An energy conservation mindset

Determining the lowest hanging fruits of optimizing and reducing energy consumption can help mining operations to achieve their decarbonization goals

By Christopher Pollon

Energy conservation in mining is all about minimizing the amount of energy you have to employ in the first place, and maximizing the efficiency of what you have to use. It necessitates the embrace of evolving technologies, careful assessments of operations, and above all, a shift in corporate culture.

Efficiency in energy use should ideally be built into the design of a mine at the outset; but regardless of when and how, the only way it can really happen in a significant way is if a culture of conservation exists across an entire organization. A conservation mindset is a prerequisite, and this is something that can be nurtured if it does not already exist within a company.

Mahtab Salehii, a global sustainability consultant to the mining and metals sector at Schneider Electric, spends a lot of time thinking about energy. In her opinion, the mining industry is on the cusp of a great shift in energy conservation, and specifically, a change in the way energy is generated, employed and managed at mine sites.

"Across the decades and even centuries that we have mined, humans have grown accustomed to a certain way of working," said the engineer and data expert, who works with resource companies to maximize the energy efficiency of their operations. "In the past we weren't necessarily worried about the carbon content of energy nor cost of energy to the extent we are today because of flat rate contracts for the energy and no carbon tax."

This is changing quickly. A shift towards ever-greater energy efficiency is being spurred by sustainability goals, regulatory pressures (or the anticipation of new regulations) and environmental, social and governance (ESG) issues. Conservation, Salehii said, is now something that the market and governments are increasingly demanding, as well as being driven by even more practical concerns.

"Now we have to be worried about the energy cost because it's getting more expensive," she said. "More companies are trying to take measures to account for [energy use], measure it and reduce it. These are all the things that drive this trend."

The rewards and challenges to achieving greater energy efficiency are myriad. New Gold's New Afton mine in British Columbia still stands out: in 2014, it became the first mine in North America to receive an ISO 50001 Energy Management Standard certification—an international standard that provides a framework for organizations to develop internal energy policies, fix targets and objectives, and measure the results.

In 2015 alone, New Afton achieved an energy performance improvement of over 11 per cent, realizing annual cost savings of $444,000, which had cost $259,000 (including utility rebates) to implement. However, energy savings were also realized through the implementation of low- or no-cost initiatives based on employee suggestions, according to Andrew Cooper, who led energy management initiatives at the New Afton mine through its efforts to achieve ISO 50001 certification. Cooper is a strategic energy management consultant with Synergise, and works with mining companies to help them improve energy efficiency and implement systems to effectively manage energy and achieve decarbonization objectives.

Perhaps the most difficult aspect of achieving these kinds of gains is creating the prerequisite conservation culture that historically has not existed at the mine site level. The good news is that there are many evolving tools, approaches and examples to emulate on the path towards greater energy conservation. Whether a site is greenfield or brownfield, there are ways to overcome the challenges and reap the rewards.

Challenges

Despite its many upsides, energy conservation can still be a hard sell. Energy reduction initiatives that sound like great ideas often lose out in budgeting and time allocation processes to urgent equipment needs or process improvements that have higher return on investment or criticality to operations, or that are seen to be less risky to the operations. In addition, once a mine is up and running, it can be too late to make fundamental changes in site design that would maximize energy efficiency.

For a company, the question of where to start can be daunting. Debra Johnson, senior advisor for mining, minerals and metals at Stantec, is a veteran leader of energy audits across just about every kind of mining operation—surface, underground, heap leach and more. She said a company initiating a formal energy audit of its operation—the design, or the existing operation—is taking the first step on a path to net-zero emissions and enabling the identification of the lowest hanging fruit of energy conservation. "An energy audit is a great way to get quick wins with practical solutions," she said.

Johnson employs the motto, "you can't manage what you can't measure," which is the underlying rationale of energy audits. The first step of an audit, she explained, is to understand which energy sources are used and how much energy is expended. There may be some combination of energy sources such as diesel, natural gas, regular gasoline and renewable energy such as hydroelectricity. "I'm also going to ask, 'where is 80 per cent of your energy being used?'" she said. "The answer might be the crusher, or the mill, or maybe it's the diesel that feeds haul trucks."

Once the site's energy gluttons have been identified, those become the focus of energy conservation efforts. Johnson and her team meet with staff across the mine site, including operations and maintenance staff, and they peruse capital budgets. From all of this, they come up with a prioritized list of energy conservation measures—what can be done and at what cost, including the investment payback time and cost savings.

For many mines, diesel fuel for haul trucks is an example of low-hanging fruit. There is a lot of talk about renewable energy like solar and wind power at mine sites, but diesel as a fuel remains a fact of life for many mines, especially those that are off grid. What can be targeted, Johnson said, is the popular

Courtesy of Copper Mountain Mining

The Copper Mountain mine in British Columbia installed a trolley assist haul ramp, which allows electric haul trucks to climb the ramp at more than double the speed of diesel trucks.

historical idea that considered diesel to be "an uncontrollable cost of operations."

In the recent past, she noted, mines did not have fuel management systems at all and they did not measure the fuel being used; they just accepted that this was a cost of doing business. "The energy manager was typically focused on electrical energy," she said. "[While] diesel is an operational aspect. It's one of those mind shifts that diesel is every bit as important as electrical energy [for energy conservation efforts], and in some cases more important."

Areas of potential savings

Ali Ghoreishi Madiseh, an assistant professor at the University of British Columbia (UBC) and Canada research chair in advanced mine energy systems, does research focused on developing ultra-efficient, renewable and decarbonized mine energy systems.

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Diesel is just one of three main types of energy employed in mining, and all of them are important to consider when it comes to managing energy conservation, Madiseh said. Firstly, mines use electricity to power all the pumps, fans, conveyance and crushing found at underground and surface operations. Secondly, some form of energy is also required for motive power, mostly provided through diesel engines—for example, to move haul trucks. The third type of energy is thermal, for heating or cooling.

Reusing waste heat created by burning fossil fuels is low-hanging fruit, according to Madiseh, whose team at UBC helps the mining industry find ways to use less energy, including less fossil fuels. "If you have low- to medium-grade waste heat available on a site that you can reuse for heating or on surface facilities, or underground intake air heating, then you're using less natural gas, propane or diesel, [which translates into] millions of litres of fuel, and many tonnes of carbon per year," he said.

He provided a scenario where this is doable: it makes a lot of sense to design a mine with diesel generators situated in close proximity to other facilities, so that the heat energy that they generate can be reused. "Recovery of the heat from diesel generators is not really hard [and] it's inexpensive. The technology is there, we were doing it back in the 1940s," he said. "As a simple example, a remote mine in the Northwest Territories may consume 12 per cent of its diesel fuel for heating; by recovering waste heat from its diesel generators and using it for intake air heating, it can save approximately $9 million and 28 kilotonnes of CO_2 each year."

Madiseh pointed to the multiple examples of energy conservation innovations that can have a real impact at mine sites, such as advanced comminution circuits that use microwave energy to cut the overall electricity consumption of the mine by between 30 and 40 per cent. He also cited trolley assist trucks as an innovation that can save enormous amounts of diesel.

A case in point: in 2021, the Copper Mountain mine near Princeton, B.C., installed a one-kilometre-long section of electric trolley assist, which was the first of its kind in North America, eventually employing 11 Komatsu 830E-5 hybrid trucks to move ore between the main pit and the primary crusher. The hybrid trucks run on their electric drive motors only when they are connected to the trolley assist on the mine ramp; this means the trolley system is able to seamlessly replace the power from a 2,600 horsepower diesel engine while the truck is carrying a load of 240 tonnes. It also allows the trucks to ascend the steep ramp at more than double the speed of diesel trucks, resulting in more production cycles and improving productivity.

The project took years of planning and the contribution of funds from both BC Hydro and the B.C. government to complete. In 2022, BC Hydro reported that Copper Mountain was one of only two mines globally with working electric trolley assist (the other is Boliden's Kevitsa mine in Finland).

Data-driven insights

Schneider Electric's Salehii helps her customers develop a "decarbonization pathway" and execute on that, including

measures that maximize energy efficiency. She pointed to how technology is providing new tools to help miners visualize and test drive new designs and approaches like never before, in particular the use of "digital twins."

In a nutshell, digital twins are virtual replicas of physical mine assets and systems that can simulate real world operations in real time. "By integrating data from sensors, equipment and other sources, they combine the power of real-time data, machine learning and advanced modelling, enabling mining operations to optimize energy use and reduce emissions," said Salehii.

A digital twin can represent an entire mining operation, or it can focus in on a system that needs to be optimized. It is a flexible tool that can model, for example, process variables like pressure, temperature or power quality. Salehii said a digital twin can be invaluable in the design of a new plant, but can also be valuable at a brownfield site, for example when a company is expanding or renewing its existing operation. In this way, a digital twin provides the ability to see the impact of changes in energy management and mine design in real time, before an investment is made. Then, once the changes have been made, the digital twin can continue to guide the optimization.

However, there is a caveat—the success of such a tool depends on quality data collection from the installation of sensors across the mine site, including so-called Internet of Things measuring data from mining equipment and vehicles. Data collection is a challenge for many companies, and something that is not always collected in a way that can be useful for this kind of high-tech modelling.

"One of the biggest challenges that a lot of organizations are facing, especially mining companies, is the availability of the data you need to effectively manage energy," said Cooper. "That's one thing you have to have, because you need to know not only how much energy you're using, [but also] how much should you be using."

Digital twins are an example of how relatively new technologies like artificial intelligence (AI) are making innovation and energy management possible. In terms of the future, where is the industry going? Madiseh pointed to other promising technologies that have not yet progressed towards scalable deployment in mining; these include microwave-assisted rock-ore fragmentation systems, the use of hydrogen as a fuel for fuel cells or as a combustion fuel, and geothermal energy for site heating and cooling.

"We are working with industry on microwave [fragmentation]; in five to 10 years, it will be here," said Madiseh. With hydrogen, he added, many big mining companies are already investing in and investigating hydrogen-powered mining equipment. "A majority of hydrogen applications are focusing on fuel cells, taking the hydrogen you inject into a fuel cell to generate electricity," he said.

What is holding hydrogen back in North America for use in underground mining, according to Madiseh, are regulations against having volatile gases underground, including hydrogen. "If there is a future for hydrogen energy in motive power in mining, it [will be] in surface mining for very heavy [hydrogen-powered] equipment, such as haul trucks," he said.

All in the details

As with energy conservation in the consumer space, a lot of energy conservation in mining is much more mundane—like installing all-LED lighting, finding ways to minimize vehicle idling and having the shortest routes possible to move ore via trucks or conveyors. It also means finding ways to deactivate ventilation fans, heating and lights when they are not needed.

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– Andrew Cooper, Synergise

This was the kind of attention to detail that helped the New Afton mine to cut down its annual energy consumption: including a focus on energy performance in underground ventilation, flotation blower control and compressed air.

As of this writing, New Afton remains the only mine in Canada to achieve ISO 50001 certification. Flyn McCarthy, principal at SysEne Consulting, who has worked with hundreds of mining companies on energy management over the years, pointed this out when asked to assess the current progress to implement energy management and conservation in mining. McCarthy added that this certification is largely off the North American practical radar, but is mandatory for European mining companies. Change is afoot, he said, but we still have a long way to go.

"It's pretty routine that a lot of new mines don't consider the actual cost of power," he said, including in new mine designs that make wrong assumptions about future energy costs. In B.C., where McCarthy does a lot of work, he has been surprised to find many companies are unaware that they must compete for electricity with liquefied natural gas and upstream natural gas producers, which are both sectors with mammoth appetites for energy. He has seen recent improvement, but an old truism still applies: "when times are good, they think there's no benefit for being efficient; when the times are bad, there's no money to pay for efficiency."

The glass-half-full view of McCarthy's assessment is that there is enormous room for improvement in the mining industry—and that education and the nurturing of a real culture of conservation within companies represents an immense opportunity to slash emissions, energy usage and energy costs.

To that end, the creation of a corporate culture of conservation within a company is a critical factor in making progress in energy conservation and efficiency. That is because progress demands a genuine conservation mindset across all aspects of a mining operation.

"Employee engagement and awareness is the key to achieving long-term decarbonization," said Cooper, who has seen what works first-hand. "It also requires competence and training because you must build the internal capacity to manage energy going forward. There's no silver bullet, and it's got to be done face to face."

He cited the example of an employee who suggested that a building required insulation to boost energy efficiency. "We studied that, we got some funding and [we did it]," he recalled. "This employee was so excited that this had been done because of his suggestion. Having that feedback mechanism for employees is key." CIM