

Pumped hydro storage serves as an energy storage system that is more cost-effective for grid scale than a battery system would be. This integrated approach can lower the operational cost of desalination facilities by taking advantage of the head pressure in the upper reservoir.

Digital Decarbonisation

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

Smart 'decarbonising' 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 optimise 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 optimise 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 optimising 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.

Digitising 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 decarbonisation efforts.

Let's Talk

To turn the energy, water and environmental challenges facing the mining sector into opportunities, mining companies need partners who specialise in integrating the many infrastructure components required for complex projects. From conventional and renewable energy, water supply and reuse, decarbonisation 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 to help you, too.

Learn more
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