

Green mining: Forget Tesla, EVs are everywhere

Research and Insights

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With a trend towards a low carbon future, we look at some of the opportunities, trends and challenges in reducing the carbon footprint of commodities and the mining operations that supply the industry, and find out whether it is really possible to build a 'green mine'. Are there opportunities in mining to reduce scope 1 and 2 emissions (emissions produced directly by the mining operation, or power consumed in the mining operation)? What are the opportunities for investors? In this note we start with the vehicles used in mining.

Mining is required to produce commodities which are integral to life as we know it, whether it be steel for construction, gold for a wedding band, lithium for batteries, cobalt for magnets, copper for the transfer of electricity or zinc for producing rust resistant steel. The mining of raw materials is also required to support the development of new energy and renewables, trends that are increasingly dominating the politics and economics of our advancing world. Renewable energy needs copper for transmission from source to users. Lithium, nickel and cobalt are needed for battery cells that can store excess electricity to smooth supply, for electric vehicles, storage at site, and bulk storage for grid support as with the recent Tesla battery installed in South Australia. Mining, historically, has been highly energy intensive, which typically means emissions can be high. Increasingly, the industry is focused on addressing this issue.

So what is a 'green mine'?

In our way of thinking, a mine that has minimal environmental impact, ideally being carbon neutral on scope 1 and scope 2 emissions, can be called a 'green mine'. For the cynics out there, we believe a green mine is entirely possible given the nature of technology now available, however, the trade-off comes down to implementation cost. As these technologies become increasingly mainstream, costs will fall, and the decision from a miner's perspective will become far more compelling. Today, there are many opportunities to reduce emissions within mining operations using technology that is available today, and new technology that is advancing quickly (such as electric mining equipment). Technologies that can bring about a green revolution in mining include EV and battery technology (to displace diesel, and increase renewable energy usage); carbon capture and storage that can offset carbon emissions in activities like smelting; chemical treatments and processing for critical resources; and water capture and recycling, for example.

In terms of carbon, the potential for technology to help companies achieve net zero targets is worth exploring, including alternative emerging developments in power generation, open pit mining, underground mining, and materials processing.

So why is green mining important to investors?

Over the past few years, we have witnessed a groundswell towards greater accounting for the environmental impact of mining, both in terms of the physical impact of mining (rehabilitation, tailings, etc) and measuring and reporting on carbon emissions. Increasingly we believe the practices used in mining operations, and the environmental impact of an operation, are increasingly becoming a core focus for investors. We believe this trend will continue to gain investor attention in the coming years to the point where those at the forefront of low carbon emissions mining, and limited environmental impact, could attract a significant valuation premium to companies which lag the trend.

Within our investee companies, we like to see an acknowledgement of the trend towards lower carbon mining, and a clear focus on opportunities or plans to reduce the carbon footprint of operations. Fortescue Metals has announced net zero targets for 2030, some twenty years ahead of many mining companies whose net zero target date is 2050.¹ For operations still under design, ideally we would like to see a clear focus on opportunities to reduce the environmental impact from construction and planned operation with a view of the future that solves for life beyond the usable term of the resource.

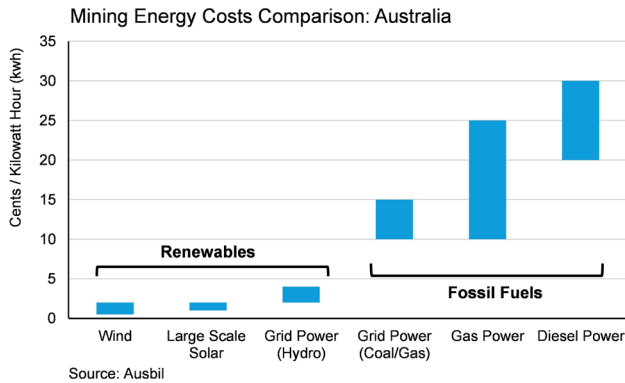
Power generation: Carbon reduction opportunities

Mining tends to be energy intensive. Some jurisdictions are fortunate to have an abundance of low cost renewable energy (such as hydro in regions of Canada/South America), whereas more remote operations often need to generate power through on-site generation. On site generation has historically been gas generation if infrastructure is available, diesel or HFO (heavy fuel oil) generation, all fossil fuels with different but damaging levels of impact on the environment. Wood Mackenzie recently estimate that around 70% of Scope 1 and Scope 2 emissions from copper mine sites come from power generation, while this figure is around 84% for gold mining.

We are now starting to see remote operations increasingly add renewables as a supplement to older methods of power generation. In addition to the environmental benefits, the cost of these renewables are significantly more attractive for mining operators, as illustrated in the following chart.

¹ <https://www.smh.com.au/business/companies/forrest-s-fortescue-fast-tracks-net-zero-target-to-2030-20210315-p57ar2.html>

Chart 1: The surprising economy in renewables for mining



As illustrated, the operating costs for renewables are substantially lower than for fossil fuel generation. However, the initial capital investment costs for renewables are around four times that of the cost of Diesel and twice the cost of gas generation, without battery storage. That said, given the average mine life, it is likely that these upfront capex costs could pay themselves off and begin to generate a positive contribution to the value of a mining project over time. As battery storage and renewable generations technologies improve, these capex costs will fall, making renewable energy increasingly attractive.

Unfortunately, generation from wind and solar is somewhat unpredictable, meaning either battery storage is required, or backup fossil fuel generation may be required, especially when there is intermittency in alternative power sources. The trend towards renewable energy generation in the mining sector is gaining a headwind, however, with a number of miners signing power supply agreements with external power providers whereby the power provider will fund the higher upfront capital, and charge it back through a long-term power supply agreement. Again, as the cost of batteries falls, the cost of renewables, and investor demand for more carbon sensitive mining, we expect to see both miners and energy providers improving practices in this area.

Open-pit mining: Low carbon alternatives

Open-pit mining is another carbon-intensive area that is seeing an evolution of renewable alternatives that can contribute to the achievement of net zero targets. Typically, mining involves a fleet of excavators (or shovels) and haulage trucks. Historically, the engines of this mining fleet has been powered by diesel. Technological development has for some time supported the potential electrification of the majority of activity in the open-pit mining process. Excavators and shovels are controlled by hydraulics, which are driven by pumps, which can be either diesel or electric. Electric shovels and excavators (Figures 1 and 2) have been used for many years in the mining industry.

Figure 1: Caterpillar's electric CAT 7495 rope shovel



Image: Caterpillar

Figure 2: The increasingly common Liebherr R9200E electric excavator



Image: Liebherr

Once an excavator or shovel has loaded ore, it is typically hauled to a stockpile outside the open pit. Haulage is typically done with a fleet of trucks, usually powered by diesel. In extremely large mining operations, electric conveyor belts may offer a low emission alternative for ore transportation. One limitation of electrified conveyor belts is the high capex, and limited flexibility. However, an alternative exists for traditional mining trucks, but to understand this, a basic knowledge of the drive train of a mining truck is required.

In a typical road car or truck, an engine provides power directly through a gearbox to the wheels of a vehicle, with mechanical energy deployed to drive the vehicle. In modern large-scale mining haulage, a truck's diesel engine drives a generator, which in turn powers electric motors within the truck's wheel assembly. Mechanical energy is converted into electrical energy, which is used to propel the vehicle. In theory, it is entirely possible to bypass the diesel motor that powers the electricity generator with a power cable sourcing power from a renewable source or the mine's main power supply. Given the weight of the large haulage trucks, and the ore in the tray, electric power has some limitations. There are some solutions, but first a little background.

Usually, mines are holes in the ground as with open pit mines. Miners dig for resources, and the pit gets deeper over time. As a mining truck is driving down into a mine, the truck is empty (so, it is low in weight), and is well assisted by gravity. As a result, its power requirements for descent are minimal. The truck is then loaded (so, its weight increases) and as the load is hauled out of the mine, the power required to move the fully-loaded truck uphill becomes much more significant. Because most of the paths that haulage trucks use are fairly consistent, a supplemental electricity supply can provide power through a trolley assist system of overhead wires, like a tram or a train, as illustrated in Figure 3. Using a trolley assist system, the higher workload (heavy load, uphill) can be supported by mine grid power, rather than the diesel engine within the vehicle. However, overhead cables are not simple to install and move, so such a drive system is suited to large mines, with longer haul distances, rather than smaller mines, where ramps and paths may change. Interestingly, for any investors with a long memory, this method was used by the Equinox Lumwana mine in the late 2000's to utilise cheap electrical power to reduce mining costs (Equinox was acquired by Barrick Gold in 2011).

Figure 3: Caterpillar's electric trolley-assist haulage truck



Image: Caterpillar

Underground mining: Low carbon alternatives

Unlike open-pit, underground obviously works in deep and contained spaces, which can provide major challenges, but also significant benefits in electrifying equipment. Usually underground mines have a central decline or shaft which provides a route for electrical infrastructure to follow. Underground mining equipment has slightly different names to open-pit equipment, but similar concepts apply. For example, jumbos are large drills used to bore for explosives, as in Figure 4.

Figure 4: A Sandvik jumbo DD422iE electric development drill rig



Image: Sandvik

The Sandvik jumbo above is battery powered. Batteries on board the machine allow for drilling and tramming (driving) on battery power. Moreover, batteries can be recharged while the machine is drilling so a charge does not interrupt productivity.

Another example is bidders, loading machines. Bidders load the ore from a stope (Blasted rock) into hoppers, ore chutes, or underground mining haul trucks, as shown in Figure 5. Unlike jumbos, electric bidders are mobile, so recharging whilst in operation is not practical. Batteries can be recharged while the bidder is not in operation, or a battery swap system can be employed.

Figure 5: A Sandvik bidder LH625iE



Image: Sandvik

Yet another utility vehicle that can be used below ground is an electric underground haulage truck, as in Figure 6.

Figure 6: The Epiroc MT42 electric underground mining truck



Image: Epiroc

Generally, there is no recharge system for trucks while they are operating, but a battery swap-out system does exist. In such a scenario, the battery pack is removed and replaced with a fully-charged unit. In theory, it is possible that a trolley assist type system could be suitable for underground operations, although this would involve a number of safety issues at low height, potentially exposing workers to risk. Irrespective, the development of electric underground mining equipment is at relatively early stages, and technology and charging systems will no doubt evolve.

As with open-pit mines, conveyors can be a useful installation in underground mines as they can provide significant volume capacity to remove ore from a mine. Capex can again be high, however, a separate development drive/access drive may be required for the conveyor system to ensure safety. Haulage of ore out of a mine can be via a decline (with conveyors or haul trucks) or through shaft haulage. Typically, shaft haulage includes an electric winder at the surface, which is able to be powered by the mine grid or any other valid source of electricity.

As with above-ground operations, the transport of personnel and equipment in most underground mining operations is undertaken via light vehicles, typically a four wheel drive. The mainstay of most mining operations is the tried and tested Diesel Toyota Land Cruiser (underground conditions tend to be harsh on light vehicles). More recently, specialist manufacturers have started developing mining specific electric light vehicles designed to handle mining conditions, as shown in Figure 7.

Figure 7: The Bortana 4wd electric light vehicle for above and below ground



Image: Safescape Bortana

There are a number of clear health, ESG and financial benefits that come with an increasing level of electrification in mining. Less combustion engines above or below ground means less ventilation and cooling issues, and improved operational performance. Underground mines are confined areas and do not have free-flowing ventilation. Ventilation systems and networks are installed in underground mines to ensure a safe and suitable working environment. This can include fans, large chillers or coolers in particularly deep mines. Engines operating underground create a huge amount of heat (requiring increased cooling or ventilation capacity), and ventilation is required to remove diesel particulate from mines. By minimising or eliminating diesel engines underground, the requirement for ventilation and cooling can be reduced. Generally speaking, electric mining equipment also requires less ongoing maintenance than traditional combustion engine equipment, for example, engine services are not required, adding further benefits.

Ore grinding and processing alternatives

In most processing operations, significant volumes of power are consumed in crushing and grinding operations, and for general activities around a plant, including pumping, conveyors, heating, cooling and other mechanical processes. There have been significant advances in the development of more renewable approaches to these activities.

Grinding hard rock and ores is very energy intensive. Historically, in hard rock mining operations, large mills were used to rotate and grind ore into small particles which then allow for the liberation of key elements from the ore. One technology which is increasingly replacing these large mills is the high pressure grinding roll, two rollers that are the hard rock equivalent of a dough press in Italian cooking.

Below (Figure 8) is a picture of one mill from the Superpit (KCGM) processing plant in Australia. These large mills rotate continuously, consuming a large amount of power.

Figure 8: An electric roller for crushing ore



Image: KCGM Superpit

HPGR (high-pressure grinding rolls) have two large rollers that roll-in towards each other, with crushed rock fed into the top, as illustrated in Figure 9. This rock is crushed further between the two rotating rollers. HPGRs are increasingly becoming common in the mining industry.

Figure 9: A Metso HPGR showing ore in the hopper to be crushed

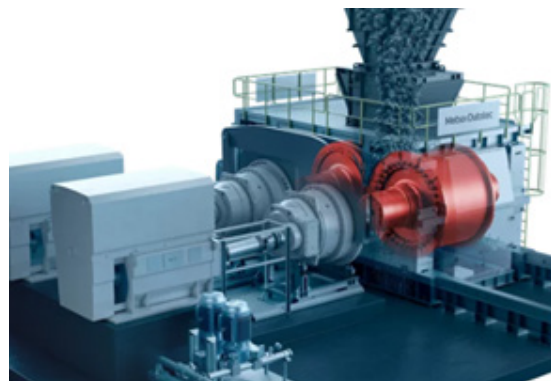


Image: Metso

Simplistically, the finer a particle needs to be ground, the more energy it consumes. In minerals processing and metallurgy though, usually the finer an ore is ground, the higher the recovery rate. Each mine runs a trade-off between grind size versus recovery to determine the best economics for the project, accounting for the machinery, energy and time taken to achieve smaller grinds. Since the early 2000s there has been a focus on increasing recovery from higher grind sizes, meaning lower energy and cost from grinding, without the loss of recovery.

Conclusion

As investors, it is easy to fall behind the rapid and urgent development occurring in mines that are leveraging the available technology to lower costs, and increase the renewability and ESG performance of their assets. Smart capital in the market is digging deeper with miners to assess how sustainable their resources and operations are in the context of looming net-zero targets, and with a world slowly divesting the idea that fossil fuels are entirely necessary. Mining is at the forefront of the adoption of electric vehicles and renewable energy in the extraction and processing of minerals and metals that are critical to society, to renewable energy generation and storage, and to the needs of humanity. There is now a virtuous circle in mining and metals that is improving and becoming increasingly economical such that investors seeking to outperform in this space can no longer ignore the how of mineral and metal extraction. Carbon neutrality offers an edge in understanding the larger ESG picture within natural resources, and we believe creates an opportunity for future outperformance.



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