

# ENERGY AND MINES



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## THE DAWN OF VARIABLE MINING

**From 24/7 to mining  
when renewable power  
is available**

KEYNOTE INTERVIEW  
**NICK HOLLAND,**  
CEO, GOLD FIELDS  
Energizing the mines  
of the future





Meliadine Mine  
(COURTESY AGNICO EAGLE)





story

# The dawn of variable mining

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**MELODIE MICHEL**  
Reporter, Energy and Mines



**I**n just a few years, the conversation around greenhouse gas emissions reduction has changed dramatically. Miners have gone from simply looking for cleaner options to power continuous, flat load operations, to rethinking their whole designs and processes to ensure the best use of dynamic green power generation.

It's a natural evolution: with building solar or wind farms and hybrid power plants on site came knowledge and experience about how these systems work. By now, it has become obvious that renewable energy supply is not constant, and that arguably storage technology is years away from being able to make up for generation gaps, particularly at night. So far, this lack in capacity has been filled by diesel or natural gas generators, but the price of renewables is now so attractive that mining engineers have a strong financial incentive to find a way to use them to their full extent.

This is particularly true for very remote mine sites that have no access to grid electricity, and would require costly development work to either connect to a gas pipeline or bring in road infrastructure for the transport of diesel. Warner Priest, head of emerging technologies at Siemens Australia, explains: "With variable mining, you can now economically mine a resource that was in the past too expensive to mine, because there were no overhead power lines or gas pipeline to service the mine in energy."

Priest has had various conversations on the topic with mid-sized greenfield mining operators that have good access to renewable resources in Australia. "For about 70% of the time through the year, they will have renewable power available to mine on the operations over a 20-year period. Now, the decision would be to fill that other 30% with energy storage or diesel, or to change their mining operations so that they only operate for 70% of the time and are off for the remaining 30%," he says.

### **Changing mentalities**

This is a dramatic shift from the traditional mining mentality, where operations run 24 hours a day, 365 days a year. But it looks like op-





Meliadine Power Plant  
(COURTESY AGNICO EAGLE)





La India Mine Mexico  
(COURTESY AGNICO EAGLE)



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erators are starting to realize that structural changes are a necessary element in the pursuit of cleaner, more efficient mining.

Agnico Eagle, for example, embarked on a journey to optimize its use of energy a couple of years ago. This year, it came up with new design principles to orient optimization of its use of energy and reduce its footprint. These include concentrating along the path, electrifying all work, eliminating waste energy, increasing the use of renewables, building a smart energy system, and liberating minerals in an energy efficient way. None of the company's current sites use renewable power, yet Agnico Eagle believes it will start implementing variable mining principles within the next decade — an impressive change of pace.

Dominique Beaudry, director of innovation at the firm, explains that there are many step changes to introduce before adopting variable mining. “Before introducing variable mining, we need to significantly reduce our current energy requirements. We think that we could save up to 30% of our energy requirements through better energy management. We need to reach an amount of energy where we think that we can make that transition, and projects such as ore sorting will be a key process for that: removing as much waste as we can before transporting the ore to the mill, and doing more selective mining,” she says.

Additionally, since the concept breaks so much from traditional mining principles, human acceptance may take a while to reach. But Beaudry is confident that following Agnico Eagle's roadmap is the best way to convince operators of the efficiency of the variable mining model: “We're going to communicate and involve our people in the decisions. The biggest change will be the human change, but people will follow once they're convinced that it is feasible because we are taking a step-by-step approach to work with new design principles.”

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**WARNER PRIEST**  
**Head of Emerging Technologies,**  
**Siemens Australia**



**The price of renewables is now so attractive that mining engineers have a strong financial incentive to find a way to use them to their full extent**

For newcomers in the market, the transition doesn't always have to be this measured. Element25 is currently developing Australia's largest onshore manganese resource to supply global battery manufacturers. In order to capture as much value as possible within Australia, the firm plans to extract the manganese from the ore on site, using a process called electrowinning. Manganese is a key element in the global energy transition, so it makes sense to try and produce it in the cleanest

way possible. But the real driver behind Element25's preference for variable processing in its pre-feasibility study is cost.

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***“The really exciting thing is thinking we use a variable philosophy to capture more of that dynamic energy provided by wind and solar”***

**JUSTIN BROWN**  
Managing  
Director,  
Element25

“We started our journey with a pretty traditional base case power solution that revolved around natural gas, because we have a pipeline traversing through our project,” recalls Justin Brown, the company's managing director. “We discovered that renewable energy is now significantly cheaper than natural gas, so we started looking at using 50% renewable energy and 50% natural gas, and the overall cost of the project was brought down because of that. But this is just using a traditional flat load profile; the really exciting thing is thinking we use a variable philosophy to capture more of that dynamic energy provided by wind and solar.”

Element25 is now doing experimental work to determine how dynamic it can make its operations, but Brown says early results are encouraging. “Aspirationally, we can see a future where we get to 80% or 90% renewable penetration,” he points out.

### **New value perceptions**

Can the same productivity be achieved through variable mining as with traditional flat load profiles? “Yes,” says Priest. “They've just got to increase the size of their mine processing and energy generation. This is a little bit tricky because they've got to balance the cost of the

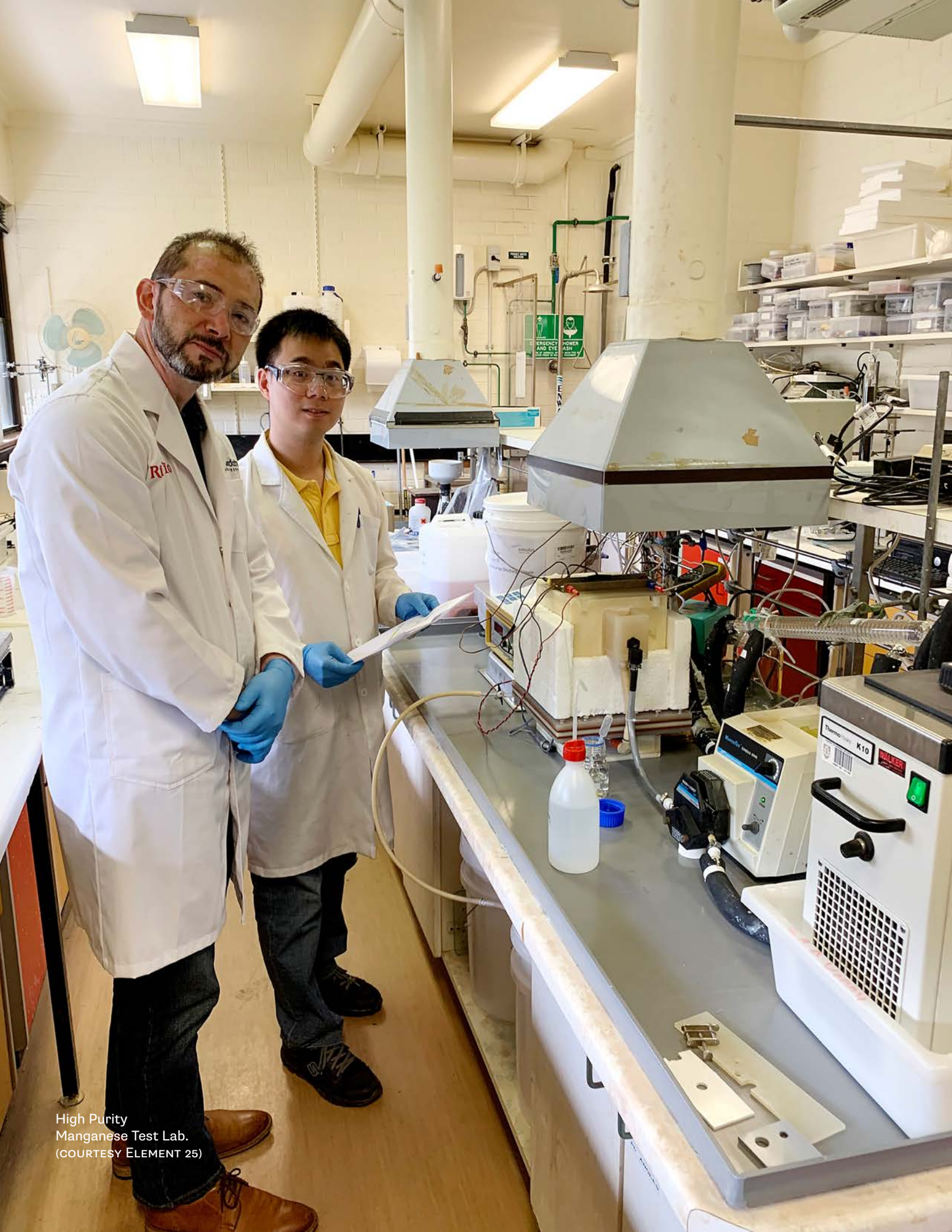




AGNICO EAGLE  
FARNELL-THOMPSON

Meliadine Process Plant  
(COURTESY AGNICO EAGLE)





High Purity  
Manganese Test Lab.  
(COURTESY ELEMENT 25)



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extra assets they have to put in with the cost savings they get from not having to use diesel or gas for the 30% of the time renewable power is unavailable.”

In this calculation, life of mine is of course a determining factor. Priest estimates that the capex required to build a greenfield variable mine cannot be amortized in less than 10 to 15 years. “It can be very expensive from a capex point of view to set these systems up: you have to build wind, solar, potentially diesel generation and batteries, but it is much lower-cost on the opex side. If you’re mining for 20 or 30 years, it will be the lowest form of power generation for your mine,” he adds.

But mining and minerals companies can go further in calculating the value of setting up their operations to rely mainly on renewables. Decoupling productivity from power costs is likely to prompt a revolution in the mining world.

Take electrowinning, for example. This is a highly energy-intensive process: about 2 to 3 MWh for copper, 5.5 to 6 MWh for manganese, and as much as double that amount for aluminium, according to Brown. Knowing this, it’s understandable that Australian miners have so far preferred to send their ore to be processed in countries with access to much cheaper electricity. But this is where the high renewable penetration achieved through variable mining processes could tip the balance for the mining sector, prompting companies to add value within countries where grid power is expensive but wind and solar energy is abundant.

At Agnico Eagle, Beaudry suggests that miners may need to change the way they calculate value as they adjust processes to fit dynamic renewable power generation. “We are to give ourselves more flexibility with regards to our production by reducing energy requirements. Depending on the context of our ore deposits, we could increase our production in terms of tonnes by lowering ore cut off grades. Or we could also lower our production in terms of tonnes, but it could be the same or even better in terms of ounces: in that case we would remove

## **There’s an urgent need for miners to start collecting and interpreting data about their energy use**



***We think that we could save up to 30% of our energy requirements through better energy management.***

**DOMINIQUE  
BEAUDRY**  
Director of  
Innovation,  
Agnico Eagle



fewer tonnes from the mine, but they would be the right tonnes. By doing that, you're reducing your footprint and cutting waste management requirements. It's very valuable," she notes.

## **Data analysis**

But first, there's an urgent need for miners to start collecting and interpreting data about their energy use. This is something mining majors have been working on for a few years, now resulting in the production of the first climate change or environmental reports by the likes of Rio Tinto, BHP and Anglo American.

It is also part of Agnico Eagle's roadmap: understanding its energy requirements and the amount of power generated from its power sources in real time, and leveraging a smart analytical software platform to optimize energy distribution on its sites.

At Siemens, Priest recommends gathering this type of data from day one. "To start off in assessing if this is a viable option, you need to do a techno-economic assessment and modelling, almost building a digital twin of your mining and energy operations and working out the technical aspects of doing so and its commercial viability over the mine life. You should build your energy system and mining plant with the view to collect data from all their components from the day you start commissioning. You can then use that intelligence to confirm that any tweaks or changes you make in the digital twin work perfectly before you make them in the actual site," he says.

The necessary software tools are already available or being developed: ABB, for example, is collaborating with Boliden in Sweden on the creation of a Sustainable Intelligent Mining System (SIMS) which will allow for real-time data collection and process control, application of scenarios on the digital twin and field trials evaluation and exploitation.

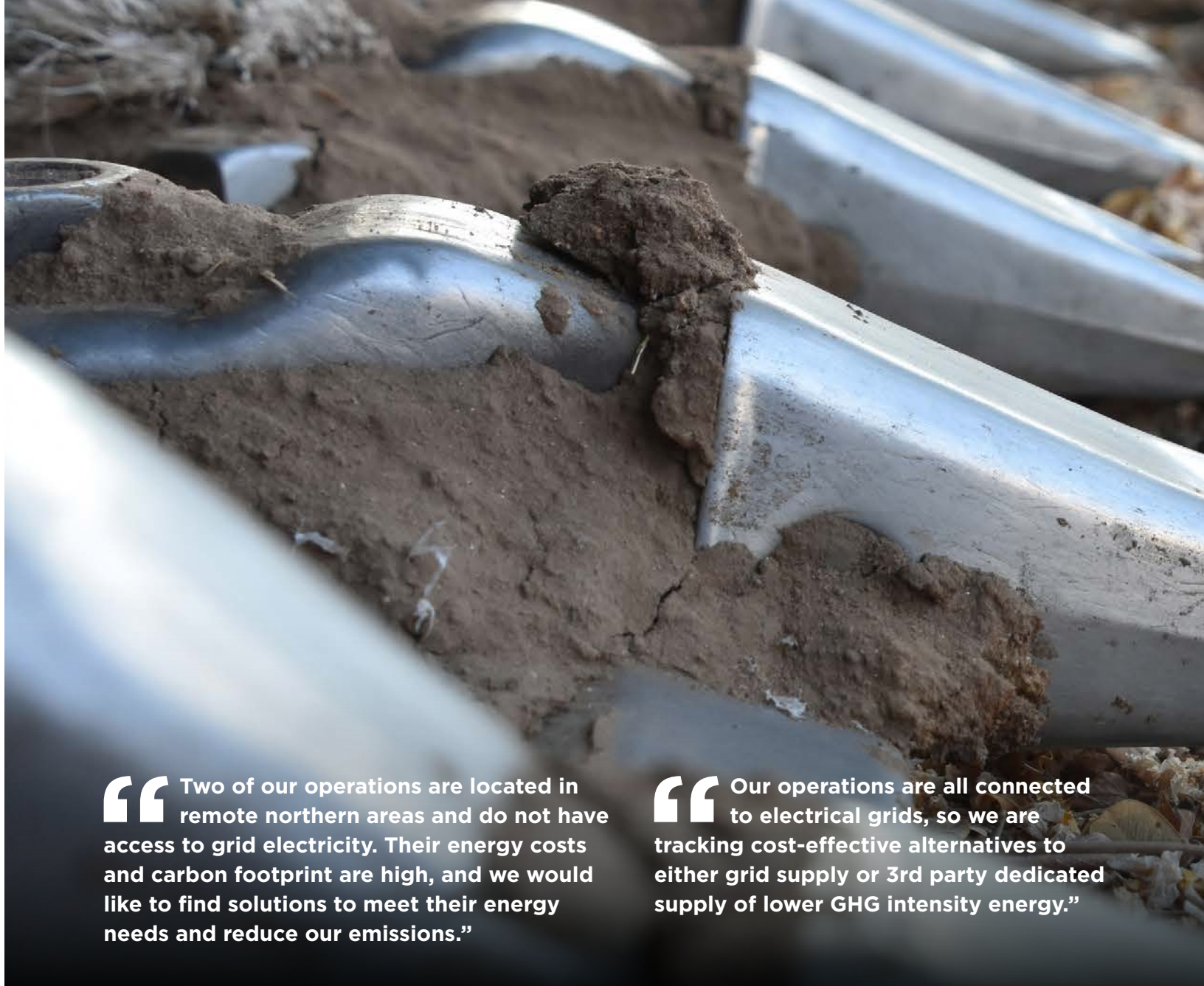
It won't happen tomorrow, it won't happen in a year, but the variable mining revolution is already underway. Greenfield developers in particular have everything to gain from putting this option on the table now, but even large miners operating brownfield sites should start preparing for the transition.





La India control room  
(COURTESY AGNICO EAGLE)





“ Two of our operations are located in remote northern areas and do not have access to grid electricity. Their energy costs and carbon footprint are high, and we would like to find solutions to meet their energy needs and reduce our emissions.”

“ Our operations are all connected to electrical grids, so we are tracking cost-effective alternatives to either grid supply or 3rd party dedicated supply of lower GHG intensity energy.”

## ENERGYANDMINES WORLD CONGRESS

 TORONTO, DEC 2-4 2019

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# Why mines are attending the Energy and Mines World Congress 2019?

Each mine attending the Energy and Mines World Congress is asked to outline their interest in renewables for their operations. The following are samples of responses:

“Using renewable energy already and looking to install more at our mines”

“In Ontario, we would like to transition from diesel underground equipment to electric equipment.”

“Our operations are expanding and we are looking at how to incorporate renewables into new operations as well as increase power supply at current operations using grid size storage using renewables instead of powerline upgrades.”

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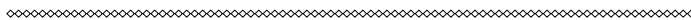


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**100%  
RENEWABLE  
ENERGY POWER  
ALREADY  
APPEARS IN  
SIGHT**

”

**Nick Holland,  
CEO, Gold Fields**





**I**n advance of his keynote presentation at the Energy and Mines World Congress in Toronto on December 2nd Gold Fields CEO Nick Holland outlines his company's approach to re-energizing and decarbonizing Gold Fields' mines.

**ENERGY AND MINES: Gold Fields has been a leader in committing to and investing in renewable energy options for powering your operations. What are the key strategic drivers behind these investments?**

**NICK HOLLAND:** For the industry there are three main strategic considerations for renewable energy options: energy availability (including security of supply), energy affordability and the drive for low carbon emissions. These are on the back of more remote mines, underground mines getting deeper and hotter, hauling distances getting longer; thus driving up energy demand, which is compounded by energy price volatilities.

**E&M: Which of your recent renewable energy projects and commitments are you most proud of and why?**

**NH:** A number of recent renewable energy and low-carbon projects are worth noting. Our Agnew mine will become one of Australia's first mining operations to have a very high penetration of renewable energy with a A\$112m investment in a world-leading energy microgrid combining wind, solar, gas and battery storage. The microgrid will

**One of the key difficulties for long-term energy planning and understanding climate-related risks is the life of a mine.**

be owned and operated by energy group EDL, which will recoup its investment via a 10-year electricity supply agreement. The project, which is already under construction, has the backing of the Australian Government with the Australian Renewable Energy Agency (ARENA) contributing A\$13.5m to its construction.

The microgrid consists of five wind turbines that will deliver 18MW of power, a





COURTESY OF  
GOLD FIELDS



10,000-panel solar farm contributing 4 MW, a 13 MW/4MWh Battery Energy Storage System and a 16MW gas engine power station to underpin supply when required. The combined project is initially forecast to provide 55 – 60% of the mine's electricity needs during daytime hours with potential to meet almost all electricity requirements at certain times.

Our Granny Smith mine is also set to install one of the world's largest renewable energy microgrids later this year, powered by more than 20,000 solar panels and backed up by a 2MW /1MWh battery system. The mine has contracted modular power company Aggreko to design, build and operate the 8MW solar power generation system along with the battery system. This project will reduce our carbon footprint by some 10 000 tCO<sub>2</sub>-e/year.

For our new Gruyere project, which achieved commercial levels of gold production in September, APA, our independent power producer, constructed a 200km gas pipeline to power the project, instead of burning diesel for power. This provides a baseload for the future mine which we can optimise with renewables at a later stage.

At our Tarkwa and Damang mines in Ghana, Genser, our independent power producer, recently completed a project to lay some 75km of gas pipeline underground to negate trucking gas to the on-site power stations, thus eliminating the related road hazards and risks.

We have had a commitment to have at least 20% renewable energy in our new mines. I am particularly pleased about the Salares Norte project

in Chile, at the Atacama desert, that promises to meet that commitment. The renewable energy aspects are critical to containing energy costs and reduce carbon footprint at this location.

**Our Agnew mine will become one of Australia's first mining operations to have a very high penetration of renewable energy**

**E&M: What areas of the business represent the greatest challenge in terms of realizing energy and climate plans?**





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**NH:** One of the key difficulties for long-term energy planning and understanding climate related risks is the uncertainty around the life of a mine. This can vary widely and is relatively volatile given that key variables – such as metal prices and exchange rates – are difficult to forecast accurately. An investment in energy plants requires a fairly lengthy period to achieve viable returns and a long life-of-mine is not always guaranteed.

**E&M: What do you think are the key ingredients for energizing the mine of the future?**

**NH:** There are a number of key ingredients that will determine the energy needs of any mine of the future: Firstly, it is about a shift from diesel-driven equipment to electrical equipment. Second, we see new energy supply and demand models, with loads becoming more smart and enabled to communicate with the supply technology more directly. Third, we see new energy supply technologies filling the gap created by shutting down fossil fuel based energy sources. For example, hydrogen, combined with solar or wind energy could become commercially viable for remote mines, as will be the increase of microgrids, even with small nuclear reactors.

**E&M: What pathways and solutions is Gold Fields considering at strategic and operational levels to realize affordable, reliable and low-carbon energy for operations?**

**NH:** We are looking at a number of solutions. One is a shift away from diesel-powered machinery; electric equipment will serve as a key ena-

**We expect our fleet of underground vehicles to gradually move to being electrified**

bler for new energy models. We expect our fleet of underground vehicles to gradually move to being battery driven. At the same time, on-surface, we see more diesel-electric hybrids, and a move towards less mobile equipment and a move towards the use of conveyor



Rows of bi-facial  
solar panels being  
evaluated  
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belts, and in-situ processing. As a mining company, one of our main activities is to move material; trucks are the main way of achieving this but we believe that this will not always be the case in future.

**E&M: Which energy milestone do you think will be realized first - fully-electric mines, decarbonized fleets or 100% renewable energy-powered operations?**

**NH:** 100% renewable energy power – it already appears in sight at some operations. Renewable energy technology has matured and is more affordable. The supplier support base is established and financiers are comfortable about the investment in renewable projects. To adapt existing mines to a decarbonised fleet and be fully-electrified would require significant mine design, mining cycles planning; fleet procurement, scheduling, maintenance and operational changes, which will take time for existing mines and could be best achieved for new mines.

**E&M: What would be useful to see from mining and energy suppliers to support the resource sector's transition to sustainable power solutions?**

**NH:** We hope for more collaboration between suppliers, and between suppliers and the industry on equipment, such as energy storage, and machinery, such as fully electric underground mining equipment. This will allow for the development of economies of scale that will drive down costs. The International Council on Mining & Metals, its member companies and some of the world's leading mine vehicle and equipment suppliers and technology providers, have been working jointly on an ambitious plan to accelerate safety and the innovative development of a safer and cleaner new generation of mine vehicles.

**Renewable energy technology has matured and is more affordable.**

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**NOTE**

Nick Holland, will be providing the opening keynote at the 7th Energy and Mines World Congress on December 2nd in Toronto. Details at <https://world-congress.energyandmines.com>



