

ENERGY AND MINES

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**HYBRID
INTEGRATION**
Insights from a
Market Leader



**HYDROGEN
AND MINES**
Standards and
Collaboration Key

**SHIFTING
PARADIGMS**
at the Energy and Mines
Australia Summit





events

Shifting Paradigms at the Energy and Mines Australia Summit

MELODIE MICHEL
Reporter,
Energy and Mines



“We’re also looking at ways to dynamically consume our energy and push the renewable penetration higher. Ultimately, if we can get cheaper power than China, the world is our oyster,”

JUSTIN BROWN,
Executive
Director,
Element 25

The third annual Energy and Mines Australia Summit, held in Perth on June 19-20, was an opportunity for mining and energy stakeholders to share experiences, anecdotes and lessons learned about the integration of renewable energy into mines’ power systems. This is no longer a new conversation: in Australia in particular, highly volatile grid electricity prices have led virtually all miners to look at renewables to manage costs and reliability. But what came out of this year’s conversations was a desire to shift the paradigm by placing power generation at the centre of new mines’ designs, leveraging not only low renewables and battery prices, but also the growing expertise in load management data systems. With over 300 attendees, the conference was also a platform for the announcement of numerous new projects and collaborations (see Project Watch).

“Australia is taking a leading role in driving renewable energy developments for the mining sector, so it’s no coincidence that we are here.” Stephan Hansen, Chief Operating Officer of juwi Renewable Energy, set the tone for the conference in his opening speech. Energy

Commissioned RE capacity in mining (MW)

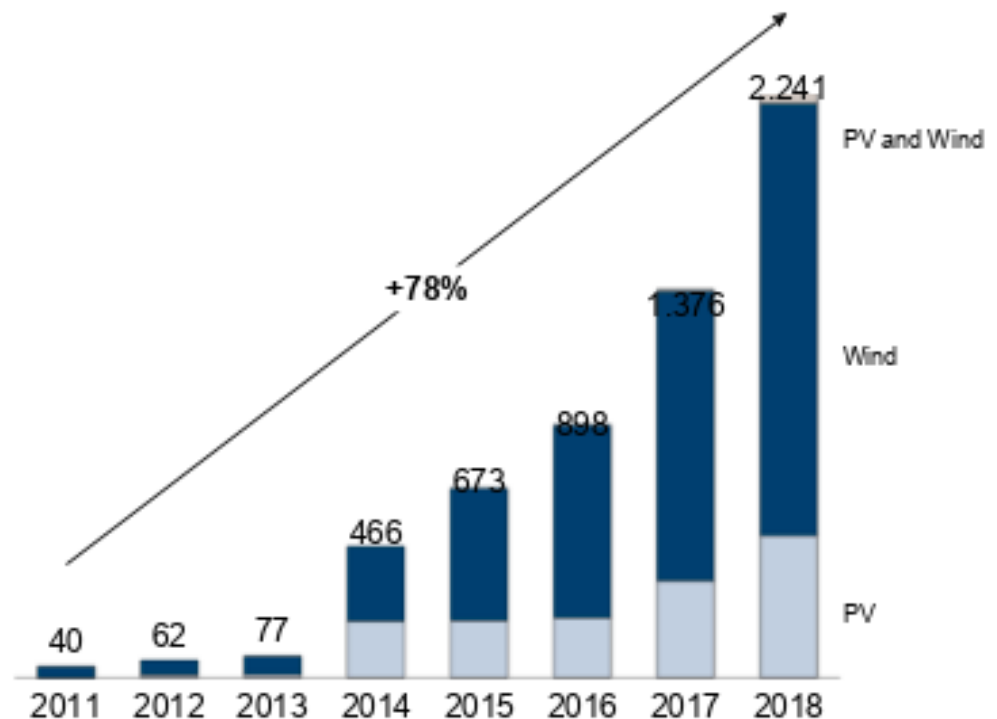
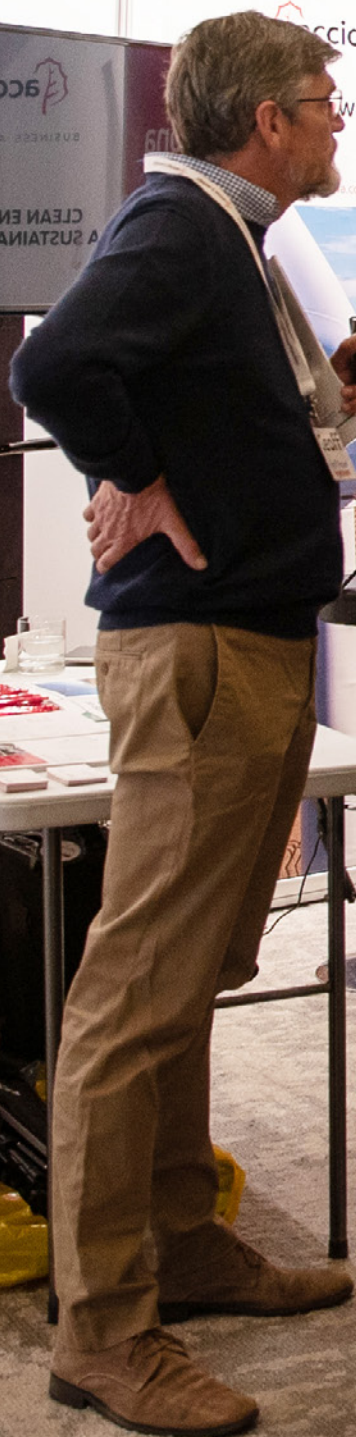
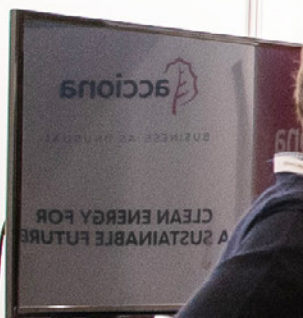


Figure 1: Commissioned RE capacity in mining from RMI





Summit Speakers
(clockwise) -
Bethwyn Cowcher,
FMG; **Darren Miller**,
ARENA; **Katie**
Hulmes, Oz Minerals;
Stephan Hansen, juwi
Renewable Energy

is estimated to represent 20% of costs for grid-connected mines and 35% for off-grid mines, but it accounts for about 95% of miners' total greenhouse gas emissions. Now that renewable energy prices have reached a price point that's often lower than traditional, fossil fuel-based energy, integrating it is a win-win for mines, particularly in Australia. "Hybrid power can cut energy costs by 10-30%, and reduces exposure to fuel price risks," added Hansen.

Market maturity

The levelized cost of energy (LCOE) per megawatt-hour has fallen by 49% and 84% for onshore wind and solar PV respectively since 2010, while for lithium-ion batteries, it has dropped by 35% in the same period, reaching A\$187MWh.

Still, it is sometimes an uphill battle to convince mining executives of the benefits of hybridization. "Part of the challenge for our mining leaders is that this is not core business for them, they don't know

Will Rayward-Smith
of SunShift presenting
the dinner speech -
see box-out on page 14



enough about renewables, falling costs, innovations. They just don't have that information, so we need to do outreach and education," pointed out Kirsten Rose Head of Low Emissions Technology at BHP during the keynote panel.

Another issue is the fact that mining is a somewhat fragmented industry, which previously did not face as much public pressure as other, more consumer-oriented sectors, to decarbonize. As an example, technology companies like Microsoft, Apple, Lego and Google have already transitioned to 100% renewable energy usage, which, considering the amount of power needed to run a data center, is proof that any industry can make the switch, saving hundreds of millions of dollars in the process.

The sheer number of mining attendees at the conference – 100 or a third of total delegates – is proof that the sector is engaged on a decarbonisation path from which there is no going back. "It's getting to the point where it doesn't matter how small your emissions

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***"We have a lot to talk
about in terms of
how to stop building
mines that need to be
decarbonised,"***

KATIE HULMES
General Manager
of Transformation
and Readiness,
Oz Minerals

Kirsten Rose, BHP



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“We are in the market in Chile and in Australia for large amounts of grid-connected electricity. We fully expect that there will be a significant renewable component to that, and that could be game-changing for our decarbonisation.”

KIRSTEN ROSE
Head of Low Emissions Technology, BHP

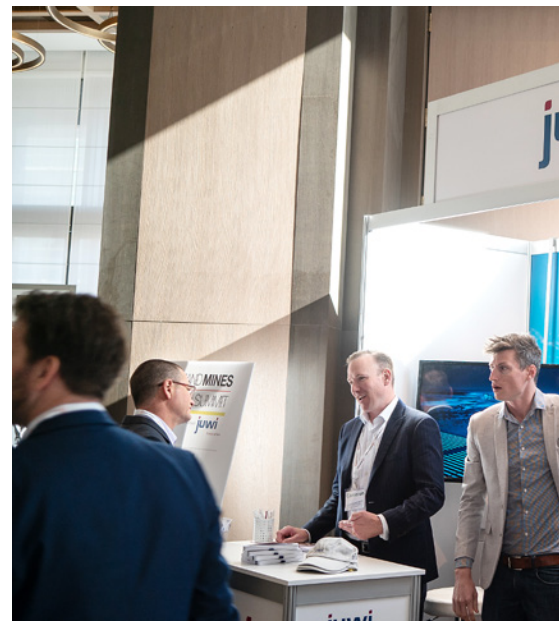
are, you’re still having to do something about it,” said Nigel Brunel, Director, Institutional Commodities at OMF Markets.

Increasingly, miners’ interest in renewables is moving away from a corporate social responsibility issue to a business strategy. For one, they are now actively pursuing opportunities in metals essential to the renewable economy, such as lithium or manganese. Additionally, there is a strong desire — at least in Australia — to move up the metals value chain and start processing domestically. According to Bloomberg New Energy Finance, over half of battery metal refining takes place in China due to access to cheap power as well as supply chain integration. For Australia to compete with that and move up the metals supply chain, renewable energy will be key.

High-purity manganese producer Element 25 has identified green power as an essential part of its strategy. “It all comes down to costs,” said Justin Brown, Executive Director of the firm. “If we do a gas-only generation strategy, we’re pretty confident that we could get our power at about A\$12 cents per kWh. We know that China is cheaper than that, so it’s a question of how close can we get to Chinese costs of production to compete with them on a like-for-like price.” Element 25 benefits from a very long mine life which will allow it to amortise its initial capital cost over a period of up to 25



Energy Challenges and Options for New and Existing Mines with **Bryan Williams**, Western Areas; **Stewart McCallion**, Australian Potash; **Greg Cochran**, Reward Minerals; **Paul Schmiede**, Sarama Resources; **Keith Ashby**, IGO; **Matt Currie**, Zenith Energy



years. After a lot of modelling, the company is aiming for 50-60% renewable penetration for its 100MW load requirement. “We’re also looking at ways to dynamically consume our energy and push the renewable penetration higher. Ultimately, if we can get cheaper power than China, the world is our oyster,” added Brown.

Changing demand, dynamic offer

Corporate power purchase agreements (PPAs) have become a popular way of achieving cost savings while integrating renewables. Daniel Trujillo, Sales Manager, Business Energy Solutions at AGL Energy, explained: “Over the last year or two, there’s been a clear change in interest from heavy energy users, fuelled by multiple reasons: the drop in the LCOE of renewables, the variability of fuel prices, social license to operate, and shareholder activism. This has really affected the demand for our services, and many of these companies come to us looking for corporate PPAs, because there’s been some headline numbers like A\$50MWh, which is quite attractive.”

But with growing awareness comes more elaborate demand, and corporate PPAs have had to evolve over the past few years. “The renewable PPA market is increasingly dynamic, you can now even find five-year PPAs,” said Chris Halliwell, Manager, Renewable Energy and Environmental Markets at TFS Green.



When procuring energy contracts, mining companies have increasingly high expectations. “For us it’s all about risk and reward,” said Bethwyn Cowcher, Legal Manager for Energy and Power at Fortescue Metals Group (FMG), about the search for an energy partner at the remote Iron Bridge magnetite mine in Western Australia. “We want parties that don’t look to pass on the risk to FMG and keep all the rewards for themselves. We need a partner that can take risk and share reward, which will allow us to come up with novel solutions. Not that long ago, it was still parties looking for a long-term off-take arrangements underwriting significant infrastructure investment, and we understand that, but we also think that the dynamic has changed a lot in power generation,” she added.

With their scale and purchasing power, large miners have the power to really change the game through their energy tenders, but renewable providers have to offer the right terms. “We are in the market in Chile and in Australia for large amounts of grid-connected electricity. We fully expect that there will be a significant renewable component to that, and that could be game-changing for our decarbonisation. The ability to use BHP’s purchasing power in this way is significant, and we encourage innovation and to bring value to the table,” said Rose of BHP.

In his presentation about oil and gas company Viva Energy’s recent wind PPA with Acciona to power the Geelong refinery, Thys Heyns,

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“We want parties that don’t look to pass on the risk to FMG and keep all the rewards for themselves. We need a partner that can take risk and share reward, which will allow us to come up with novel solutions”

**BETHWYN
COWCHER**

**Legal Manager for
Energy and Power,
Fortescue Metals
Group (FMG)**

the refinery's General Manager, confirmed that heavy energy users are in the driver's seat — as long as they are informed and savvy about their investments. He urged miners to get the right advice, be clear about what they want, and to “not to put all their eggs in one basket,” using a portfolio approach to energy procurement in order to manage over-hedging risks. Doing your homework clearly pays off: “Just in the first quarter of this year, we literally saved millions of dollars due to this wind PPA,” he concluded.

Ready for the next step

One thing became clear at the conference: with the level of maturity reached by both renewable providers and mining energy strategists, a complete paradigm shift is appearing on the horizon. “We have a lot to talk about in terms of how to stop building mines that need to be decarbonised,” urged Katie Hulmes, General Manager of Transformation and Readiness at Oz Minerals. The company took advantage of the event to announce an Energy and Mining Collaboration with a partnership with Adelaide University, the Department of Energy and Mining, the Rocky Mountain Institute, solar company SunSHIFT, Tonsley Innovation Precinct and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) at its Carrapateena copper-gold mine site in South Australia.

Will Rayward-Smith, General Manager at SunSHIFT, explained: “The first stage is a 250KW solar farm with a battery, wind turbines with electrical vehicle charging and demand management. The idea is to have this platform that can then be used for experiments in the future.” Oz Minerals is now looking for collaboration with other forward-thinking miners who would like to test technologies and rethink processes to maximise renewable energy penetration. “We need to rethink mining, the value chain and opportunities. We're all asking the same question so why not ask it together,” said Hulmes.

“For that to happen, we need to get miners comfortable with demand management, and that's what we're going to be proving as part of the South Australia experiment: turning certain parts of the operation on and off according to the availability of renewable energy,” added Rayward-Smith.



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Diversity for a sustainable future



Speaking at the Mines and VIPs dinner in the evening of June 19th, SunSHIFT General Manager Will Rayward-Smith brought up a topic rarely mentioned at mining and energy conferences: diversity as a driver for the energy transition. “We hear about the three ‘D’s of Decentralization, Digitalization and Decarbonization, but fundamentally the most important D is Diversity. To make sure we are accessing all the talent and all of the people who think bravely and differently, we need to create an environment where all people can come to the table. Ultimately, it’s the right thing to do to ensure that at the end of this energy transformation, the make-up of the people in the room is different and that we add voices who historically have been excluded or under-represented,” he said. An inspiring reminder that sustainability goes beyond green energy.

Data and digitisation have a large role to play in helping miners think differently about their energy sources, and Oz Minerals hopes that the collaboration will lead to the creation of an open data platform shared throughout the industry.

Fortescue Metals Group is also actively looking at data to help design future mines. “We’ve been starting to look at power on a granular basis, when we used to look at it in blocks. One of the things that data analysis really helps us to do is understand our average loads, so we can really start to design generation solutions to meet actual demand and understand what the risk is around peaks and drops. At the moment for example, we’ve got some excess capacity at one of our sites, but as we start to develop new mines and understand the data we can really start to optimise generation solutions, and future-proof our power generation,” said Cowcher.

When considering energy options, miners are increasingly thinking about aspects of their operations that previously would have been disconnected. Anglo American, for example, is looking at oversizing its solar generation to use the excess energy in its vehicle fleet, either through batteries or by producing hydrogen for fuel cell trucks. This type of horizontal thinking is making an ever-stronger case for renewable integration in mines.

While renewable uptake in the mining sector is still arguably slow, at least compared to other industries, the pace of change is accelerating. Business and environmental interests are aligning. Investors and shareholders, having to abide to their own environmental rules, are putting increasing pressure on their mining clients to decarbonize. Solar, wind, battery and load management technologies are increasingly cheap, precise and adaptable. But more importantly, miners are finally ready to collaborate to rethink the future of the industry. The best is yet to come.



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Gold Field Agnew mine project

Project watch

Every year, the number of projects announced at the Energy and Mines Australia Summit increases. Here is a summary of this year's big reveals.

Agnew Gold Mine

Gold Fields and EDL have entered a A\$112 million (\$78 million) 10-year supply deal for a microgrid combining wind, solar, gas and battery storage in Western Australia. It includes 8MW of solar PV, 18MW of wind power, a 13MW lithium-ion battery and a 16MW gas plant, and received A\$13.5mn of funding from ARENA. The project will help Gold Fields achieve a 50-60% renewable share of energy at Agnew. "We see gas as a key transition fuel as the mining sector weans itself off diesel," said Gold Fields Australia Vice President of Operations, Graeme Ovens.

Butcherbird Manganese Project

Element 25 Executive Director Justin Brown presented his company's energy plans for the Butcherbird Project, a manganese mine in Western Australia. "Making metal through electrolysis involves passing a current between a cathode and anode through a pregnant liquor. Making manganese metal (EMM) takes approximately 6.5MWh/t of metal produced, so electricity to power the cell house is the largest single cost in making EMM at Butcherbird," he explained. The

company has conducted a scoping study comparing gas-only generation to hybrid generations and concluded that renewables would help it achieve significant cost savings to compete with Chinese producers. Element 25 expects to use 50-60% renewables at the beginning of operations, and is looking at optimising its electrowinning processes to utilise dynamic energy supply, in a research project partly funded by ARENA.

Syama Gold Mine

Resolute Mining Acting Chief Operating Officer David Kelly gave the audience an update on the 40MW hybrid plant powering the Syama mine's operations in Mali. Announced in November 2018, the project should be commissioned in 2020, and is expected to achieve 30% solar penetration. "We use 100,000 litres of fuel per day to run our power station and mobile equipment, and because we are so remote, we needed to reduce our reliance on this fuel. Syama has a very long mine life, so we have the benefit of a long-term view. The plant will combine a whole lot of technologies that we consider mature enough to use," he said.

Kirkland Lake Gold electrification

The company has 33 battery-electric vehicles in operation at its underground Macassa mine in Ontario, Canada, which transport 80% of its load. While this is not a new project, Kirkland Lake President of Australian Operations Ian Holland disclosed some interesting new details about how the charging station has been improved with experience. "Originally it was a fixed station where units would go in and have their battery removed, but it's now essentially mobile and automated with three cycles of batteries: one on the unit, one cooling and one charging."

Port Gregory Wind Farm

Another investment in ARENA's portfolio, the A\$11mn Port Gregory project will achieve 60-70% renewable penetration for GMA Garnet's operations near Kalbarri. It includes a 2.5MW wind farm using second-hand turbines, a 1MW solar farm and a 2MW battery. The project was developed by Perth-based Advanced Energy Resources (AER), and received A\$3mn of funding by ARENA.

ENERGY AND MINES WORLD CONGRESS



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70

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CONTENT





KEYNOTE SPEAKER:

Nick Holland
CEO
Gold Fields



GOLD FIELDS



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Hybrid Integration - Insights from a Market Leader

*Using battery storage to fill load gaps in hybrid power systems is now a reality for mines. **Amiram Roth-Deblon**, Head of Global Business Initiatives at juwi Renewable Energy, shared the company's latest insights about the technical integration of wind, solar and batteries in hybrid diesel or gas plants at the Energy and Mines Australia Summit in June. Below are the main takeaways from his presentation.*





Amiram Roth-Deblon, Head of Global Business Initiatives, juwi Renewable Energy

As part of a recent feasibility study conducted for an ASX-listed Western Australia (WA) mining client, juwi attempted to determine which combination of renewables and gas and diesel would result in the client's target levelized cost of energy (LCOE) of AU\$15 cents per kWh. The desired power purchase agreement (PPA) term was 10 to 15 years for a mine life of 25 years and beyond, off-grid. juwi based its findings on its experience at the DeGrussa mine, which achieved 20% renewable penetration within 11 months of installation, as well as its recent solar-wind hybrid project with EDL at Gold Fields' Agnew mine in WA.

As the chart below shows, the higher the renewable penetration, the lower the energy cost in a diesel hybrid. A diesel hybrid would also provide the lowest overall LCOE at this site. This surprising finding vs a gas hybrid for this project is due to high upfront capital costs for a gas pipeline. Pipeline fees or costs do not change much with gas throughput, and therefore cheap renewable energy can not provide much further savings in a gas hybrid, while being able to do so in a diesel hybrid.

-Then comes the challenge of integration. Roth-Deblon showed the

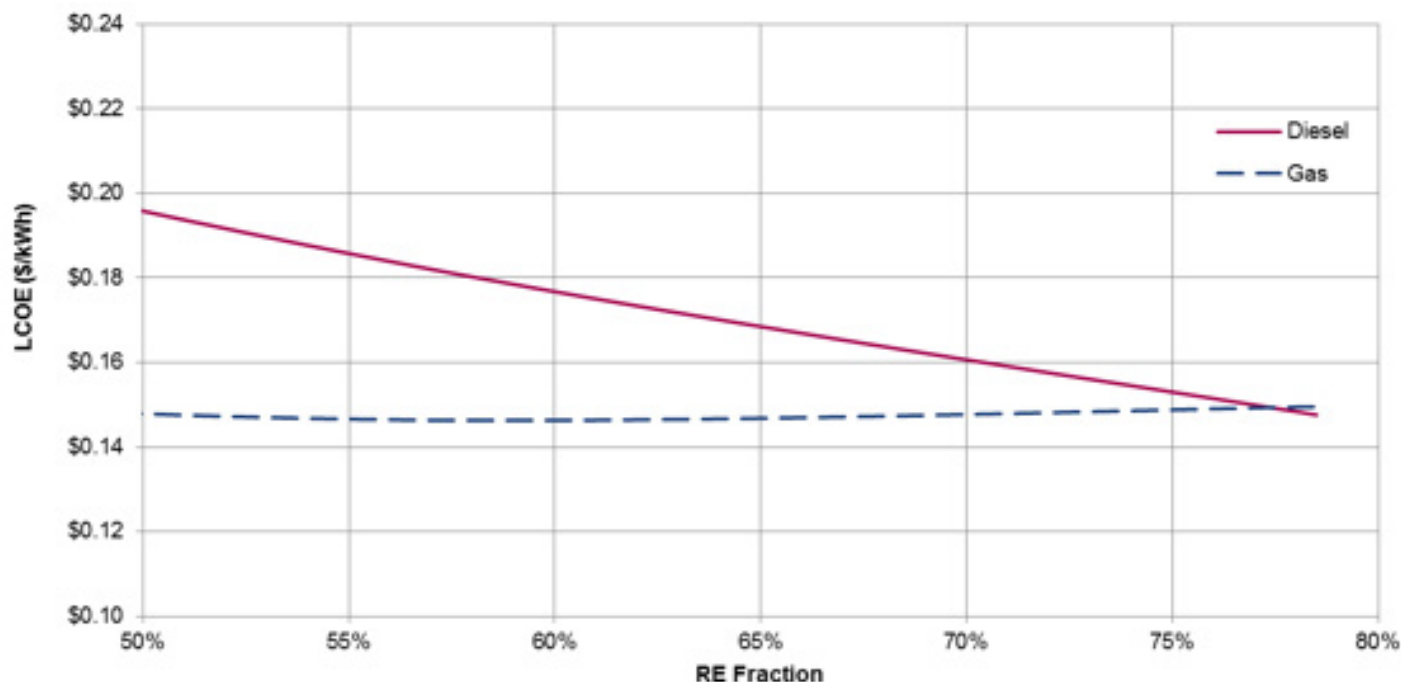


Figure 1: LCOE (diesel v. gas)

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audience the typical load profile of a mine, which tends to be covered quite nicely by daily wind generation, in WA. When the wind is less strong during the day, solar generation can fill a large part of the gap. Still, in order to achieve the 99.8% power reliability which is the standard in the region, the game-changer is battery storage. “You can use the battery as fast-responding spinning reserve to make sure that the gas engines or diesel generation you have onsite can ramp up and down according to the availability of wind, or when you’ve got cloud movement”, said Roth-Deblon.

While gas can certainly be integrated into hybrids as we are showing right now at Agnew Gold, it is more complex than with Diesel gensets, diesel can accept step load changes of 100% within less than a minute, whereas the step load change capabilities are lower on the gas side. “That means that you need to have a much more balanced and forecasted energy production with gas generation than with diesel,” he pointed out. A diesel generator can ramp up within 20 seconds, a reciprocating gas engine within five minutes, and a gas turbine can take up to 15 minutes to ramp up. And while gas is usually more efficient than diesel, the difference between the two becomes marginal at low load.

Adding Battery and Diesel to fill gaps

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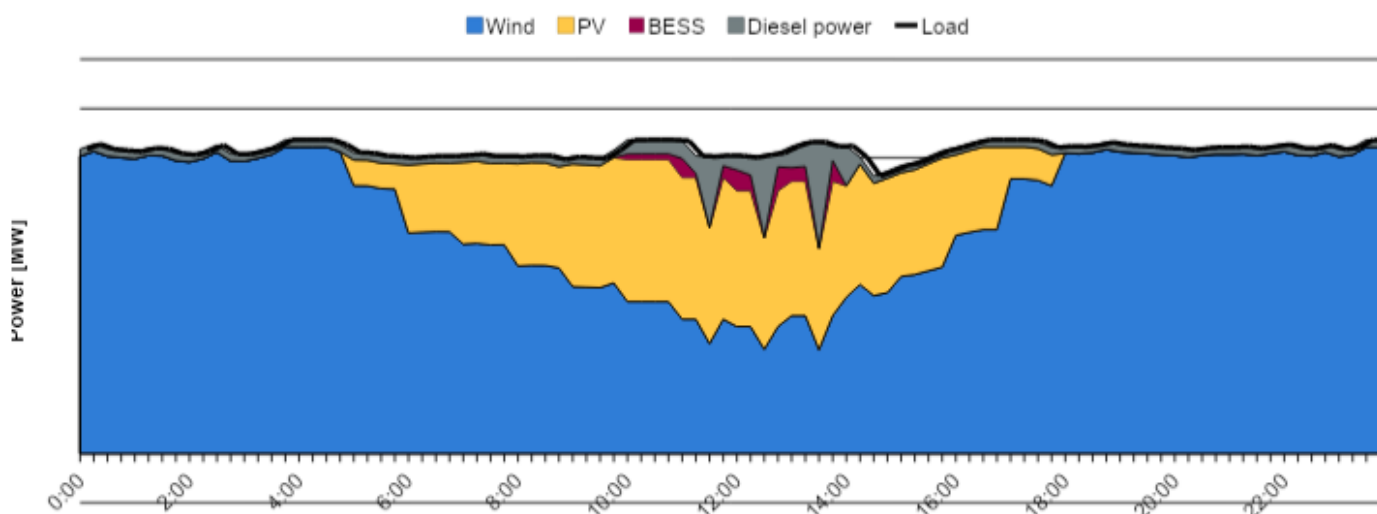


Figure 2: load management data is helping miners to use energy more efficiently

Stephan Hansen,
juwi Renewable
Energy, contributing
to the Summit
discussion





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PRESENTATION**

“By using the battery for spinning reserve, as renewable energy generation decreases, the battery takes over and gives time for the fossil generation to cover the demand,” said Roth-Deblon. With a diesel hybrid + battery storage and 70% renewable integration - something that hasn’t yet been done - you can achieve savings of 80 million liters of diesel a year, along with the equivalent carbon emissions.

However, for this result to be achieved, you also need intelligent data-driven microgrid management. “Thanks to our learnings at DeGrussa and in various other projects, we’ve been able, with our industry partners, to come up with juwi hybrid IQ. Hybrid IQ is an integrated mine site-specific micro-grid control that can deliver reliable 99.8% electricity at a lower cost,” explained Roth-Deblon. The product has been specifically designed for the mining sector, and integrates with mine sites’ energy management systems and optimizes for lower cash operating costs as well as maximum CO2 savings. Adaptable to changing operating requirements, it also provides detailed reporting and analysis, delivering the data digitization longed for by the mining sector.



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focus

Standards and collaboration seen as key to hydrogen development for mines

Over 190 mining leaders and hydrogen developers gathered in Perth, Australia on June 18 to discuss the potential for hydrogen to fill the remaining gaps in the resource sector's path to decarbonization. While the Australian government and industry see great domestic and export opportunities for hydrogen, it's clear that there's a long way ahead before these become a reality. Still, companies' readiness to overcome intellectual property concerns and collaborate as a sector bodes well for the future of H₂.

MELODIE MICHEL
Reporter,
Energy and Mines



Because of its vast renewable energy resources and proximity to growing export markets, Australia has the potential to become a leader in the production of hydrogen as a fuel. Keynote speaker Alannah MacTiernan, Western Australia Minister for Regional Development, Agriculture and Food, pointed out that WA has the highest levels of solar irradiance in the country, as well as some of the greatest potential for wind generation. Taking advantage of existing LNG shipping infrastructure and commercial relations with Asia, Australia could tap into Japanese and Korean hydrogen demand, which is expected to reach 502,000 tons, or A\$2.2bn, by 2030.

While the export of hydrogen is a focus area for the Australian government, mining firms are concentrating on domestic applications — namely for transportation, power generation and processing systems.

First movers

Various miners announced or confirmed initial investments to develop hydrogen technology on their mine sites. Michael Dolan, Hydrogen Innovation and Development Lead at Fortescue Metals Group (FMG), detailed the company's hydrogen ambitions, which are to monitor, use and finance technologies, develop the domestic industry through partnerships, focus on the growth of an integrated hydrogen supply chain for export and use hydrogen to reduce its operations' carbon footprint. In November 2018, FMG entered into a strategic partnership with the Commonwealth Scientific and Industrial Research Organization (CSIRO) to develop and capitalize on an efficient Australian hydrogen economy, including a five-year agreement to fund and support select CSIRO technologies in the hydrogen space.

Meanwhile, BHP also announced investment into hydrogen to reduce scope 1 and 2 emissions in its operations. "We are looking at green hydrogen as a transport fuel, as one of several options that we can use to decarbonize our operations globally, in support of our public target which is net zero emissions by the second half of the century. We see that green hydrogen could be a net zero fuel source that could drive mobility, including haul trucks and other types of heavy mobile equipment, rail and other applications which affect us downstream," said Kathryn Horlin, Principal, Low Emissions Technology, at BHP.



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“Since November last year, the interest from the mining sector has grown exponentially: I have people calling me to know more about the technology, whether they can retrofit existing turbines to cater for hydrogen, what the costs are, etc.”

MATTHEW MARINOVICH,
Sales Leader, Turbomachinery
and Process Solutions,
Australia, BHGE



At Anglo American, there was a realization that by oversizing solar PV applications, there would be a great opportunity to use the extra energy on mobile fleets, either through batteries or via fuel cell vehicles. The miner is now working on a proof of concept to test the full supply chain from solar generation to use in a hybrid fuel cell and battery truck, which they plan to have running on site in 2020. “The cost of storage both on the ground and on the vehicle remains a challenge, and the fact that we actually need to build the supply chain,” noted Jan Klawitter, Head of International Policy at Anglo American.

In South Africa, platinum producer Impala has been working on a fuel cell roadmap for a few years, and Market Development Manager Fahmida Smith shared some of the lessons learned in the process with the attendees. For example, she pointed out that the firm’s prototype fuel cell forklift has been operating for a total of 688 hours, moving three tons of load per operation and reaching 12-16 KW of power capacity. Yet, these 688 hours of operation required no less than 4,026 hours to compress 1,377 metric tons of hydrogen for refueling. Impala invested a total of R1.94mn (A\$200,000) in its



“It’s the chicken
and egg problem:
there is currently no
infrastructure and no
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awareness, because the
technology is ready – and
scale is of the essence,”

KOEN LANGIE,
Head of the
Mining Program,
ENGIE,
Business Unit Hydrogen

Alannah MacTiernan,
Western Australia
Minister for Regional
Development,
Agriculture and Food



refueling station, but believes that switching from diesel to fuel cell vehicles would save it 11% in fuel costs.

“South Africa has 95% of the world’s platinum reserves, and we have a vested interest in hydrogen, especially with changing carbon legislation globally that could potentially threaten the auto catalyst sector or our sales into that sector,” Smith said. “Events like this are important to ensure correct advocacy around hydrogen and fuel cell technology. It’s very interesting and promising for me to see the interest that’s shown by the mining sector in Australia, but also other mining companies into the green hydrogen economy.”

Judging from the interest at the conference, the mining sector has a clear interest in encouraging the development of the hydrogen economy, and these first movers have the advantage of being able to shape the future of this industry — though investment in these early stages is a lot more significant.

Electrifying fleets

“Heavy duty vehicles is the real sweet spot for hydrogen use, since it is very heavy equipment and batteries are not powerful enough



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“We want to find companies that are interested in helping us define and lead this effort.”

JAMIE ALLY,
Chief Technology Officer,
H2U



The Economics and Business Fundamentals of Hydrogen and Mines panel



Louis Kent,
BHP



Attilio Pigneri,
H2U and
Australian
Association
of Hydrogen
Energy

to reach zero emissions on these,” noted Alfred Wong, Managing Director, Asia Pacific at Ballard Power Systems.

Indeed, it appears as though most mining investment into hydrogen is focusing on transportation applications: forklifts, hauling trucks or even staff buses have all been identified as opportunities. Because hydrogen fuel cells have already been installed on long-haul trucks, train or even ships in other industries, miners could benefit for the available technology for their vehicles – with the caveat that traditional mining original equipment manufacturers (OEMs) have not started producing them.

“It’s the chicken and egg problem: there is currently no infrastructure and no trucks, but it is just about awareness, because the technology is ready – and scale is of the essence,” said Koen Langie, Head of the Mining Program at Engie. In response, Anglo American’s Klawitter noted that everywhere where a hydrogen economy has been developed, the chicken and egg issue also existed. “The beauty of the



Michael Dolan, FMG

opportunity in mining is that you have the opportunity to deploy in a few trucks the entire fuel cell capacity of California. You can do it at the same time and place, and at scale,” he added.

While some miners would like to see more collaboration from OEMs to develop the fuel cell vehicles they need, others (like Anglo American) are building their own prototype vehicles, bypassing OEMs completely. Still, building a reliable supply chain and overcoming safety concerns will require collaboration and the sharing of information that many are not willing to disclose as they hope to maintain their first-mover advantage.

Hydrogen to power operations

In power systems, most of the interest in adding hydrogen to hybrid plants is in remote operations, according to Warner Priest, Head of Emerging Technologies at Siemens. “However, when the mine is very remote, bringing a virtual pipeline for hydrogen will drive the cost up,



“We see that green hydrogen could be a net zero fuel source that could drive mobility, including haul trucks and other types of heavy mobile equipment”

KATHRYN HORLIN,
Principal,
Low Emissions
Technology, BHP

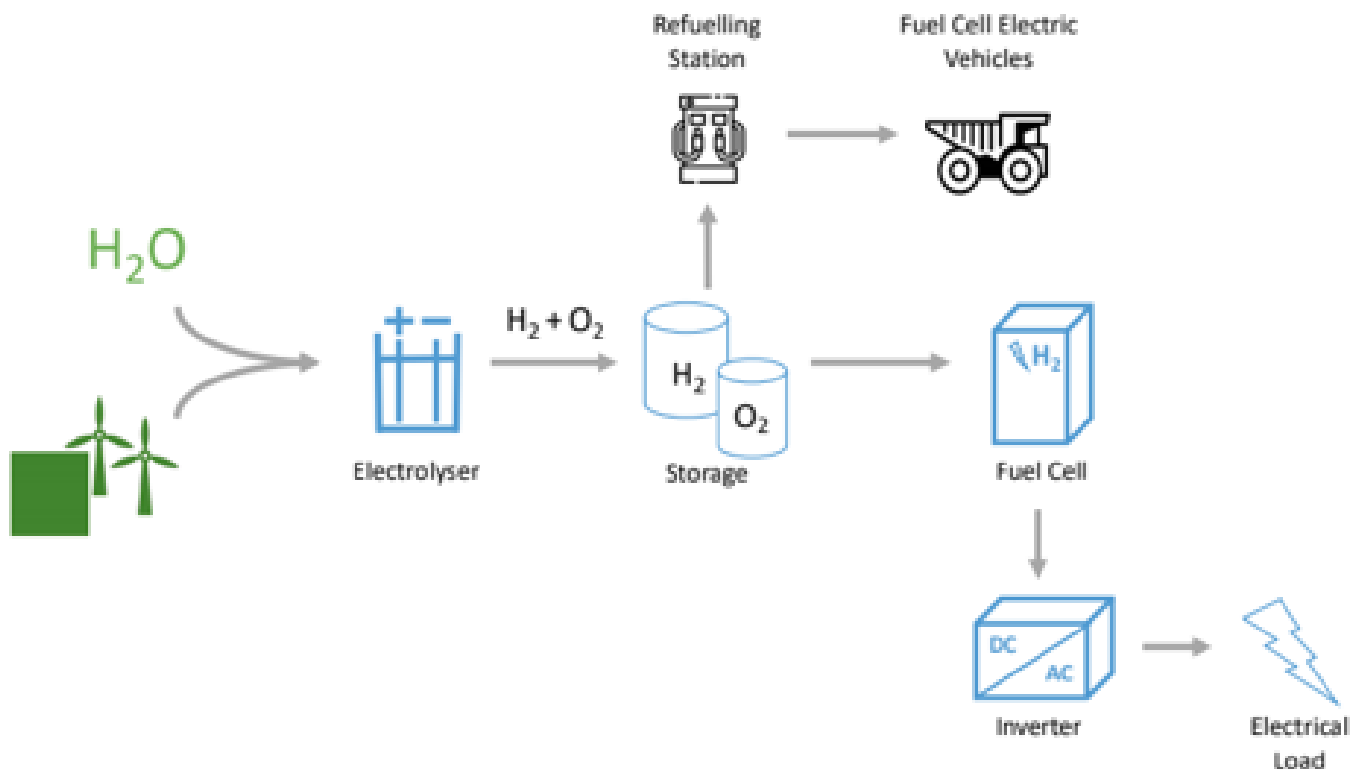
so it may be worth producing the fuel on site,” he added. Siemens estimated that a hybrid solar and wind power system, spills about 15% of renewable energy per year – energy that could be used to produce hydrogen through electrolyzers. Adding hydrogen to a hybrid power plant could bring the renewable share of energy over the 70% mark and reduce diesel consumption to below 20 million liters a year. However, today, the Capex required for this type of power plant is estimated around A\$153mn, compared to A\$135mn for a hybrid wind + solar plant, and A\$90mn for a solar-only hybrid plant.

Another hydrogen power application relevant to the mining sector is the 100% hydrogen gas turbine being developed by BHGE for H2U, the hydrogen utility. The pilot project is focusing on the production of green ammonia to be distributed to farms in South Australia, but there could be much more direct applications for the mining sector. “The basic premise is you take renewable power off the grid, put that through an electrolyzer, produce hydrogen and then put that into one of our gas turbines during periods of interruption of power or of very high prices from the grid,” said Matthew Marinovich, Sales Leader, Turbomachinery and Process Solutions, Australia, at BHGE. “Since November last year, the interest from the mining sector has grown exponentially: I have people calling me to know more about the technology, whether they can retrofit existing turbines to cater for hydrogen, what the costs are, etc. The level of inquiry has gone from very high level to a more detailed analysis on the efficiency of the turbine, the footprint and the layout,” he added.

Interestingly, Marinovich pointed out that existing miners wouldn’t need to buy new gas turbines to start using hydrogen: a few adjustments in valves and leak detection technology would be enough to incorporate up to 30% hydrogen.

High-purity manganese producer Pilbara Metals Group is one miner looking at transitioning from natural gas to hydrogen to power its operations. “Because we’re producing a product that is going into the renewable economy, we want to make sure our process is as green as possible and has a low impact on the environment,” explained Annette Crabbe, Executive Director. “When we first invented the process it actually used coal, and we’ve now taken that out and are using natural gas, but the whole point of coming to the hydrogen conference was

H₂ in Mining



Source: www.flatiron.com

Figure 1: MacTiernan presentation page 11

to try and see what other energy sources we could put in place to try and eliminate that natural gas.”

Other potential applications for hydrogen revolve around the production of green ammonia for leaching, thermal applications and methanation, the conversion of carbon oxides and hydrogen into methane and water, to achieve CO₂ reduction.

Cost reduction and standardization

Despite all the enthusiasm around hydrogen applications for mines, everyone involved recognizes that the costs of producing green hydrogen need to come down for it to become a viable alternative energy source.

Gordon Weiss,
of Energetics
addresses the
packed room at
Hydrogen and
Mines



Electrolyzer prices have already come down dramatically, and this trend is expected to continue at least until 2025, reaching US\$15/GJ, according to Sophie Liu of Bloomberg New Energy Finance. Still, producing hydrogen from renewable sources remains a very costly enterprise, around US\$35-41/GJ.

Until scale and uptake force prices down, government support is essential. “It is a mature technology — we’ve been delivering them as fuel cells into submarines since 1995 and there’s very little room for improvement. It’s all about scale and market uptake. This will bring down prices, and this is where organizations like ARENA [the Australian Renewable Energy Agency] play a very important role: they will help to make this technology commercial here in Australia, as they’ve done with solar,” Siemens’ Priest pointed out.

Additionally, miners are hoping for the adoption of safety standards in Australia, detailing the correct ways of producing, transporting and using hydrogen. The good news is the government is proactively looking at standards as a way to encourage the development of the domestic hydrogen economy. Emelia Addo, Stakeholder Engagement Manager at Standards Australia, announced the creation of a hydrogen committee mirroring the various committees of the International Standards Organization (ISO). “The international space has already charted the way and there are standards already existing in the safety, transport and production space that are ready for adoption and use. What’s left is for Australia to look at adopting them,” she said.

Ultimately, collaboration will be key to the development of the hydrogen sector, and miners appear ready for it. Pilbara Metals’ Crabbe, who chaired a panel at the conference, noted the keen interest for collaboration around the room. “Being able to have a larger voice in the conference has led to a lot of networking for us, so there’s a lot of potential now to work with other organizations. That’s a huge takeaway from the hydrogen conference: organizations now want to collaborate and not just hold on to their intellectual property. We will now go and meet with these companies and hopefully we can come up with some pilot projects to put in hydrogen either into our future mines or in our existing processing plant,” she said.

The day ended on a high note for future collaboration, with the launch of an international hydrogen and mining program by H2U, in conjunction with the International Energy Agency Hydrogen Technology Cooperation Program (IEA H2). The program is currently focusing on five themes: technology, applications, value-adding, operating environment, and commercialization. Jamie Ally, Chief Technology Officer at H2U, encouraged the audience to get in touch to express interest, with the goal of forming a steering committee and begin work by the end of 2019. “We want to find companies that are interested in helping us define and lead this effort. It’s going to be a pay-to-play kind of setup, but there will be a very good leverage opportunity because not only will you be co-invested with other mining companies, but also with the government,” he said. The program will apply for funding from National Energy Resources Australia (NERA) in order to start work in November 2019, but hopes to become a self-sustaining entity responsible for the collaboration longed for by all mining and hydrogen stakeholders.



“Being able to have a larger voice in the conference has led to a lot of networking for us, so there’s a lot of potential now to work with other organizations. That’s a huge takeaway from the conference”

ANNETTE CRABBE,
Executive Director,
Pilbara Metals

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