

Crusheries

How can mining companies reduce their energy costs and increase output? One way is through the much-disputed route of eco-efficient comminution.

Guy Richards reports.



Rising energy costs and the falling quality of ore bodies are putting a squeeze on the bottom line for mining companies. As higher-grade ore bodies become exhausted, miners are being forced to move on to the poorer ones that inevitably lie in more remote areas, where access to energy is more expensive. To extract these minerals, the ore has to be crushed and ground into finer particles, dramatically increasing energy use.

This crushing and grinding (or comminution) represents more than half the total energy cost of the extraction process, according to figures obtained by the Coalition for Eco-Efficient Comminution (CEEC). The cross-industry, not-for-profit group was set up in 2011 and helps reduce project costs and improve energy efficiency by publicising the latest research and field studies on the issue. It says that comminution alone accounts for 530/o of a site's energy consumption (or at least 100/o of its production costs), and that huge savings can be made by improving and optimising the process via technological as well as non-technological means. The CEEC has published a roadmap to help companies find ways of cutting these energy costs (see overleaf).

Against this backdrop and given the recent volatility in metals prices, awareness among mining companies of eco-efficient comminution (EEC) is now growing. Although several companies are starting to implement energy-saving strategies, progress has been slow in some quarters, in part due to the industry's innate conservatism. Paul Lucey of global mining consultancy VCI says, 'Aware? Yes. Keen to implement? No. The rate of change in mining is about 15 years, while the more recent advances in comminution have only occurred in the past 10-15 years, so it is early days yet.'

However, Ted Bearman of mining consultancy Bear Rock Solutions, based in Australia, is more upbeat. 'I think it's fair to say that people are actively seeking ways to introduce EEC methods that fit with their needs. Mining is always about imperatives, and the industry responds well when faced with challenging situations.'

With EEC relevant to mining companies in all sectors and not just the usual suspects such as gold and copper, this is an issue for the entire industry. Mike Battersby of Maelgwyn Mineral Services, a global mining technology company headquartered in Cardiff, UK, explains, 'Gold and copper are the two major sectors whose historical processing has used finer and finer grinding to recover the valuable constituents, so they tend to use the most energy in the comminution process. However, all the other processing sectors, including lead, zinc, iron ore and industrial minerals, can equally benefit from EEC.'

Size matters

While there is a consensus on this point across the industry, opinion is divided on whether EEC measures are appropriate for companies and projects of all sizes.

Joe Cucuzza, Managing Director of minerals research broker AMIRA International, says, 'Technology improvements often mean changes to capital equipment, and the larger the project and capital investment, the more risk-averse companies tend to be to new technologies. Smaller projects are therefore more conducive to the implementation of improved EEC measures.'

Lucey agrees, 'Mining companies tend to be quite conservative, so you are more likely to find a small to medium company trying this process than a large one. However, Bearman argues, 'Larger companies have more in-house business improvement capability, so in theory they should be able to apply resources to address EEC in a more effective manner.'

The third opinion comes from the larger companies themselves, some of whom disagree with both of these arguments. Jeremy Mann, Head of Geosciences, Process and Sustainable Development Technology



at AngloAmerican, says, 'Implementation may or may not incur capital expenditure or production disruptions to install the appropriate technology solution and, as such, will affect all companies in a similar manner.'

Ivan Mullany, Senior Vice-President of Capital Projects at Barrick Gold Corp, agrees, 'This is an issue for everyone across the board. The reality is that we are seeing reduced grades and higher power costs across the resource industry, and we all have to look at changing the way we do business.'

Such change has to start somewhere, regardless of the company or project. 'There is one non-negotiable baseline that must be common to any EEC work, and that is to understand the liberation characteristics and true economic value of the feed material,' says Bearman. 'You can say that of any mining operation, but in the case of EEC you are looking for characteristics that will make it amenable to reductions in energy, including size versus grade behaviour, scale effects/liberation trade-offs and mineral associations.'

'Closely associated with these is the need to understand the spatial relationship of ore and waste, and the logistics of material movement – logistics sits at the heart of waste rejection and, therefore, EEC:

But logistics is a management rather than a technological issue, and while there's a wide array of existing and emerging technologies being considered by the industry, the approaches with the broadest applications are not necessarily centred on pieces of kit. For example, Bearman suggests widening thinking to a system level so that the total energy picture becomes clearer, and encouraging a culture of maximising extraction of value recovery and not just metallurgical recovery. In addition, Lucey suggests embracing the concept of geometalurgy, 'crossing the line between mining and metallurgy to define the correct comminution process for your ore body'.

While EEC-relevant technologies are being adopted, it is agreed that on their own, none offer a step-change in energy efficiency. Mann reasons, 'Current solutions are a combination of a number of incremental changes that span the entire activity chain, from more efficient blasting, haulage and ore sorting to mill-circuit modification and control:

Bearman adds, 'Differential blasting is well known, coarse gravity techniques are evolving and single-particle ore sorters are available in a wide number of forms. There has also been increased interest in electric pulse disaggregation (EPD) comminution. In terms of sorting in general, rock-by-rock single-particle techniques tend to be suited to lower throughput operations, but a solution has always been elusive for higher throughputs. As such, mass sorting has attracted an increasing amount of interest:

Lucey agrees, 'There has been a great deal of work on liberation processes, such as high-pressure grinding rolls (HPGRs) and vertical impact crushers, but less so in the more value-adding and widespread application of ore sorting. I suspect this is because it is still the realm of miners, and they are not so keen to give up turf to metallurgists.

'The other subject that is further out – and some say the Holy Grail of mining – is continuous mining, which includes tunnel boring machines, slot hole bores, road headers and surface miners:

For Battersby, however, the standout technology is in HPGRs, which have been around for more than 25 years and more recently have been accepted as a less risky new technology. They can offer large energy savings as a direct replacement to old technology in various grinding circuit configurations: he says, although he stresses that many other technologies and practices are applicable, and that a system-wide view is needed.

Comminution: the future

Looking ahead, Cucuzza says, 'The future trends in reducing energy consumption are likely to continue

along the lines of most recent developments that consider both the upstream and downstream processes to comminution. For example, improvements in blasting technology (upstream) and coarse-particle flotation (downstream) may reduce comminution energy consumption. Increasingly, energy consumption is being optimised through an integrated processing view, with a holistic view of the entire processing flowsheet rather than a simple focus on comminution alone.

'There is also likely to be more use of renewable energy sources to trim energy consumption, rather than replace base load consumption: he adds.

Ultimately, however, it's what the mining companies do, both now and in the future, that counts. Mann describes how AngloAmerican is undertaking detailed plant sampling and simulation on most of its processing plants, and has implemented a number of changes in the milling circuit configurations using standard technologies that have low technical risk, including comminution process control systems. 'Our longer term vision is to develop and implement technologies that, for example, focus on liberation of minerals along the full activity chain from the rock face rather than grinding ore in the process plants, and prevent overgrinding of liberated material:

In Barrick's case, Mullany explains, 'We have surveyed all our milling circuits and identified comminution inefficiencies. This work, coupled with a focus on geometalurgy, has allowed us to increase comminution efficiency in some circuits by up to 300/o. The CEEC roadmap largely aligns with our internal roadmap, and for some years we have been pursuing components such as pushing the size reduction upstream to reduce the amount of more expensive grinding, and assessing alternative comminution technologies, such as autogenous and high-pressure grinding:

With EEC a potential game-changer, it demands a revised view of recovery, plant design and how comminution in its widest sense is applied.

A CEEC roadmap

Compiled in 2012 by nearly 40 industry experts, the CEEC Roadmap is a template that mining companies can use to develop a strategy for eco-efficient comminution (EEC) at any mine site. Its aim is to define the issues relating to EEC, recommend strategies for addressing the problem and suggest mitigating actions.

According to the document, reductions in comminution energy consumption of 15–30% in the short term, and 50% within 10 years, are feasible. However, it warns that one-off interventions that lead to a step-change in efficiency are rare and should not be relied on to solve the issues. Instead, it advises the cumulative effect of relatively small improvements as a route to achieving substantial gains.

The roadmap also lists EEC performance targets, with key recommendations including the introduction of a four-star energy rating system, before tackling the issue of barriers to action and then providing a detailed list of possible actions. This includes the use of existing technologies in both the short and longer term, as well as long-term actions that involve some risk.

To download a free copy of the roadmap, visit www.ceecthefuture.org/publication/2012-ceec-roadmap