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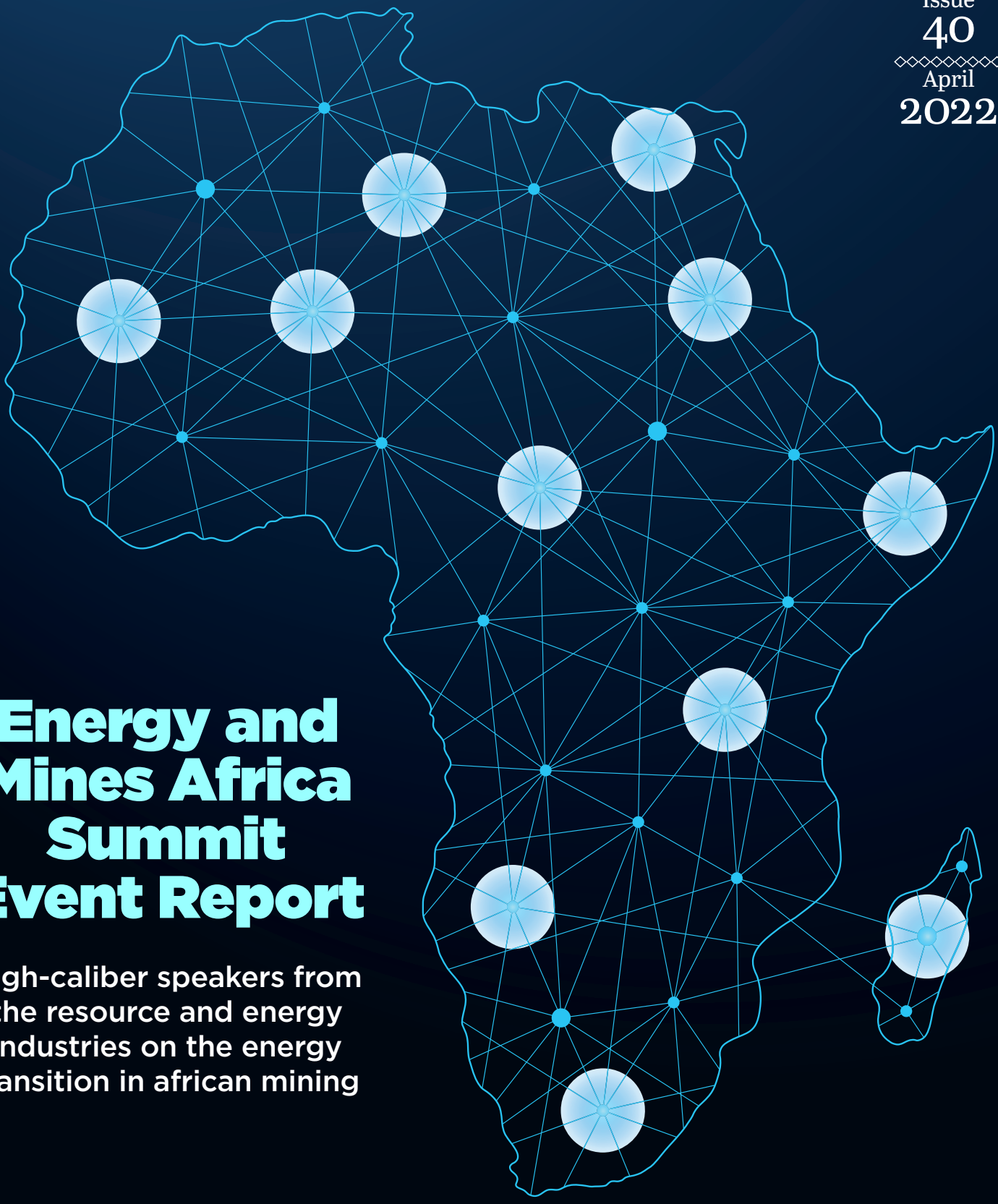

Energy and Mines Africa Summit Event Report

High-caliber speakers from the resource and energy industries on the energy transition in african mining

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Introduction

Mining's energy transition is well underway in Africa with major and mid-tier mines integrating utility-scale and hybrid renewable energy solutions to address energy, climate and ESG goals.

With increased urgency to decarbonise power in line with 2030 and 2050 carbon targets, mining companies are being challenged to identify the optimal pathways to realize energy cost and carbon footprint goals as well as integrate power strategies with decarbonising plans for mobile equipment and trucks.

The Energy and Mines Africa Virtual Summit, February 22-23, provided a valuable opportunity for African mining experts to benchmark their decarbonisation strategies against their peers and for independent power producers, finance and low-carbon solution providers to understand the needs of mining companies.

Delivered over two days with 40+ high-caliber speakers and 300+ participants from mining and energy, the event featured content pods on:

Pod 1: Decarbonising Power for African Mines

Pod 2: Meeting ESG and Climate Goals with Hybrid Solutions

Pod 3: Utility-Scale Renewables and Storage for South African Mines

Pod 4: Green Hydrogen and Mining

POD 1 : Decarbonising Power for African Mines


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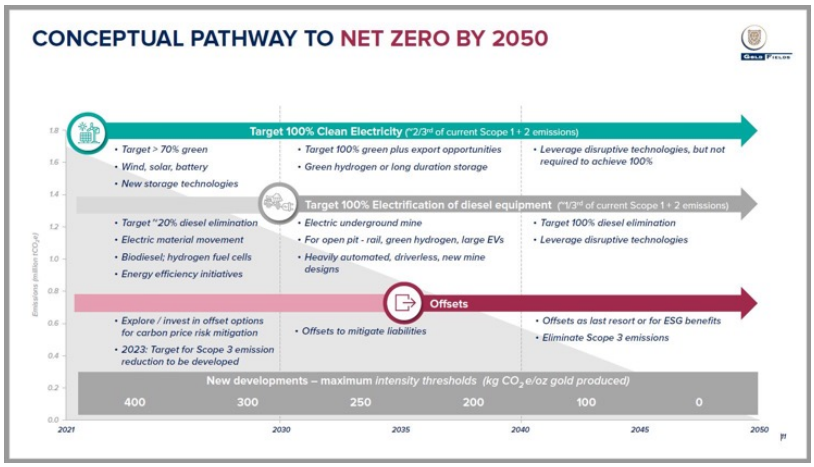
OPENING KEYNOTE: ESG, CLIMATE AND ENERGY PRIORITIES

Chris Griffith, CEO, **Gold Fields**

Gold Fields Group is a globally diversified gold miner with nine mines across five countries.



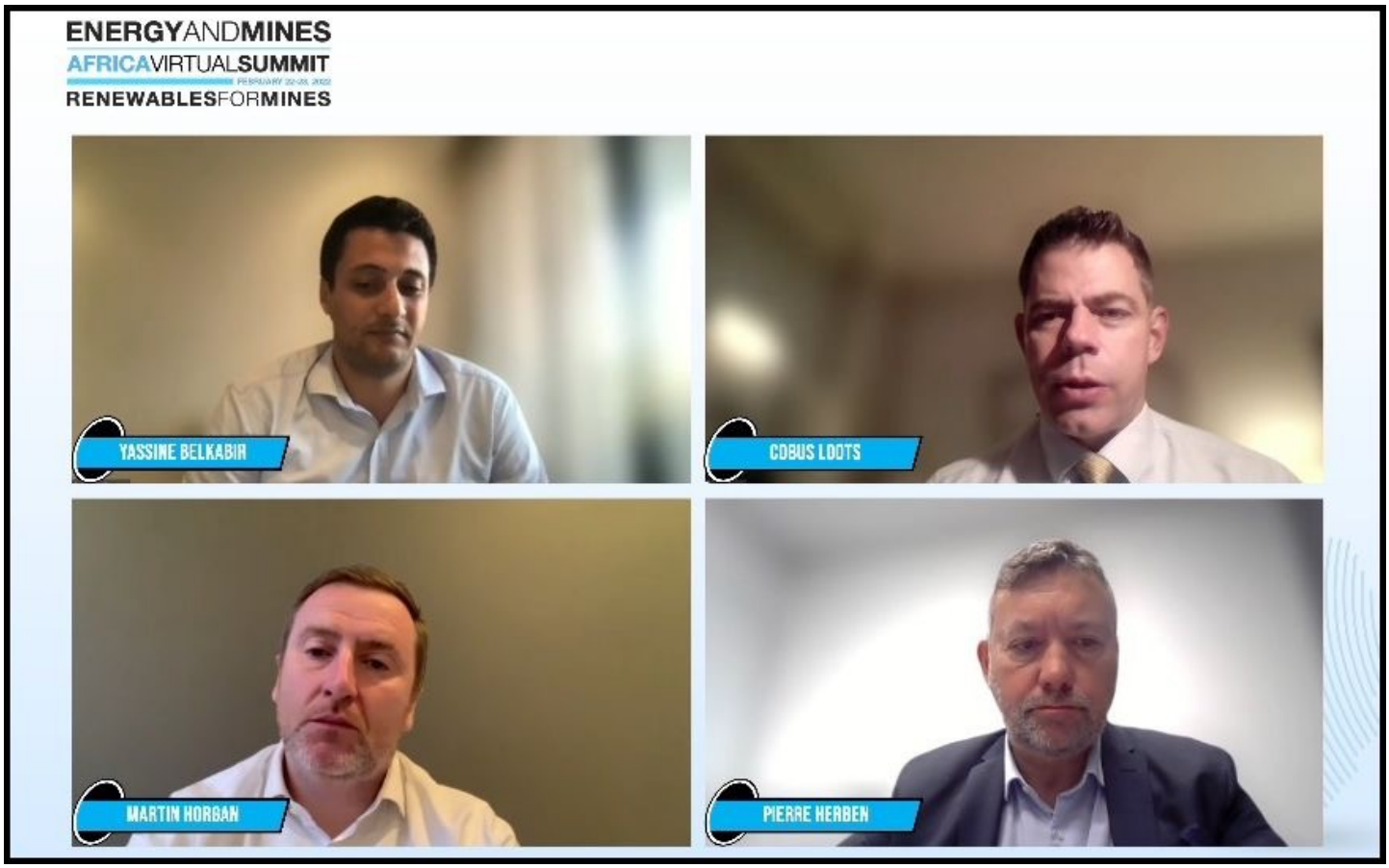
Gold Fields' emission reduction journey commenced in 2016.

The company is targeting 50% absolute emission and 30% net emission reductions from 2016 baseline (Scope 1 and 2) and net zero by 2050.

Initiatives include the integration of decarbonisation into business strategy, processes, and capital programmes; investment in renewables; and a reduction in the use of fuels.

Up to 80% of gold mining emissions are Scope 1 and Scope 2.

"For the next few years our focus will be on replacing our gas and coal fired electricity with renewables," said Mr Griffith.



KEYNOTE PANEL: DECARBONISING ENERGY, ESG AND CLIMATE GOALS FOR AFRICAN MINES

Chair: Yassine Belkabir, Managing Director, **AB Mining Consultants**
Cobus Loots, CEO, **Pan African Resources**
Martin Horgan, CEO, **Centamin**
Pierre Herben, Group Head of Carbon Neutrality, **Anglo American**

Yassine Belkabir, chairing the keynote, set the tone for a stimulating and illuminating discussion with his remark that decarbonisation had been ranked among the top three business opportunities facing mining businesses in 2022.

"Decarbonisation could be ranked as a business's structure impacting strategy and operations," he said.

This view was echoed by Martin Horgan who revealed that Centamin, in the course of a "reset and reinvestment" of its mining assets, had defined ESG and decarbonisation as an integral part of the new corporate framework devised for the company.

"What we're actually realising and recognising now is that a number of these initiatives make sense from a decarbonisation perspective, but also

make huge business sense," Horgan commented.

Centamin's 36 MW solar plant, to be built at a capital cost of $36 million, has a three-year payback given the current diesel prices.

Meanwhile, Anglo American had adopted an "ecosystemic approach" in its strategy for carbon neutrality, said Pierre Herben. Based on connecting its disparate sites, tapping the best resources available, and in sync with the grid operator, the company will use several levers to achieve a truly renewable ecosystem.

These include renewable energy, a reduction in emissions, energy storage, hydrogen for mobility, and carbon negative activities.

Cobus Loots gave valuable insights into Pan African's decarbonisation journey, stressing that miners needed to start early to complete studies and feasibility analysis, select the right technology and transaction structure, assess physical positioning, and understand permitting requirements.

Also: Pick the right partner.

"So we've partnered with juwi, following an EPC contract on our initial site, and the relationship has been an excellent one, I have to say so, over the experience of practically implementing these projects in South Africa," Loots advised.

CEO Horgan seconded that.

"We want to focus on mining gold as efficiently and as cheaply as possible," he commented. "And therefore the ability to outsource that to a mature and experienced partner means that we can get on with our job, allow them to do that for us, as well."

At Pan African, efficiency of operations was another focus area. "Can we reduce the amount of energy we need to actually use and I think that obviously is an important part of that decarbonisation process."

How are investors reacting to ESG initiatives by mining companies?

Loots said Pan African had seen a huge interest in ESG from investors over the past three or four years. "Somebody said if you're not compliant, or if you can't demonstrate clear progress, then you become simply uninvestable for certainly a number of the large funds."

"At Pan African we say we are mining for a future. So if you want to succeed in that you need to certainly have your ESG strategy and importantly, your move to a more carbon friendly situation - you have to have that clearly mapped out."

Horgan said that ESG targets and decarbonisation had become key metrics for executive remuneration. "Cobus's point - we won't invest in you is the ultimate, you know, sort of leverage that they have is that we just won't buy your stock."

KEYNOTE: B2GOLD: AN INDUSTRY LEADER IN RENEWABLE ENERGY FOR MINING IN AFRICA

Clive Johnson, President and CEO, **B2Gold**

B2Gold has three operating gold mines and numerous development and exploration projects in various countries including Mali, the Philippines, Namibia, Colombia, Finland and Uzbekistan.

Since 2018, at the Otjikoto Mine in Namibia, B2Gold has been operating the world's first autonomous hybrid solar/HFO power plant.

Each year, the Otjikoto 6 MW solar power plant generates 13 GWh of electricity, reducing HFO consumption by 2.8 M litres and eliminating approx. 9 K tonnes of CO2 equivalent emissions.

At its Fekola Mine in Mali, the company has constructed one of the largest off-grid hybrid solar/HFO power plants in the world, generating 47.2 GWh of electricity in 2021.

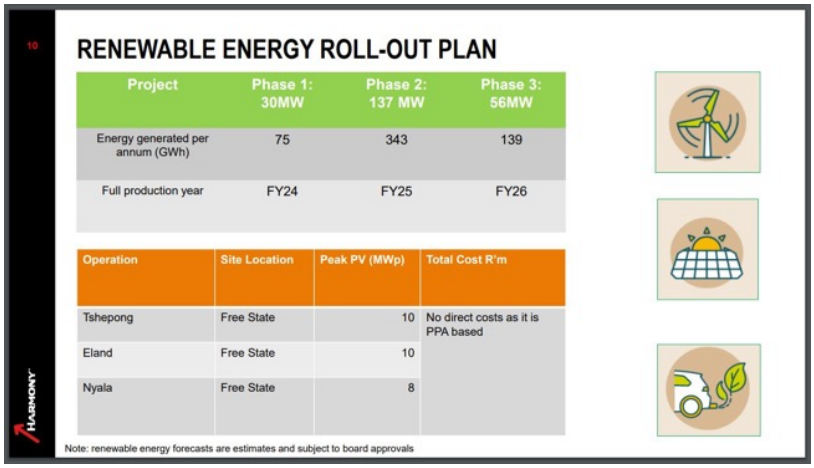
"As a company we will continue to be an industry leader in renewable energies for our mines and sustainability," said Mr Johnson.

"I believe there is great opportunity here for the mining industry to talk about how successful we have been during Covid in continuing responsible mining," he added. "This is an opportunity to showcase what we are able to do in very a challenging time to ensure that we continue to support the countries where we mine."

KEYNOTE: MINING AND RENEWABLES: BUILDING A ROADMAP TO DECARBONISATION

Peter Steenkamp, CEO, **Harmony Gold Mining Company**

Harmony, a gold mining and exploration company with a copper footprint, operates in South Africa and Papua New Guinea, one of the world's premier new gold-copper regions.



With more than 70 years in the industry, Harmony is the largest gold producer by volume in South Africa where the company is also a significant operator of gold tailings retreatment facilities.

"With hydro power already in use in PNG, we have an exciting and comprehensive renewable energy roll out plan in place in South Africa to reduce our reliance on coal-based energy," says Steenkamp.

About 84% of the company's South African emissions are attributable to energy purchased from state utility Eskom.

Harmony's strategy to achieve operational excellence generates "cash certainty" and the capital to use for various projects including renewable energy.

"I believe that corporate climate leadership is a means to take positive actions and to create value," said Steenkamp.

ADVANCING CARBON FOOTPRINT GOALS WITH LOW-EMISSIONS TECHNOLOGY

Alex Pickard, Vice President Corporate Development, **Ivanhoe Mines**
Olivier Binyingo, Vice President, Public Affairs DRC, **Ivanhoe Mines**
Jasmine Abrahams, Group Manager - Sustainability, **Ivanhoe Mines**

Ivanhoe Mines is a Canadian mining company executing on three joint-venture projects in Southern Africa: the development of major new, mechanized, underground mines at the Kamoa-Kakula copper discoveries in the DRC and at the Platreef palladium-platinum-nickel-copper-rhodium-gold discovery in South Africa; and the redevelopment and upgrading of the Kipushi zinc-copper-germanium-silver mine, also in the DRC.

Kamoa-Kakula began producing copper in May 2021 and, through phased expansions, is positioned to become one of the world's largest copper producers. Kamoa-Kakula and Kipushi will be powered by clean, renewable hydro-generated electricity and will be among the world's lowest greenhouse gas emitters per unit of metal produced.

It also helps that the three mines are blessed with very high grades, much higher grades than typically found elsewhere in the mining industry.

"This means that for every unit of

copper that we produce, it requires 10 times less energy in terms of digging and transporting rock to a processing facility," says Pickard. "And also in terms of crushing and beneficiating that rock into a usable copper product."

Pickard also stresses the advantage of being "a brand new mining company."

"We have an advantage that we can look at things completely differently to everybody else in the industry. So when it comes to building a mine of the future, a mine with a lower environmental footprint that has lasting benefits for all of its communities, we can design for that from day one."

Ivanhoe's projects in the DRC have access to renewable hydro power through a strategic partnership with La Société National d' Électricité (SNEL), a state-owned power utility.

In South Africa, however, Ivanhoe's Platreef operation is reliant on predominantly coal fired grid power. The company is looking to pivot to a 24-hour solar supply including grid scale battery storage.

Says Pickard: "From day one at Platreef, we will be using battery electric underground equipment instead of diesel powered underground equipment. So that's much cleaner emissions free technology. And in order to charge the batteries on this new battery electric fleet, we will be installing a smaller scale solar farm on surface so that from day one, at least from an underground point of view, we are operating on a net zero basis."

LOWERING MINING'S ENERGY COSTS AND REALIZING ESG GOALS

Peter Drager, Head of Development - Hybrid and Offgrid - EMEA, **juwi Renewable Energies**

Founded in 1996, the juwi group focuses on the planning, construction and operation of wind farms in Germany and on utility-scale solar energy projects in the United States, the Middle East, South Africa as well as South-East Asia and Australia.

Since 2014, juwi has dedicated a team to the deployment of hybrid power systems for the mining industry, primarily in Australia and Africa.

Why is the clean technology market and energy transition relevant for mining operations and why is the uptake of renewables now occurring at such a high rate?

Drager observes that more and more company boards are committing to ESG, driven by expectations from various stakeholders.

Further, favorable regulatory changes for grid-connected projects; rising costs and unreliability of conventional energy supply systems; and the decline in costs of

renewable energy and battery storage have all combined as motivating factors.

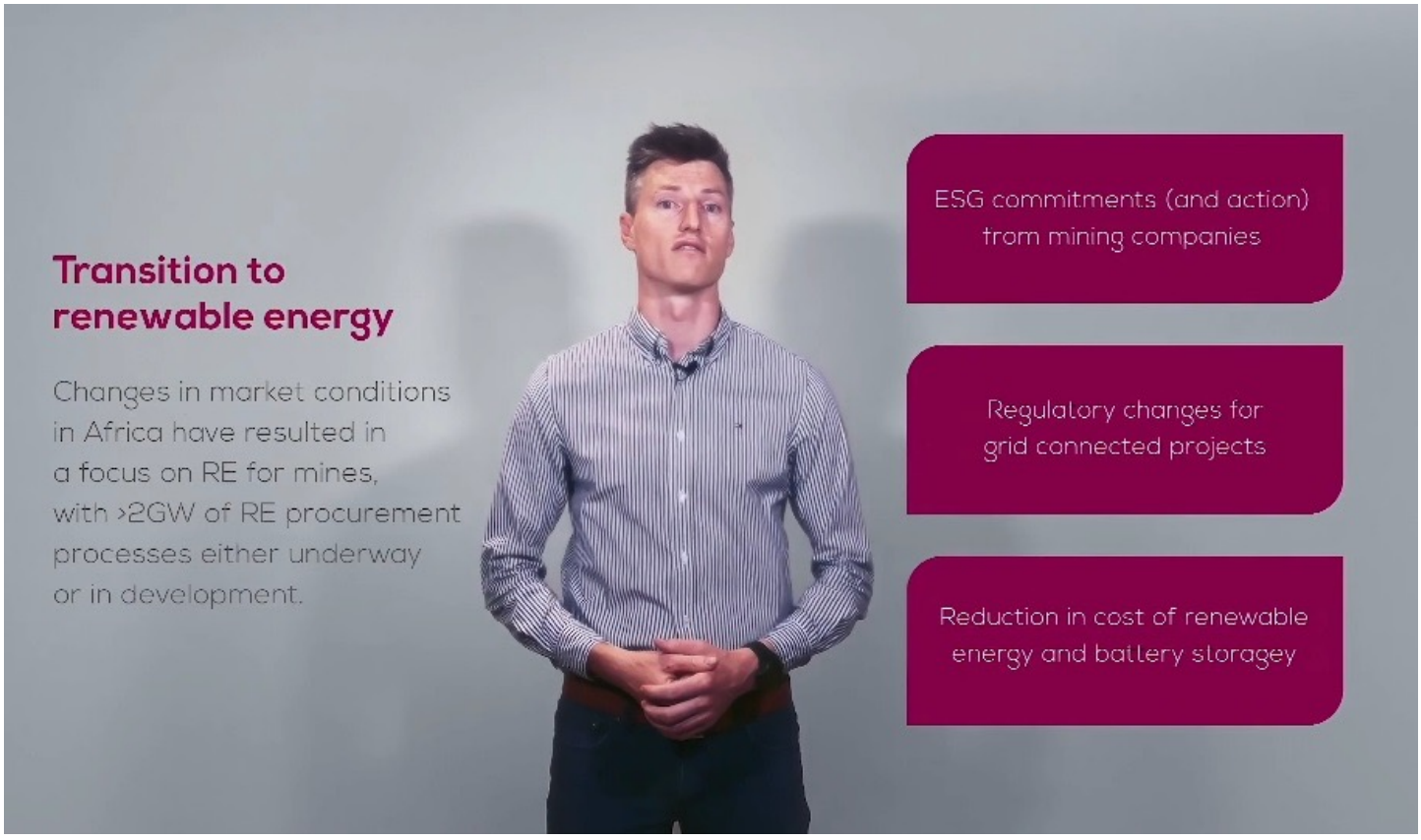
On the other hand, mines will be required to address the rising demand from the clean tech industry for minerals and metals including copper, nickel, lithium, zinc and graphite.

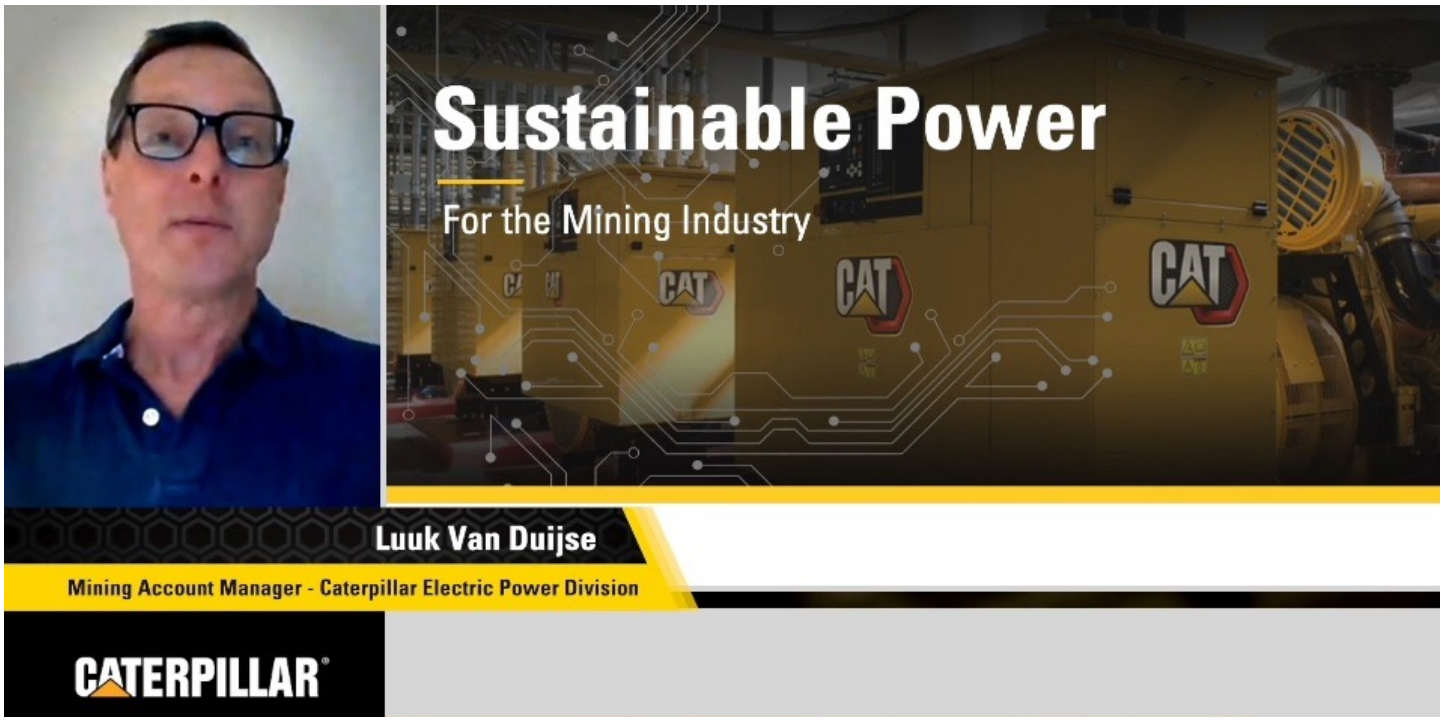
"The demand for copper in this space is forecast to double between now and 2040, at which time it will make up 40% of the overall market for copper."

Clearly, mines need to step up their decarbonisation efforts, and power generation is a low hanging fruit.

Current advantages for going that route: "Renewable energy can not only reduce production costs and carbon intensity, but also improve grid reliability and energy security," says Drager.

Solutions for mines include onsite renewable energy and battery storage; offsite renewable energy such as wheeling arrangements; adoption of energy-efficient mining technologies; and smart load management technology to manage the renewable energy configuration.





SUSTAINABLE POWER FOR THE MINING INDUSTRY

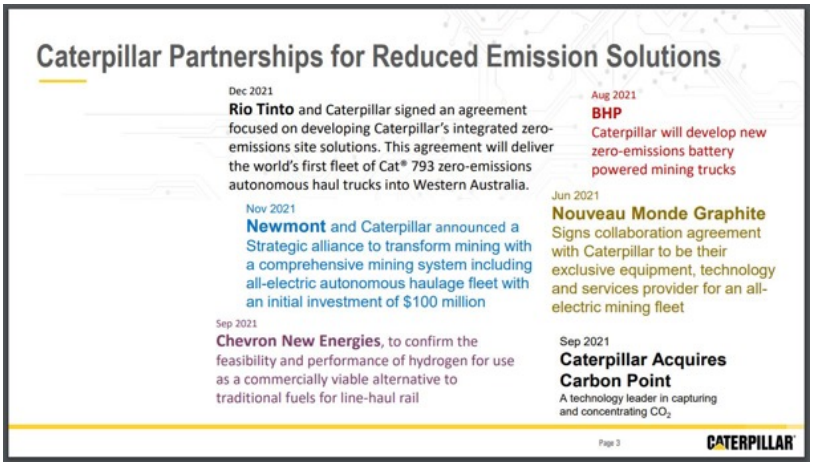
Luuk van Duijse, Mining Account Manager, Electric Power Division, **Caterpillar**

Caterpillar is the world's leading manufacturer of construction and mining equipment, off-highway diesel and natural gas engines, industrial gas turbines and diesel-electric locomotives.

Luuk van Duijse gives an overview of the company's products and partnerships that help the mining industry achieve a reduction in emissions. Tie-ups with major miners, particularly for haul trucks, include Rio Tinto, BHP, and Newmont.

Environment-friendly products from the company's Electric Power Division for the mining industry include gensets, solar solutions, energy storage, controls and remote monitoring systems.

On hydrogen: Duijse said Caterpillar has been building gas-fired gensets for the past many years. A large number of those have been running with a blend of gases including hydrogen up to 80%. These have proved operationally robust, and have set the stage for the next step - 100% hydrogen specialized gensets.



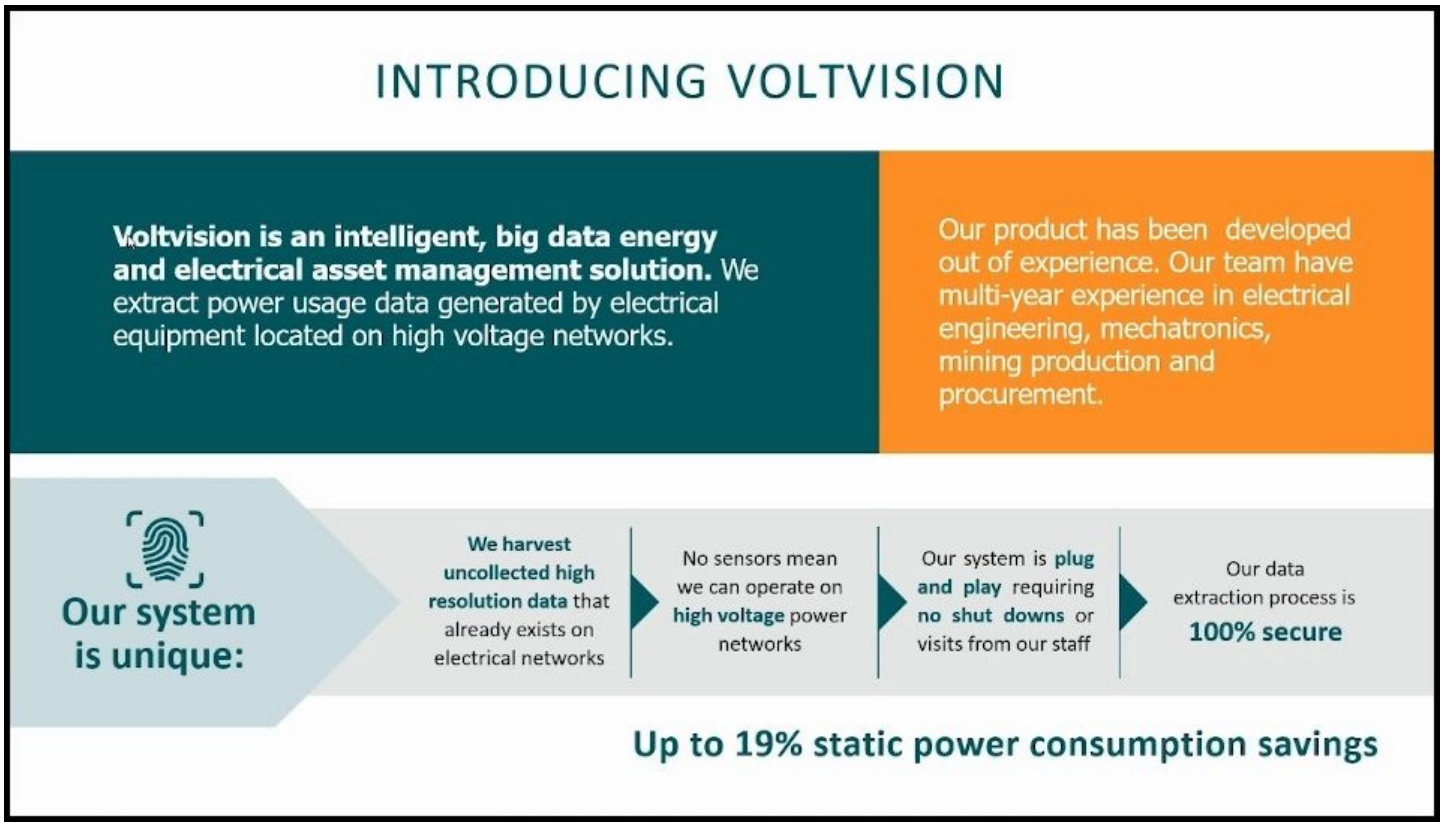
FINANCIAL IMPLICATIONS FOR THE NET-ZERO JOURNEY

Dominic Goncalves, Senior Associate – Decarbonisation Solutions, **Cresco Group**

Cresco is an Africa-based financial advisory specializing in feasibility and financing for the mining industry. Since 2014, the firm has advised on more than 200 captive power bids for more than 20 African mines.

Cresco presents on developing a strategy for 100% power decarbonisation and the pathways to net zero mining. Corporates can progress on their decarbonisation targets in a structured "realistic" manner – taking lessons learnt and improving on likelihood of success.

"Solar and wind have become in many cases the cheapest form of bulk power," says Goncalves. "As such it has become cheaper to start decarbonising than to not."



TO MEASURE IS TO MANAGE: QUICK CARBON AND ENERGY SAVING OPPORTUNITIES

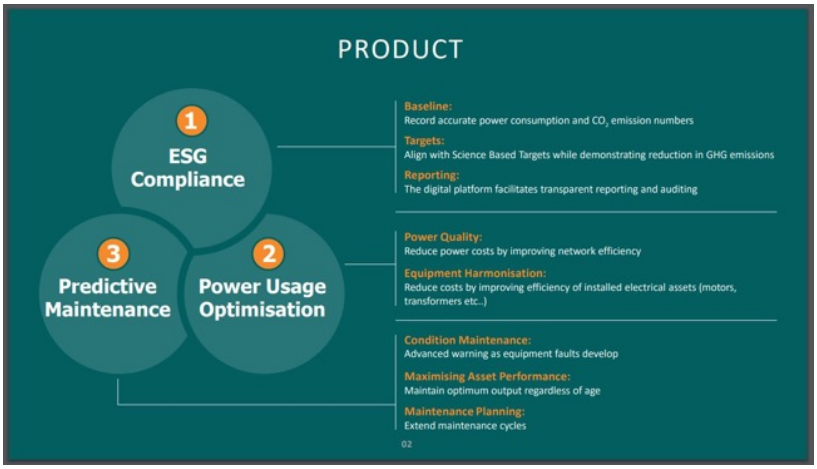
Manoli Yannaghas, Managing Director, **Voltvision**

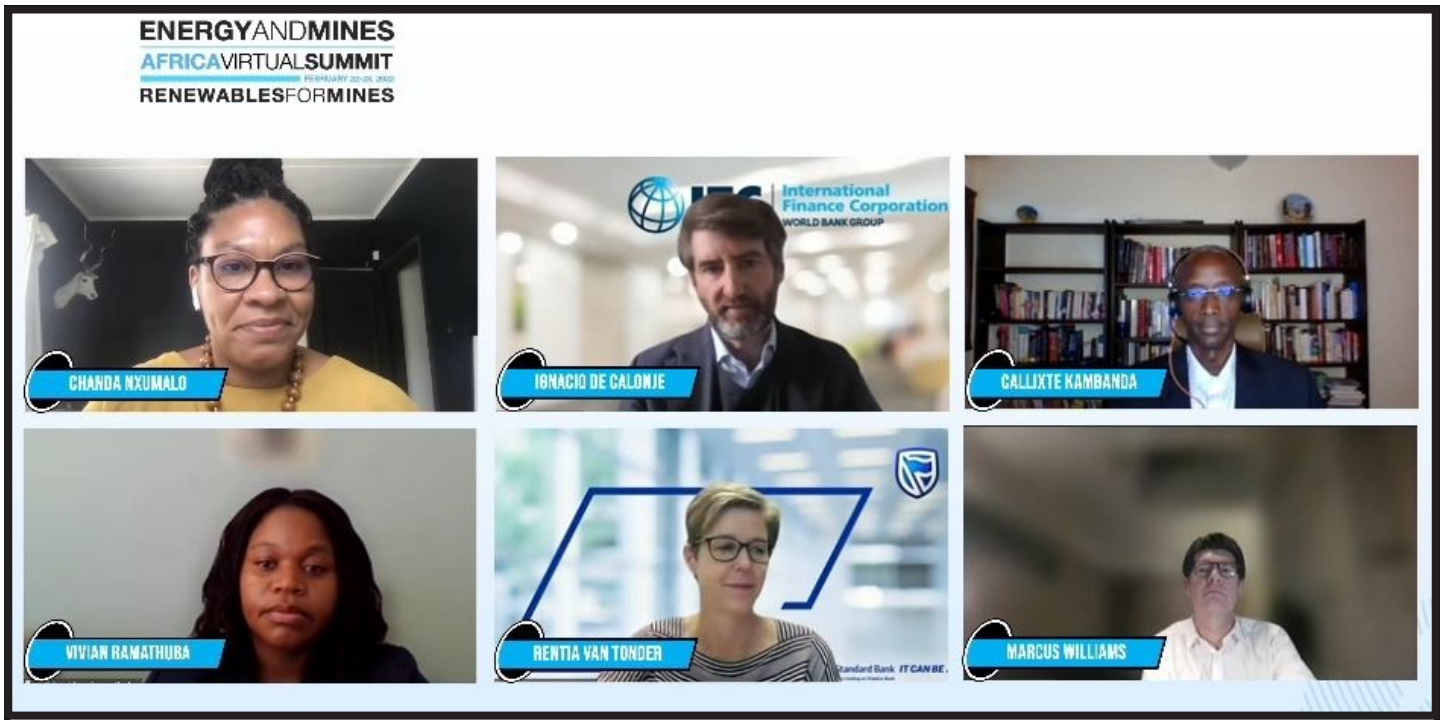
UK-based Voltvision's "plug and play" system extracts power usage data generated by electrical equipment located on high voltage networks, without requiring multiple sensor installation.

The data is highly useful for a mine's ESG compliance, power usage optimisation, and predictive maintenance.

Unsurprisingly, Yannaghas asserts that "data is power."

Voltvision is providing all the data analytics for a 3.5 MW prototype hydrogen electrolyser being built at Anglo American's Mogalakwena mine and processing complex in South Africa.





FINANCING NET-ZERO MINING

Chair: Chanda Nxumalo, Vice Chairperson, **SAPVIA**
Ignacio de Calonje, Chief Investment Officer, **International Finance Corporation (IFC)**
Callixte Kambanda, Infrastructure Specialist, **African Development Bank**
Vivian Ramathuba, Senior Professional, **New Development Bank (NDB)**
Rentia van Tonder, Head: Power, Corporate & Investment Banking, **Standard Bank**
Marcus Williams, Global Head and Sector Manager – Energy and Extractive Industries, **The World Bank Group**

This panel discussion offered valuable insight into a key question facing mining companies embarking on carbon neutrality: How do we access the financing, potentially in the hundreds of billions of dollars, that's required for long term, deep decarbonisation?

Another key concern for miners is the increasingly hostile investing environment they face. According to an FT report, over 1100 investors have pledged to remove fossil fuels from their portfolios by 2030. That's up from about 180 in 2014.

But are mining companies committed to decarbonisation? Yes, according to Ignacio de Calonje. "I think the good message is, as was said previously by a number of CEOs, the mining industry has taken this to heart and is at the forefront of change. Amongst all the industries I think the mining industry is really out there in terms of leading the pack."

So the starting point for sourcing and attracting capital as the mining company

pivots to renewables is its decarbonisation strategy, according to Ramathuba. That plan would determine the funding strategy, including questions such as to whether the project would implement "on balance sheet" or take the IPP route.

Also relevant is the stage of the project - some financial institutions are happy to participate in early stage project development; others at a more advanced, "bankable" point.

"I think most of the projects that we've seen mining houses are actually inviting the independent power producer to participate," observed Ramathuba. So current financing trends skew more towards the latter stage, she added.

The risks that banks and financial institutions face around renewable mining projects include life of mine, offtake risk, technology, and regulatory action. According to Rentia Van Tonder. Another challenge is the "stop-start" nature of these projects, particularly in the context of a long-term financing commitment.

De Calonje also highlighted that from a credit committee perspective, the termination risk in some corporate PPAs was top-of-mind.

On regulatory risk, Marcus Williams said the World Bank was working on a stability cover that would allow investors to go in with a reasonable expectation of the regulatory environment.

However, on a brighter note, Van Tonder revealed an encouraging trend: "We've seen more and more ESG money coming to the fore. And I think to that extent, financiers are actually competing for many of these projects. I do like to believe that the challenges are actually becoming less significant as we move forward to bring more of these opportunities to the full."

Van Tonder also emphasised that Standard Bank proactively supports clients in the energy transition, and has set up a sustainable finance unit within its investment banking team for this purpose.

These sentiments were echoed by Ignacio de Calonje: IFC has put together a climate advisory team to assist mines with net-zero ambitions. It has also set up the Climate Smart Mining initiative in collaboration with the World Bank, Anglo American and Rio Tinto to assist the mining industry in planning out the net zero pathway. The bank also stood ready to translate these moves into financing, de Calonje said.

What are the key considerations for financing assets such as greenfield mines and requests from smaller, less established houses?

Callixte Kambanda stressed that for the African Development Bank the paramount concern was the developmental impact of the project given (a) the rising demand for energy projected in Africa, and (b) the crucial role that mines will play in supplying metals and minerals required for the energy transition.

Other crucial factors for ADB include the project's impact on greenhouse gas emissions, the mine's projected energy requirements, and the overall bankability of the proposal.

POD 2 : Meeting ESG and Climate Goals with Hybrid Solutions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GAS-TO-POWER AND HYBRID SOLUTIONS FOR MINES

Alex Marshall, Group Director, **Clarke Energy**

Clarke Energy has supplied and installed over 7.4 gigawatts of power generation and energy storage equipment globally. Operating in 29 countries and employing 1,300 people, the company specializes in the engineering, installation and maintenance of gas fuel power plants and other distributed energy resources.

Clarke Energy has installed over 700 MW of power generation in Africa, where it has operated for 25 years.

Its environmentally friendly solutions for the mining industry include displacement of diesel generators; high efficiency combined heat and power generation; renewable power sourced from biogas, biomethane and hydrogen; grid balancing stations; and battery energy storage systems supporting micro grids.

Marshall observed that carbon reduction could also enhance business profitability. "On a basic level an industrial customer in Nigeria can switch from diesel fuel power generation to natural gas fuel generation and pay off the capital expenditure within a two to three year period on fuel cost savings alone," he said.

At the Abakaliki mining site in Nigeria, which was awaiting the connection of pipeline gas, Clarke demonstrated a compressed natural gas solution for the interim.

Clarke Energy's expertise can be valuable

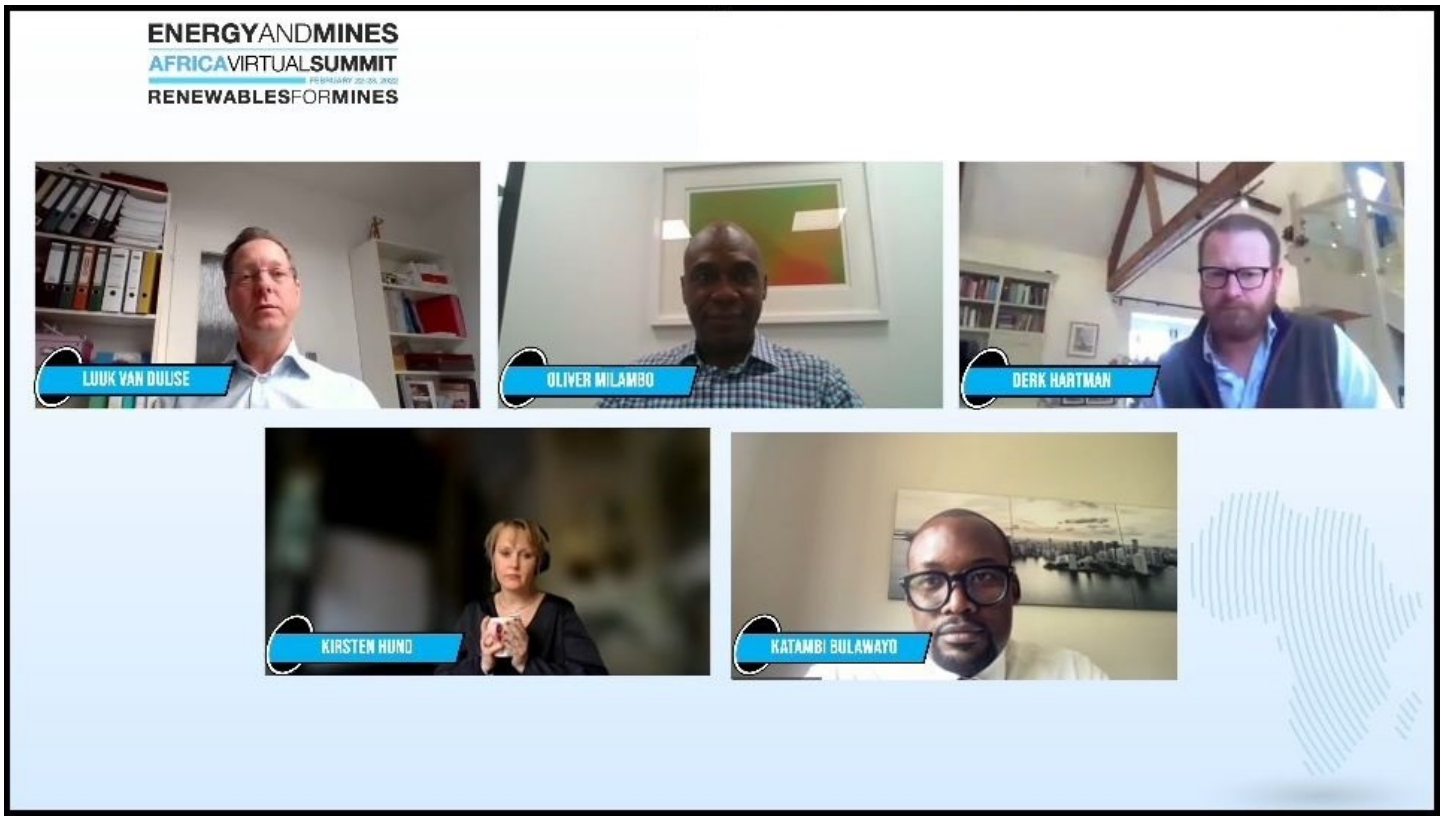
to the mining industry, which seeks stable, reliable and affordable energy above all else, including the ability to operate completely independently from the grid.

"Operating on a power island with large elements of heavy loads being brought to bear on the power supply gives challenges we can resolve with specific step loading rates or with hybridization with battery energy storage systems."

Marshall observed that the global trend is for the displacement of diesel and heavy fuel oil (HFO)-based power with pipeline compressed or bottled gas, and also hybridisation with solar, wind and energy storage.

While mines using a natural gas solution can enjoy significant carbon savings versus diesel or HFO, Clarke's generators can also operate on completely decarbonised fuels including biogas, biomethane, and hydrogen.

At the Alinta Newman Power Station in Western Australia, Clarke Energy is constructing a large island grid consisting of a 14 engine 60 MW gas fuel power station linked to a 60 MW solar PV station.



KEY CONSIDERATIONS FOR SWITCHING TO RENEWABLES

Chair: Luuk van Duijse, Mining Account Manager, **Electric Power Division, Caterpillar**
Oliver Milambo, Commodity Manager - Engineering, HME, Fuels, Power & Water, **AngloGold Ashanti**
Derk Hartman, President & Chief Operating Officer, **Giyani Metals Corp.**
Kirsten Hund, Head of Carbon Neutrality, **De Beers Group**
Katambi Bulawayo, CEO, **Insignia Corporation**

The panel opened with a very interesting question from the chair. Luuk van Duijse asked the participants to comment on whether, in addition to internal motivation, they faced any external, positive "pressures" to make the transition to renewables.

Diamonds group De Beers has a two-pronged incentive for decarbonisation. One, an internal drive and sustainability framework to do good and leave a lasting legacy. Another, a more customer-facing one. "We are facing very direct demand from consumers and also from luxury brands to give them carbon neutral diamonds," revealed De Beers' Head of Carbon Neutrality Kirsten Hund.

At Giyani Metals, whose product is high purity manganese required in batteries, there is a similar impetus arising from climate-conscious end buyers such as EV makers. According to Hartman, these customers are examining their whole supply chain to ensure input materials are carbon neutral. "We want to have metals that have the lowest carbon footprint possible," these buyers say.

Giyani is targeting the start of operations from 2025, and according to Hartman, the EV makers are demanding to see Giyani's road map towards carbon neutrality. The company also identifies a demand for low carbon metals sourced ex-China, hence the possibility of premium pricing.

On a similar note, Katambi Bulawayo observed that prices of electrical metals would rise to record highs following the global drive to net zero.

"So there's already the obvious upside; plus, clients are willing to pay a premium if you can demonstrate that your ESG credentials are up to the global standard," Katambi commented. "So I think that there is a clear win-win there for the mining companies as well as for the global community as a whole."

At Insignia, a company in the exploration stage for key metals relevant to the energy transition, the pressures for carbon neutrality are mostly internal. The question facing the company is: How can we create a roadmap from day one that already sets us up as a carbon neutral mining company?

According to Insignia CEO Katambi, this is an advantageous situation from the outset. The company can demonstrate that it is responsible enough for the environment, and leave a lasting legacy of having been a responsible company from day one.

At AngloGold Ashanti, a combination of factors are at play. The company has been reporting its carbon intensity for a while now. Of late however, decarbonisation has taken a fresh momentum within the company and according to Milambo, this is supported by an internal drive, pressure from investors, and the company's environmental values.

Giyani's Hartman stressed how important mine life was in planning the path to carbon neutrality. With a short mine life it becomes prohibitively expensive to invest in the battery storage required to back up a solar operation for a 24-hour supply. The answer is to increase the resource base, as his company has done. After the mine is finished, Hartman suggested the battery can be handed over to the national grid collaborator.

On lasting legacies, Katambi said Insignia had no access to grid, and was betting on solar. Apart from mine life considerations, the company was also planning ahead for creating a good legacy in the local area through the creation of sustainable farming and agriculture.

BEST PRACTICE FOR IMPLEMENTING RENEWABLE PROJECTS FOR MINES IN AFRICA

Lukas Haack, Head of Engineering, **Suntrace**

Lukas Haack delivers a presentation on the stage-wise approach to successfully implement a renewable energy project at an African mine.

Two valuable points at the outset. One, power supply is a quick win, because it has by far the largest carbon footprint, and renewable energies present the lowest hanging fruit to really start decarbonising mining operations. Two, renewables have become cost competitive and can also hedge against energy costs for future operations.

Considering the current volatility in fuel prices, renewables present an opportunity for improved mine profitability, and in some cases they may even extend the life of mine due to lower electricity cost and open the option to explore lower grade resources.

Haack: "And it's a stage-wise approach. The way to net zero will be a long journey, and I say, let's hit the road."

Haack takes us down the implementation process including project assessment, integration of the renewable energy project into the existing infrastructure, fixing cost estimates, the transaction structure (EPC, IPP or lease?), tendering, and selection of contractor.

Haack also showcases Suntrace's success at the landmark B2Gold Fekola project in collaboration with BayWa r.e.

The project has been in operation since July last year and continues to outperform expectations.

GOODBYE GENSETS – A PATHWAY TO ZERO CARBON MINING

Bruce Anderson, CEO, **247Solar**

"Imagine a roadmap that uses 21st century technology as efficient, clean, highly reliable, and of course, addresses your ESG targets, and does so quickly," says Anderson. "It's a rational approach that is profitable, it's flexible, and it's low risk."

And it does away with gensets.

247Solar's zero-carbon, 24/7 baseload equipment comprises a container-sized, long duration heat store battery, and a 24/7 solar plant.

The battery is the only one of its kind that is tailored in size for the mining industry. "You need a longer duration battery that can operate for 10 to 20 hours in order to get to zero carbon, and then a battery that can continue operating, even when it's fully discharged as a way of replacing the gensets," says Anderson.

The solar plant uses heliostats, or sun tracking mirrors, to reflect sunlight to the top of a truss tower where it is converted into heat for heating air to almost 1,000 degrees. The hot air is routed to either a storage system or a turbine for generating power. At night, hot air moves from storage to the turbine for power when the sun is not shining.

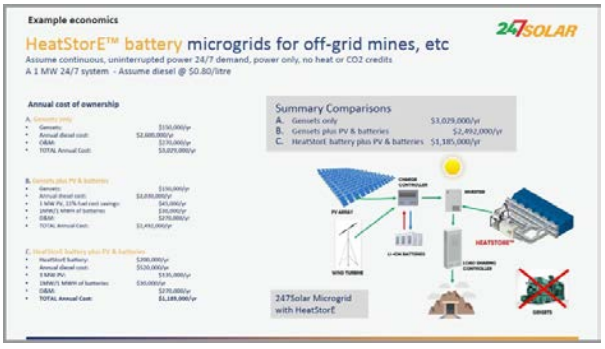
Core to these two products is the 247Solar Heat2Power Turbine, a so-called 21st century "genset."

The capstone turbine is highly reliable and can burn almost any fuel. Robust, and with very high uptime, the turbine needs only a couple of hours each year for maintenance, while its air bearings need no lubrication. Over 10,000 of these have been sold, according to Anderson.

The economics are really impressive, he says.

As shown below, gensets are 3X more expensive compared to the battery and solar plant respectively:

247Solar works with the mine on a pre-feasibility roadmap concept and stands ready to supply a completely turnkey solution including financing for the solar plant.



WHAT WE'VE LEARNED FROM OUR SOLAR PROJECTS

Mohamed Ourriban, General Manager, **Essakane, IAMGOLD Corporation**

IAMGOLD's Essakane gold mine in north-eastern Burkina Faso produced a record 457,000 ounces of gold in 2021. The open pit mine started in 2010 and its life extends to 2027.

The company also operates the Westwood mine in Quebec, Canada, and the Rosebel mine in Suriname.

It is committed to achieve net negative greenhouse gas emissions by 2050.

Spread across 22 hectares, the solar plant at the Essakane mine has 128,880 thin film solar modules with an installed AC power capacity of 12 MW. The plant was commissioned in March 2018.

The production of the solar park represents 7% of Essakane's energy demand per day (25,000 MWh annual). Essakane found the following impacts after the installation:

- Reduction of 16.5 teq CO_2
- Reduction of 5.5 million liters of fuel
- Reduction of 120 fuel delivery trucks annually (further impact on our

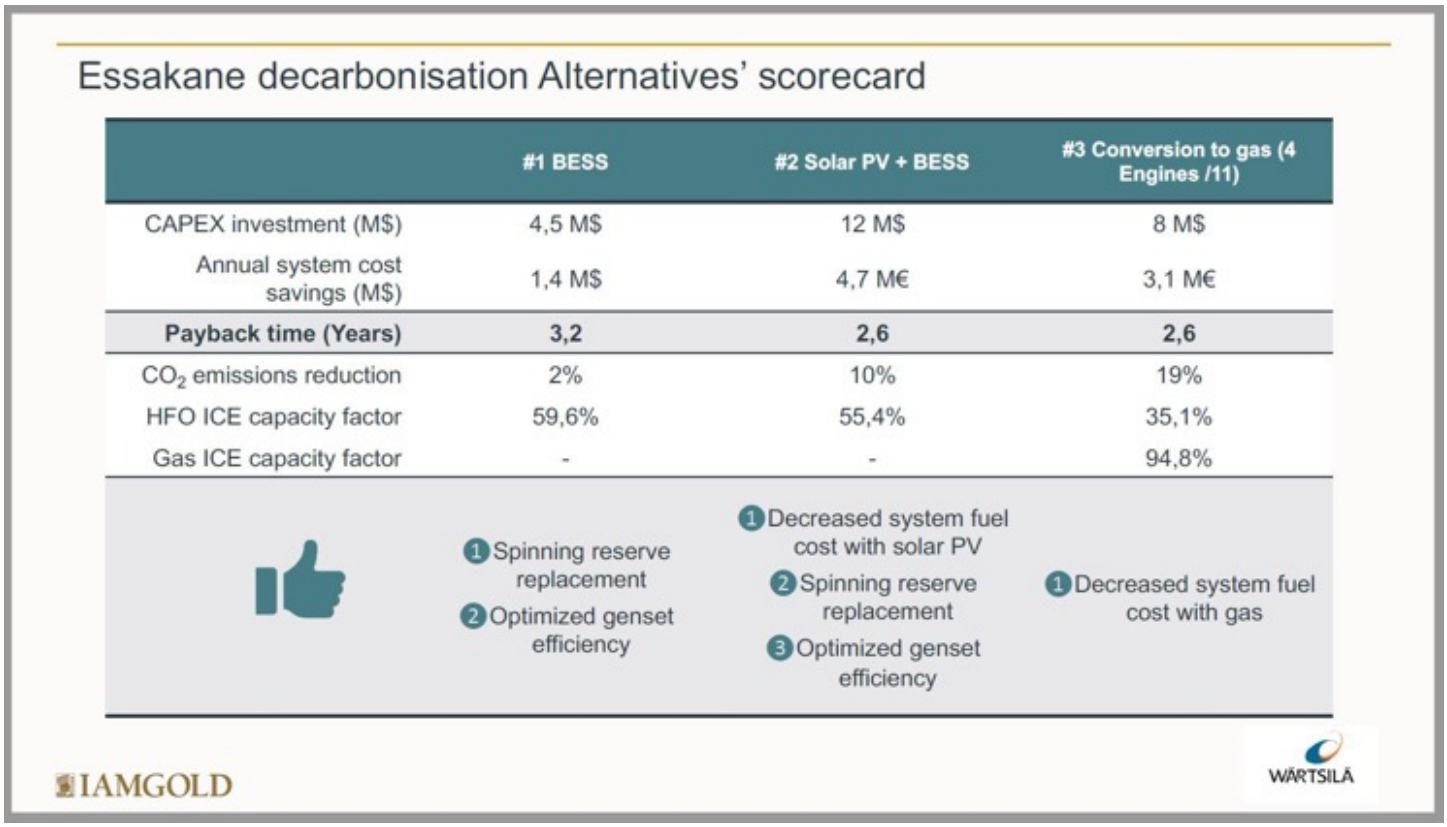
emissions reduction)

- 2% reduction in operating hours of the thermal plant
- 0.75% increase in fuel consumption at the thermal plant due to the need for a spinning reserve

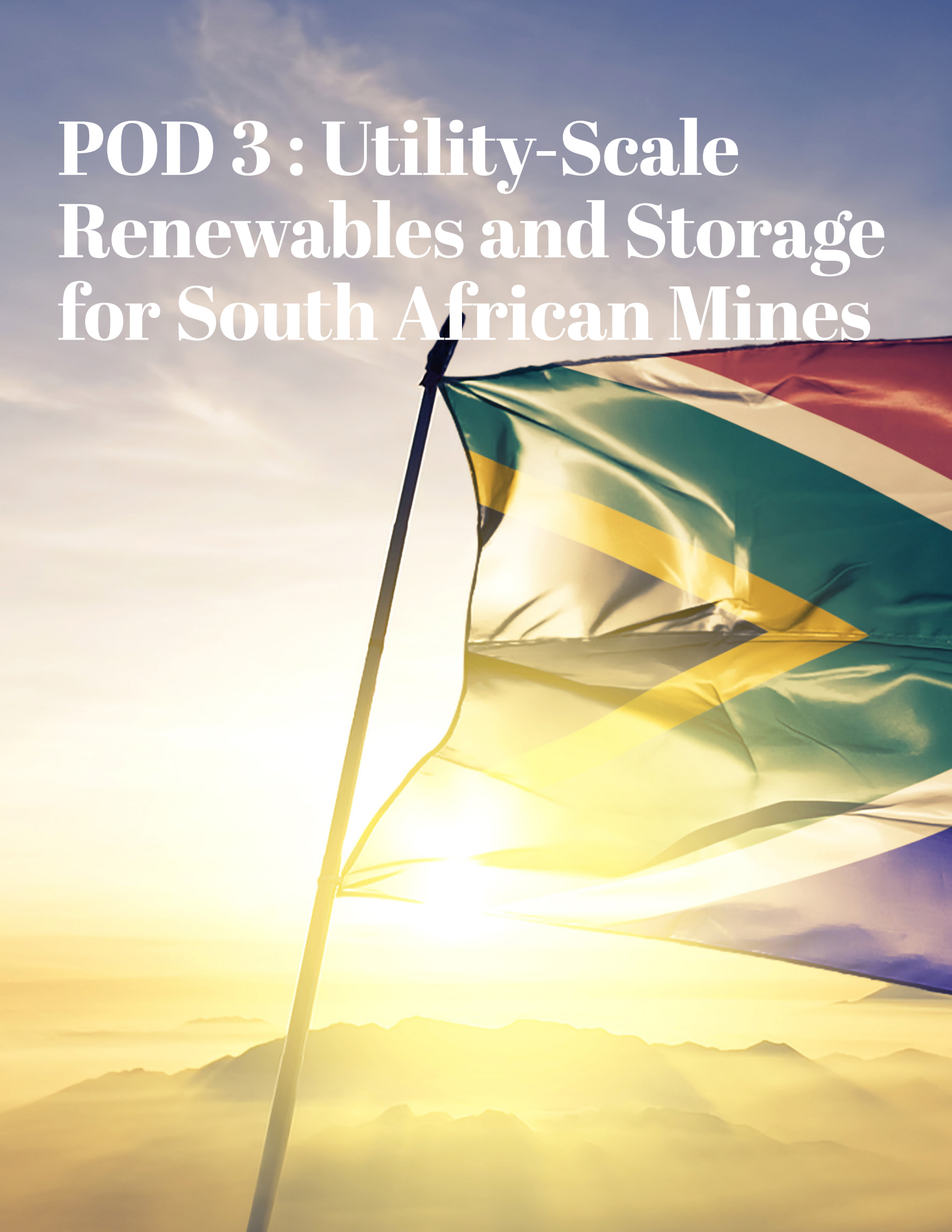
IAMGOLD is evaluating various options to achieve its decarbonisation objectives including extending the solar plant by 10 MW, installing battery storage of 5 MW/ MWh , and the use of LNG as an energy fuel source as well as for use in Cat 785C trucks.

Ourriban says these projects may not see the light of day given the short mine life remaining.

"But for Essakane, or IAMGOLD it's an experience and the projects could be done at Essakane or at other operations in the future," he adds.



POD 3 : Utility-Scale Renewables and Storage for South African Mines



Tronox on energy challenges, strategies and renewables.

Tronox Holdings plc is one of the world's leading producers of high-quality titanium products. They have set a 2050 target for carbon neutrality as well as a number of emissions reductions milestones. In advance of her participation in the panel discussion, South Africa Mining Energy Transition: Challenges and Opportunities, Technology & Improvement Manager Reinet Van Zyl spoke to *Energy and Mines* about Tronox's energy challenges and strategies

Energy and Mines: Can you please describe Tronox's current energy challenges?

Reinet Van Zyl: The main challenges for Tronox, along with all mining and industrial users in South Africa, are the cost and security of supply of electricity which can only be purchased from a single, state-owned supplier, Eskom. Loadshedding (rolling black-outs countrywide) have become a long-term feature of the South African economy. These periodic power outages negatively impact on production in the country as a whole. This coupled with the significant annual electricity price increases over the past 10 years, has placed a huge cost burden on producers. This in turn has the potential to impact South Africa's competitive viability compared to mining and manufacturing in other countries.

EandM: How are Tronox's sustainability goals shaping your energy strategy?

RVZ: Tronox's ultimate aim is to become an industry leader in sustainability. To get there, we have set big goals to reach carbon neutrality by 2050. We are currently working on a detailed decarbonisation roadmap for Tronox in South Africa and to prioritise milestones for this journey. The first milestone in the journey to carbon neutrality is a reduction of Scope 1 and 2 emissions of 15% by 2025, moving to 25% by 2030. Renewable energy will play a key role, especially in the early stages of this ambitious plan. Tronox's ultimate sustainability goals have given a clear direction, and we are formulating the action plan to ensure expedited progress to reach the end goal of carbon neutrality.

EandM: Which technologies are on your radar for Tronox's future energy plans?

RVZ: Given the location of Tronox's operating sites in South Africa, renewable technologies such as wind and solar are obvious choices. The recent changes in South African legislation have created opportunities that were previously considered too high risk. Storage of energy is still expensive, but the expectation is that within the next five years the technology will mature


Reinet Van Zyl, Technology & Improvement Manager, Tronox

and become more affordable. Additionally, we will continue to scan the environment for cost effective solutions to reduce our GHG emissions and find ways of utilizing waste more effectively, thereby reducing our carbon footprint altogether and living up to our company values of being adaptable, decisive and effective.

EandM: What do you see as the main barriers to the further integration of renewables for mines in Africa?

RVZ: In the short term, the grid capacity infrastructure to accommodate distributed generation will be the biggest barrier for further renewables in the mining environment. This inhibits the wheeling of electricity or off-site power generation options for mines. From this perspective, on-site generation is more attractive, but comes with a host of different financial and safety considerations.

EandM: What are some of the key market developments in South Africa that are expected to facilitate further uptake of renewables for mines?

RVZ: The change in legislation in August 2021 is a positive change that will drive the uptake of renewable energy going forward. It allows for large scale (less than 100 MW) renewable generation facilities to utilise a curtailed registration process rather than the previous, lengthy licensing process. It also allows for multiple off-takers from a facility as well as the on-selling of energy. This has the potential to de-risk to a large extent possible renewable generation projects for mining companies, who would now be able to share the burden and benefits associated with the secured, sustainable supply of electricity. A further driver is the affordability of renewable energy, which is presently more economical than the coal-based energy currently available.

CENNERGI: THE DRIVE TO DECARBONISE MINING IN SOUTH AFRICA

Roland Tatnall, Managing Director, **Cennergi**

Cennergi focuses on the three business pillars of utility generation, services related to renewable asset management, and distributed generation.

In the words of Tatnall, the company is a solutions provider looking to solve customers' needs including cost reduction, energy security (or a combination of these two), plus emissions reduction.

Cennergi's flagship project is its solar PV project at Lephalale for customer Exxaro Resources. "We're providing energy to the largest open pit coal beneficiation project in the world with long term offtake agreements with Eskom, so really a great customer to be providing a long term renewable energy solution for," says Tatnall. Work is well advanced on Phase 1 of 70 MW (behind the meter), and financial closure should be "fairly soon."

Phase 1 is expected to save 36% on Scope 2 emissions for Exxaro, plus more than 12% annual savings in electricity cost upon full production.

The latter could magnify, according to Tatnall.

"Cost saving from now are obviously going to increase in terms of the gap between the pricing that we deliver and

Eskom tariffs as the tariffs increase on the Eskom side," he observes. "But our tariffs increase in alignment with CPI."

In general, Cennergi can solve for 60% plus of a customer's energy needs with a fairly low-risk combination of renewable resources, without taking the customer entirely off-grid.

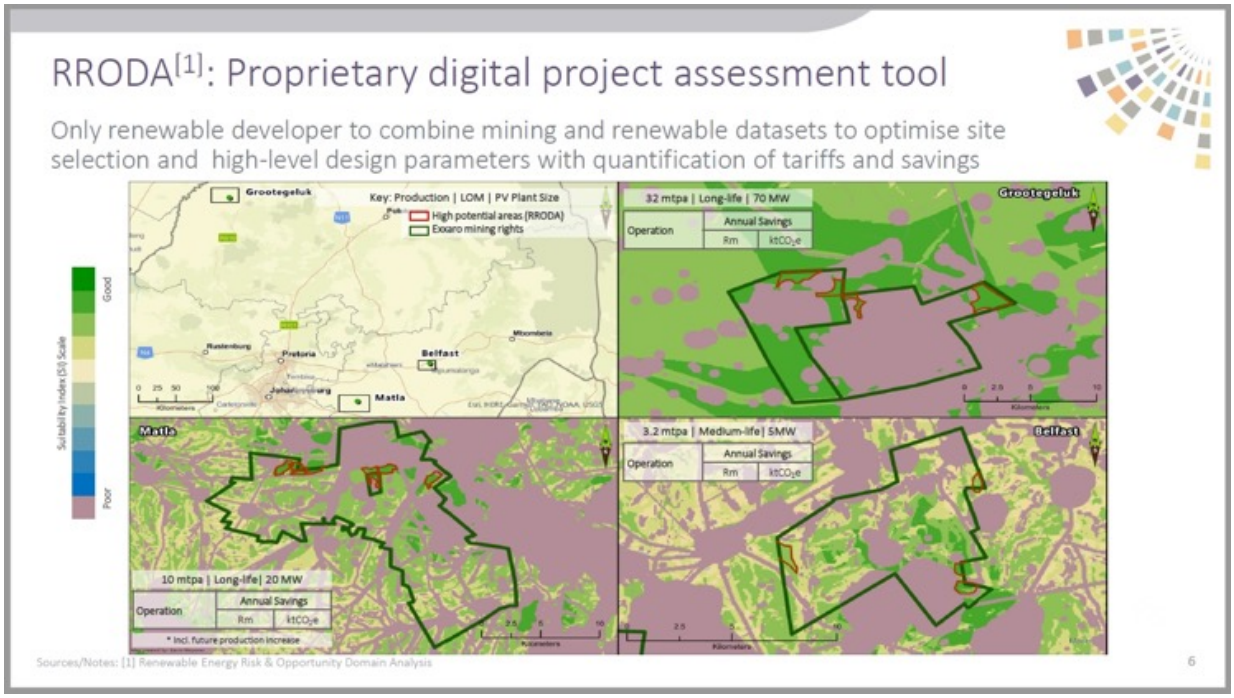
However, there are many challenges in providing a bespoke renewable solution to a customer, and this fact is coming to the fore on analysis of the rash of RFPs/ tenders during 2020 and 2021.

"The solutions that were actually provided partly as a consequence of the way the RFPs were written, were not actually practicable or executable in the current environment," according to Tatnall. "And I think that's the reason why we've seen in the last six to nine months a tail off of RFPs."

Cennergi's RRODA (Renewable Energy Risk and Opportunity Domain Analysis) is a proprietary, digital project assessment tool that could make the process more reliable.

Cennergi is therefore the only renewable developer to combine mining and renewable datasets to optimise site selection and high level design parameters with quantification of tariffs and savings - in both Rand and CO2 terms.

RRODA played a role when Cennergi signed an MoU last year with Eskom and Seriti to decarbonise cost-plus coal mines in Mpumalanga, and as well reduce the costs to Eskom.



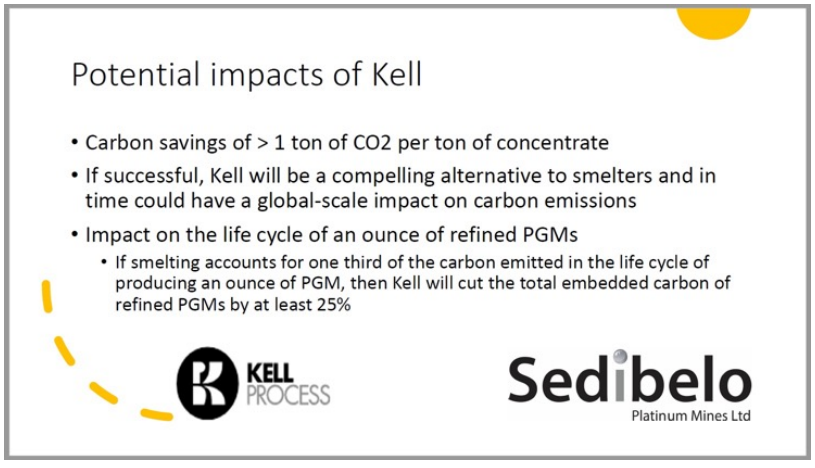
TOWARDS LOW-CARBON PLATINUM PRODUCTION

Lael Bethlehem, Chief ESG Officer, **Sedibelo Platinum Mines**

Sedibelo Platinum Mines is a mid-tier miner of platinum group metals (PGM) owning the Pilanesberg Platinum Mine in the North West province of South Africa.

It has ambitious plans to scale up its production. It is working on a second pit at Pilanesberg, and will commence building an underground mine in 2022.

The company currently sells its production of concentrates to third party smelters. Smelting is a process that uses very high temperatures, and therefore large amounts of energy, to liberate the metal from the concentrate. It is very dependent on grid power, and very carbon intensive.



Sedibelo intends to set up a plant, the first in the world, to extract the metal from the concentrates without smelting by using a revolutionary, hydrometallurgical process known as the Kell process.

Sedibelo is a co-owner of Kelltech SA, the company in South Africa that has the license to use Kell technology. Compared to smelting, this process cuts energy consumption by about 80% and reduces greenhouse gas emissions by 70%. According to current estimates, carbon savings could be more than one tonne of CO_2 per tonne of concentrate. Kell also cuts the use of water and emissions of sulphur dioxide.

"If we can make Kell work, it will be a very compelling alternative to smelters," says Bethlehem. "And in turn, we think it could have a global scale impact on carbon emissions."

Separately, Sedibelo intends to source 55 to 60% of its energy needs from renewables by 2024.

By 2030 this percentage will go up to 65 to 70% regardless that its electricity consumption is likely to double due to expansion.

SOUTH AFRICA MINING ENERGY TRANSITION: CHALLENGES AND OPPORTUNITIES

Chair: Fanele Mondi, CEO, **Energy Intensive Users Group (EIUG)**
Fhedzi Modau, Group Head: **Energy, Impala Platinum**
Reinet Van Zyl, Technology & Improvement Manager, **Tronox**
Andre Botha, Engineer Energy Management, **Rio Tinto**
Lael Bethlehem, Chief ESG Officer, **Sedibelo Platinum Mines**
Emeka Wosu, Director of Business Development, **LONGi Solar**

The highly experienced and well-informed panel brought before the audience the challenges and opportunities facing the South African mining industry in its energy transition.

The cost, availability, and reliability of electricity, as well as the related emissions, are key concerns for South African mines.

The transition to cleaner energy has received additional momentum from shareholders and their emphasis on compliance with ESG norms.

Reinet Van Zyl from Tronox struck a note of caution, saying mines should understand they still need to address an uncertain and changing environment, and that key energy decisions have serious

costs and risks.

So, what's in flux? The regulatory environment, market structure, and forex exposure due to dollar-based EPC pricing given the volatility of the rand currency, are some factors that accentuate uncertainty of project outcomes, according to Reinet.

An additional factor, for a larger renewable energy project, is the impact of its accounting in the books. "Even if you have a strong balance sheet, if you have to consolidate the project and the liabilities into your balance sheet, it actually can have quite significant consequences and impact on your credit rating," observed Reinet.

The tenure mismatch between the length of a PPA (typically 20 years) and the three-five year tenure of the average corporate supply contract is also a source of financial risk. Not to mention clauses in the PPA such as force majeure and termination.

One suggestion to mitigate the risks from long-term PPAs was to enable the energy market for aggregation and on-selling of energy where a mine was unable to use or evacuate it.

Another key challenge: Eskom. "Changes in the Eskom pricing might impact and influence or will impact and influence the modelling in terms of the financials of these projects," stated Reinet.

Also to consider is whether the mine's project team is up to speed in terms of experience and knowledge given the issues likely in permitting and sizing the project.

However, Lael Bethlehem of Sidebelo Platinum asked the participants not to lose sight of the progress that has come about since when REEEP started.

Availability of finance, its pricing, an impressive array of EPC and O&M providers, legal expertise ("Every legal firm is now able to give you a decent PPA"), equity investors, and nature's bounty of solar and wind resources are now working in favor of South African mines in their drive towards decarbonization, said Lael in her views on market developments.

However, other participants too weighed in on the challenges presented by Eskom and need for the utility to strengthen its grid to receive and evacuate power. Also, the swift pivot towards decarbonisation and demand for sites to install renewable energy projects had created a shortage of suitable locations.

"There's talks about some of these grids going to be taking up to 10 years to strengthen and open up those corridors," observed Rio Tinto's Andre Botha. "I believe with working together - with government and industries, Eskom, everyone, - we can try and expedite that."

"Because there's quite a bit of a challenge and also as Lael has mentioned, there are limited sites available that is called shovel-ready, that's got all the permitting in place."

REGULATORY UPDATE FOR RENEWABLE ENERGY PROJECTS FOR MINES

Chisilo William Mwanza, Compliance Monitoring Engineer, **National Energy Regulator of South Africa (NERSA)**

Mwanza, representing NERSA, advised the mining industry that his organisation's primary role was to facilitate new entrants into the electricity supply industry in South Africa to ensure security of supply, facilitate investment and to promote competition.

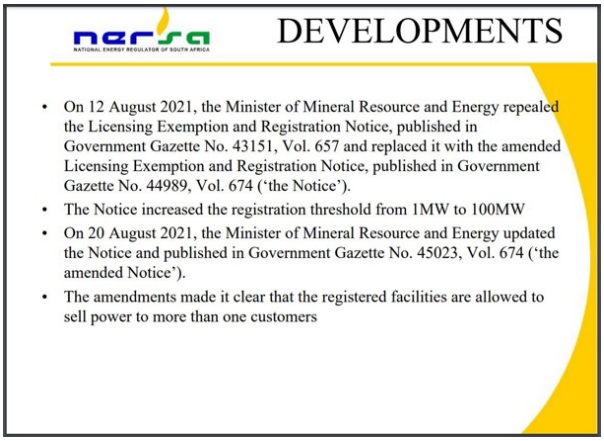
As such NERSA was always open for consultations with the mining industry.

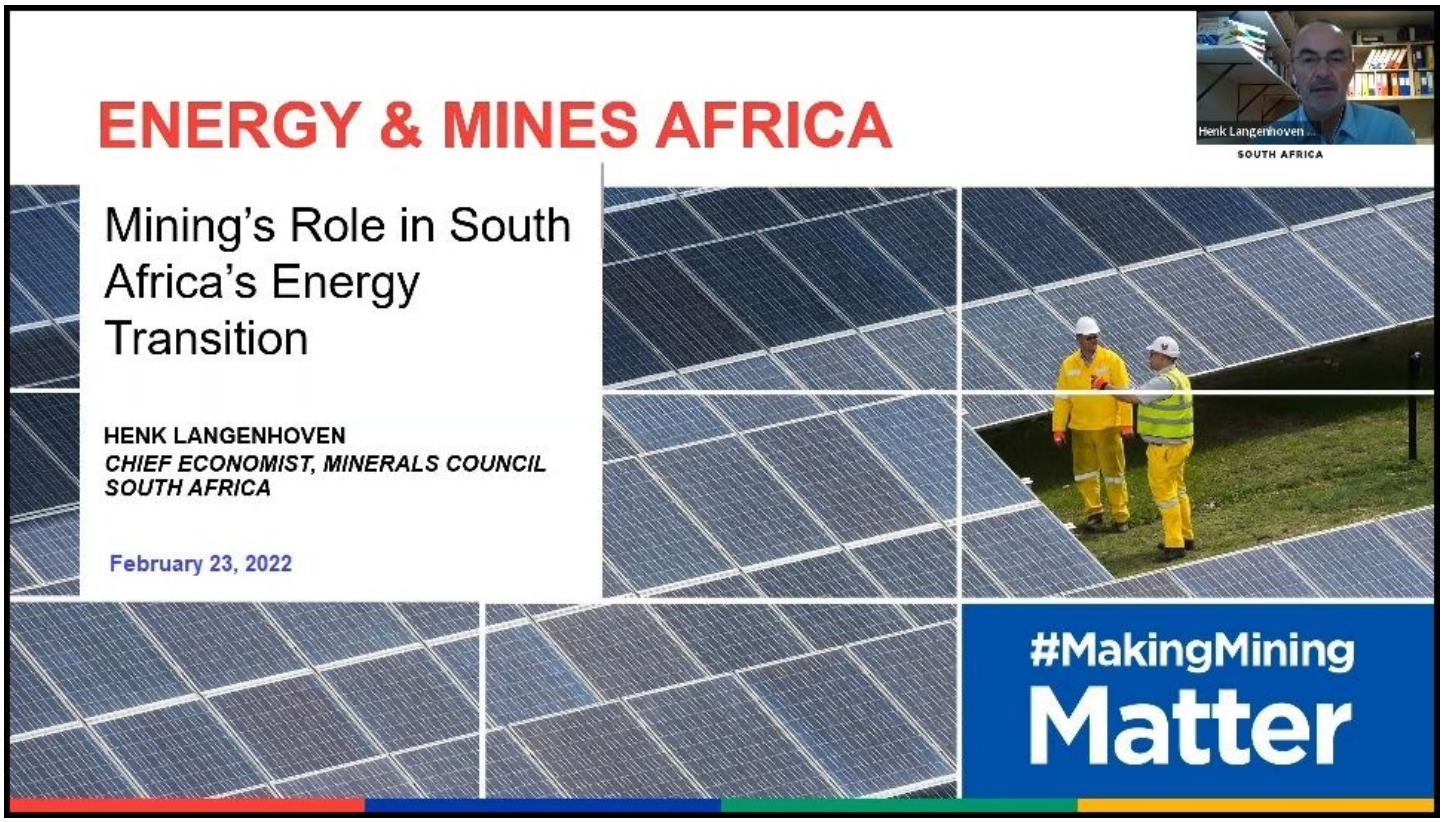
Focusing on self-generation, Mwanza emphasised that effective August 2021 when NERSA moved the threshold from 10 MW to 100 MW, its philosophical approach was to make the process of registration for self-generation a "lighter process compared to licensing."

He clarified that for the registration process NERSA required only a consent from the network service provider, be it Eskom or the local municipality, where the facility would be connected to the grid.

As a result of the simplified process, registration is usually completed in four to five working days, compared to 120 days for licensing.

Furthermore, there is no longer any need for submission of an Environmental Impact Assessment.





MINING'S ROLE IN SOUTH AFRICA'S ENERGY TRANSITION

Henk Langenhoven, Chief Economist, **Minerals Council South Africa**

Henk Langenhoven drew attention to the dire situation of electricity supply in South Africa, an economy that is very energy intensive. In a study he found that the different sectors that are using more than the average amount of electricity per one unit of GDP employed 40% of the country's people, generated about 42 or 43% of the GDP, and accounted for 70% of exports.

Langenhoven also cites a study by the Council for Scientific and Industrial Research had projected a power shortage of 4,500 - 5,000 MW in South Africa by 2022. That deficit is already a reality, he asserts.

All this is leading up to the urgency for self-generation of power by the country's mining industry. Another set of statistics from Henk: The mining sector buys about 15% of all electricity generated in South Africa, and if you add the smelters, that percentage goes up by another 10%.

However, due to the high cost and unreliability of energy supply, as many as 50 smelters are currently mothballed. This has serious implications for

employment, exports and foreign exchange reserves.

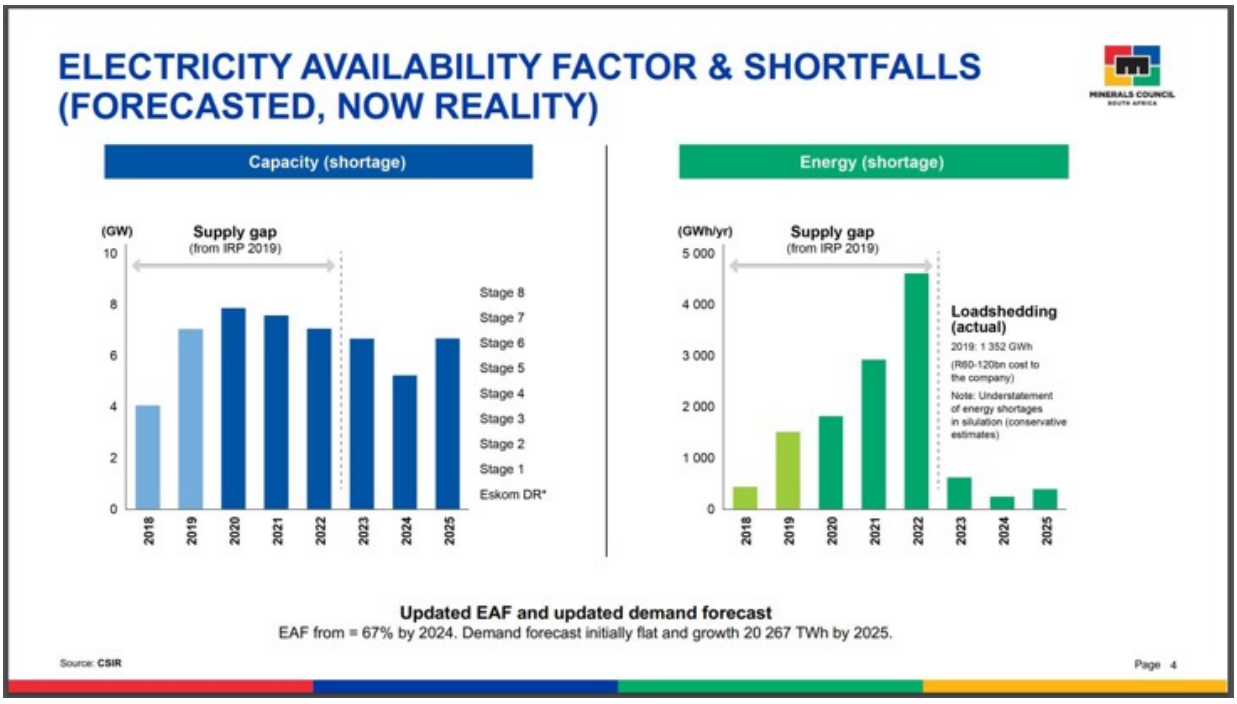
Unfortunately, though the enhancement of the self-generation limit to 100 MW is welcome, on the ground, there are many bureaucratic hurdles that essentially nullify the advantage of registration versus licensing for self-generation.

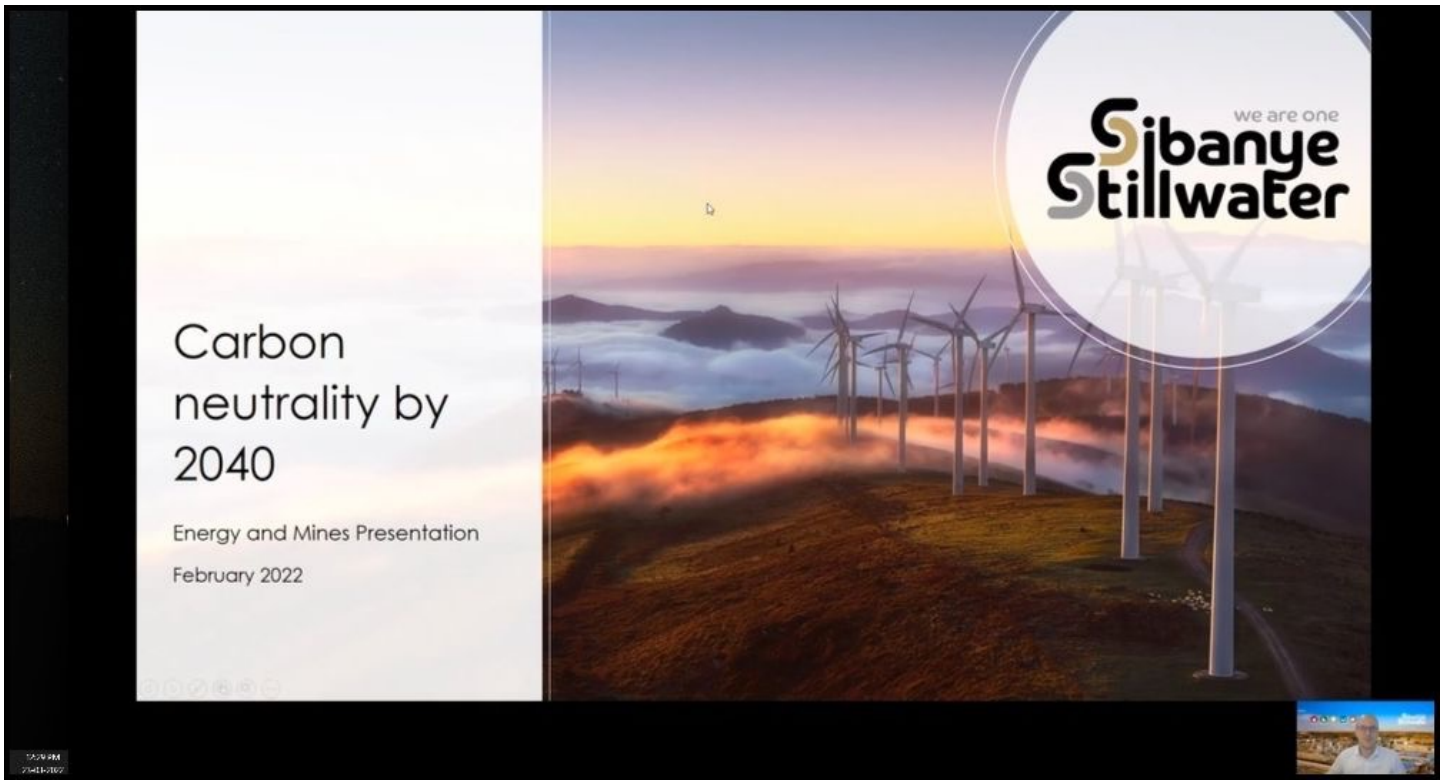
Langenhoven has a number of suggestions to expedite self-generation by miners. These include not having to conduct a fresh EIA when an earlier one is available for the site, for example, a decommissioned Eskom site.

He suggests that miners having excess self-generated energy should have the means to trade it. Also, that Eskom's wheeling framework should become a national framework, to achieve standardisation.

These, and other initiatives including building out transmission infrastructure and land reforms, need to come from the government on a war footing. As far as the mining industry is concerned there is no shortage of self-generation proposals.

"When we did a study a year ago, the companies were telling us there was about 2.4 gigawatts of projects in the pipeline," says Henk. "When we did it last year in December, that number has gone up to nearly four gigawatts. So you can see the growing interest in this."





INVESTING IN OVER 450 MW OF RENEWABLE ENERGY IN SOUTH AFRICA

Jevon Martin, Manager - Energy and Decarbonisation, **Sibanye-Stillwater**

Sibanye-Stillwater is an international precious metals mining company. It owns platinum group metal assets in South Africa, as well as deep level underground gold mines. In the US it has platinum group metal assets, as well as a number of portfolio projects across the globe, including lithium, nickel and copper.

Sibanye-Stillwater's South African operations account for 92% of its energy consumption.

The company has adopted a 5-pronged strategy for overall decarbonization including energy intelligence; demand side energy management to control energy waste and enhance opertional efficiencies; strategic energy sourcing; new technologies for rapid decarbonisation; and taking accountability for upstream and downstream emissions.

However, the installation of renewable energy in South Africa is a special focus - "its strongest lever" for decarbonisation, and as well to manage its "Eskom risk."

"We've continued to experience volatility in the grid emission factor which has, in certain instances stifled our decarbonisation efforts," says Martin. "We also continue to face risk in terms of Eskom above-inflation tariff increases and unreliable electricity supply."

Eskom contributed 97% of Scope 2 emissions, and its 3.9% increase in grid emission factor in 2021 offset the company's decarbonisation gains.

Accordingly, Sibanye-Stillwater is developing a portfolio of renewable energy projects in South Africa including a 50 MW gold solar project, 175 MW PGM solar projects, and 332 MW wind energy projects.

These are proposed as PPAs and have a combined cost of approximately 11 billion rand.

The projects will deliver renewable electricity at a 40 to 50% discount for solar and 20 to 30% discount in terms of wind relative to the forecast Eskom tariffs escalating at CPI from commercial operation. They will also aid in closing the national electricity supply deficit.

However, it hasn't been easy. In response to a question on challenges facing these projects Martin said: "I think the biggest hurdle is the long lead times in regulatory permits and consents. I think anyone that's undertaking one of these projects realises there's a huge amount of these across various governmental departments, NERSA, and Eskom."

POD 4: Green Hydrogen and Mining

SUPPORTING GREEN HYDROGEN OPPORTUNITIES FOR MINES

Rebecca Maserumule, Chief Director: Hydrogen and Energy, **South Africa's Department of Science and Innovation**

The Department of Science and Innovation, South Africa, has created a Hydrogen Society Roadmap that seeks to achieve six high-level outcomes to create an inclusive, sustainable and competitive hydrogen economy by 2050.

These include the decarbonisation of the transportation sector; decarbonisation of energy-intensive industries; and the greening of the power sector and buildings. The Roadmap also plans to create an export market for green hydrogen and green ammonia, as well as set up manufacturing capabilities for hydrogen products and components.

The actions relevant to the mining industry and proposed in the Roadmap include the classification of hydrogen as a transport fuel, and the development of a regulatory framework to support zero-emission transport across road, rail, and shipping.

Maserumule observes this could be useful for mining companies in the context of Scope 2 emissions when they

ship their output from the mine to the port for exports.

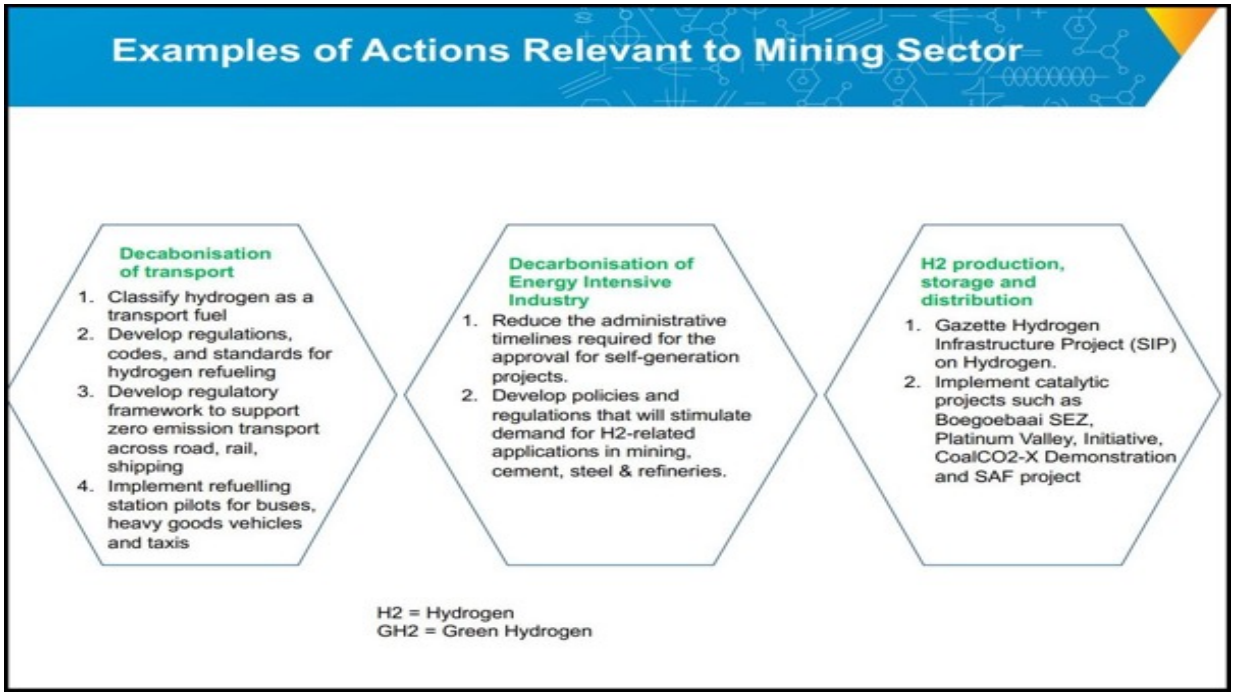
On the new self-generation threshold of 100 MW, the Roadmap calls for a reduction in the administrative timelines required for the approval of self-generation projects.

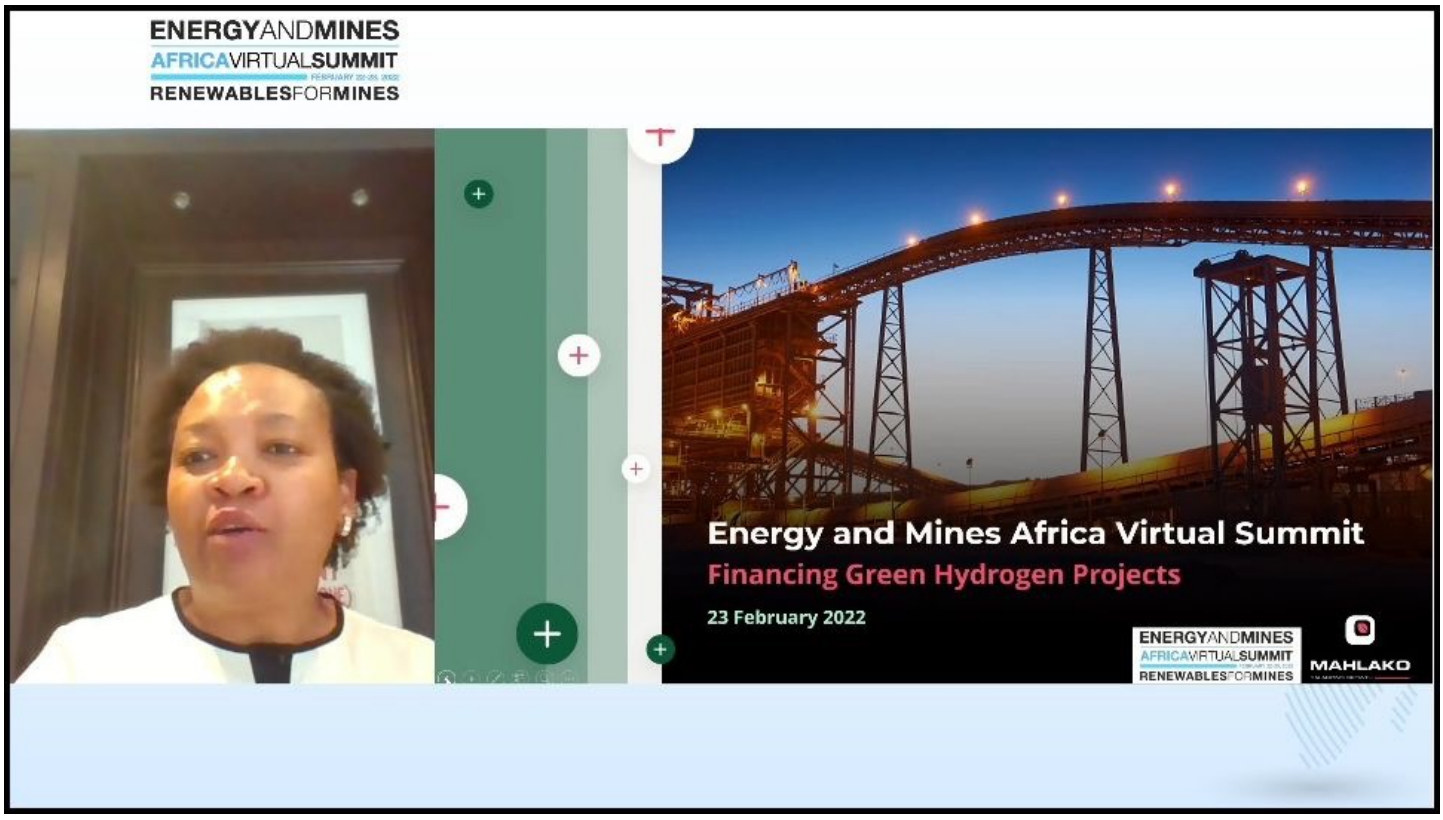
"There's a number of ways to do that through the system, you know, through strategic infrastructure projects, which can reduce your legislative and administrative processes from 18 months down to 51 days," says Maserumule.

The Roadmap envisages the establishment of catalytic projects to kickstart the hydrogen economy. These are the Boegoebaai SEZ, Platinum Valley Initiative, CoalCO2-X Demonstration, and SAF (sustainable aviation fuels) projects.

"We feel that catalytic projects, which we call shovel ready with the existing legislative regulations in place, will be really important to getting the mining sector involved in green hydrogen," Maserumule said.

Hydrogen pilot projects relevant to the mining industry include mining trucks at Mogalakwena and the Anglo-American corporate office buildings in Rustenburg.





FINANCING GREEN HYDROGEN PROJECTS

Makole Mupita, Co-Founder & Executive Director, **Mahlako a Phahla Investments**

Makole Mupita outlines the typical funding structure of a renewable energy project, usually an IPP. The company implementing the project is a Special Purpose Vehicle (SPV) that has in place a Power Purchase Agreement with an off-taker, for example, a mine.

Usually, the PPA is a "take-or-pay" contract, an arrangement preferred by financiers.

For diversifying risk, the SPV will also have a fixed-price construction contract with an EPC Contractor, and an Operations & Maintenance contract with an O&M Contractor.

This structure is then funded by debt providers or equity investors. Makole Mupita is a principal at the Masako Energy Fund, which looks at transactions in the energy value chain in renewables including hydrogen and gas.

Notably, financiers, for abundant caution, also have binding contracts with the project's EPC Contractor and O&M Contractor.

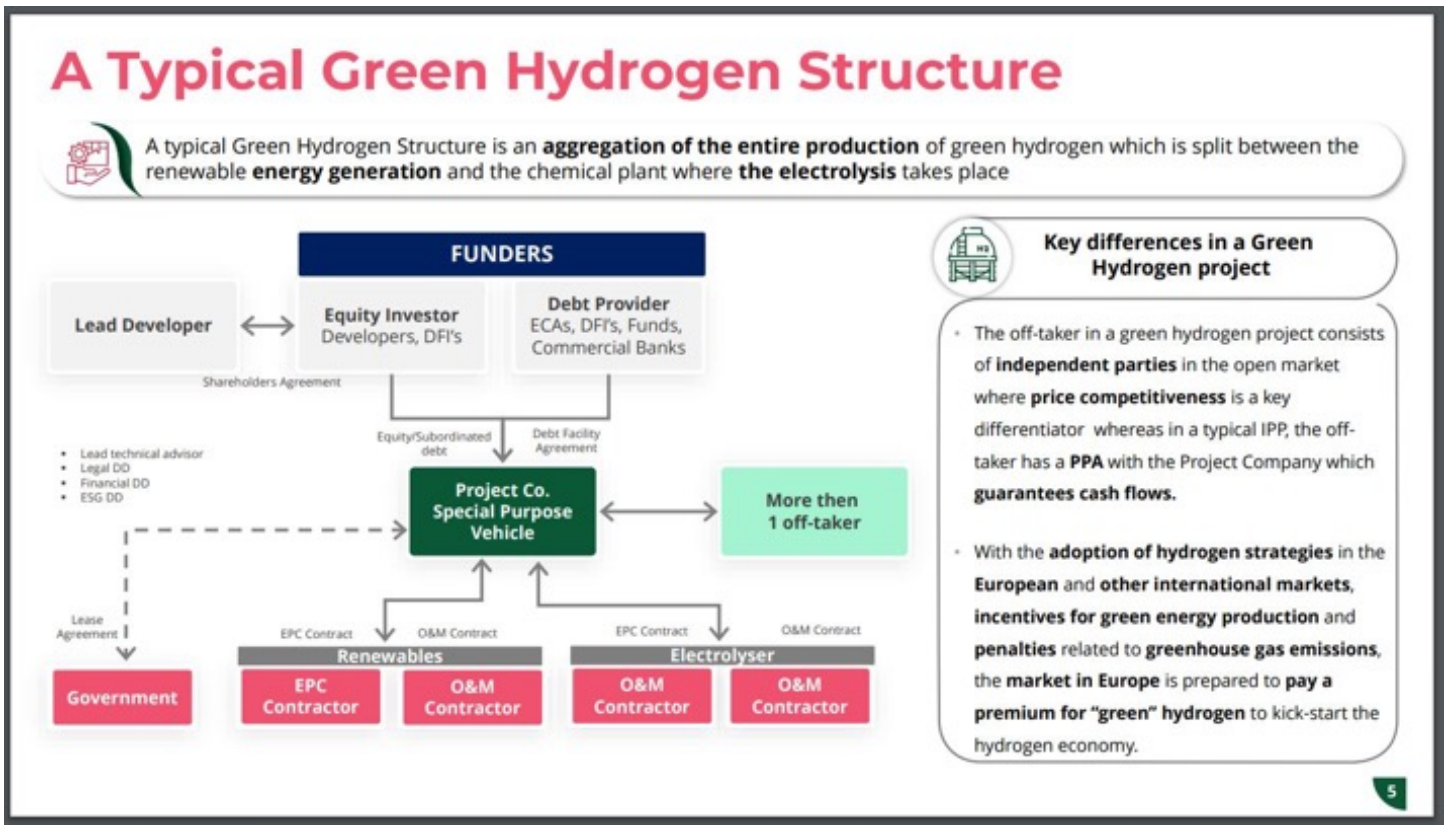
This structure is modified for a green hydrogen project by adding on an Electrolyser module with its own EPC and O&M Contractors. The offtake

arrangement is also different from a standalone renewal project. In the green hydrogen project, the PPA is usually replaced by several independent parties in the open market.

Despite off-take, EPC, and O&M agreements, the project still presents other risks for financiers including technology, operational, regulatory, geopolitical, and social risks.

Mahlako has expertise in green hydrogen. It is developing the Prieska Power Reserve Project in the Northern Cape Province of South Africa.

Prieska is a catalytic green hydrogen and ammonia project that aims to produce green hydrogen and ammonia through a combination of high-yielding renewable solar and wind energy resources, along with the other natural resources of water and air.



GREEN HYDROGEN COSTS, APPLICATIONS, AND MILESTONES

Bridget van Dorsten, Research Analyst - Hydrogen and Emerging Technologies, **Wood Mackenzie**

Africa has great potential for green hydrogen production because of the geographic advantage of renewable energy production, which is a major cost driver for green hydrogen.

However, despite having some of the best sun and wind resources in the world, Africa accounts for only 6% of the low-carbon hydrogen pipeline of 50 MTpa comprising quarterly project announcements between 2015 - 2021.

"This isn't surprising, given the lack of funding available for projects," observes Bridget.

However, that might change sooner rather than later, because of Africa's potential to generate cheap renewable energy. Note that the operating cost to run an electrolyzer is largely determined by the cost of electricity.

In a study of the levelized cost of hydrogen projected in 2030 for 24 countries, Wood Mackenzie found that Brazil, Chile, Morocco, Spain, and Portugal produce the cheapest green hydrogen.

Unsurprisingly, these very same countries are able to produce some of

the cheapest renewable energy - which augurs well for the future of green hydrogen in Africa.

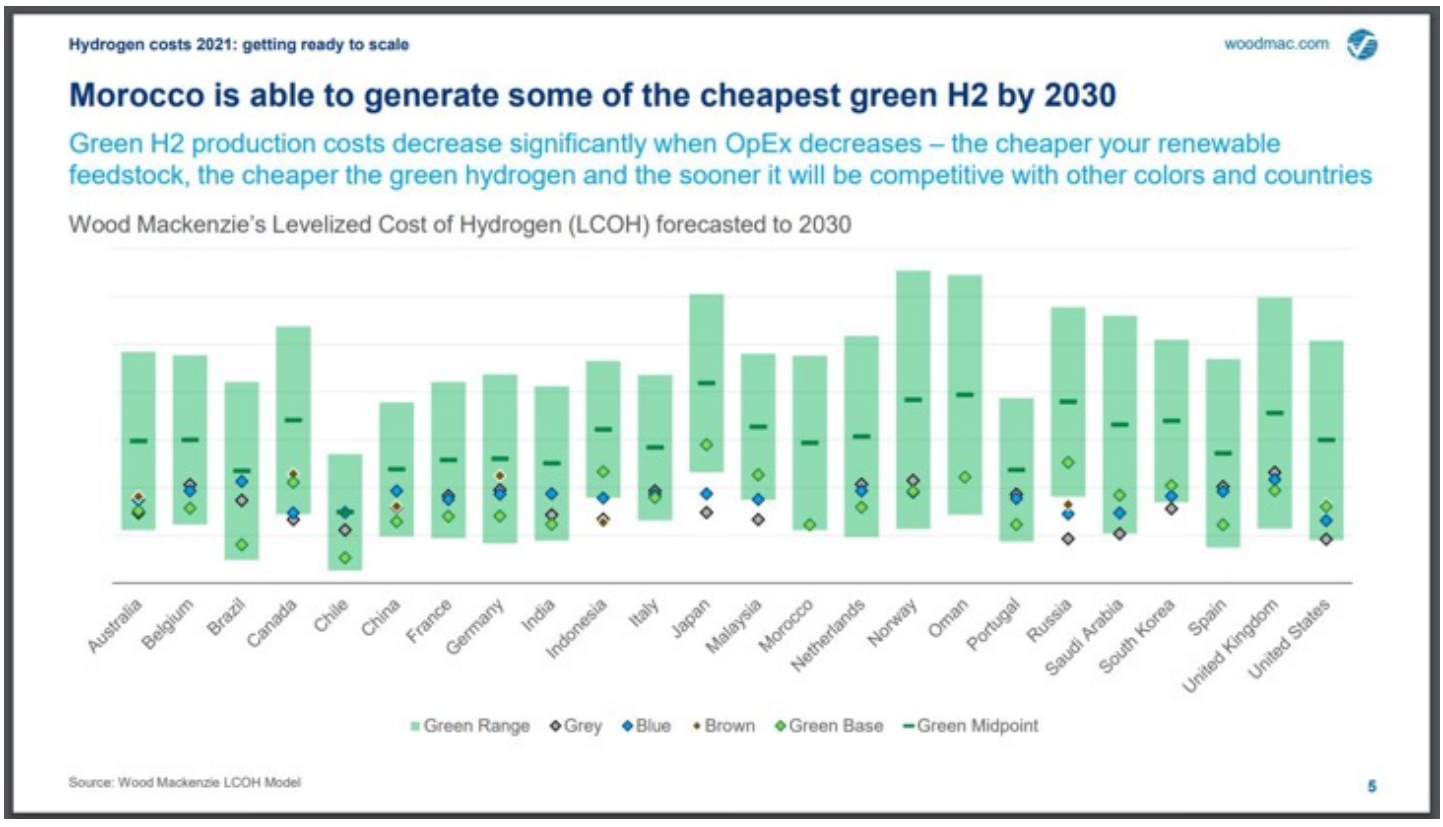
How would green hydrogen help the decarbonisation drive at African mines?

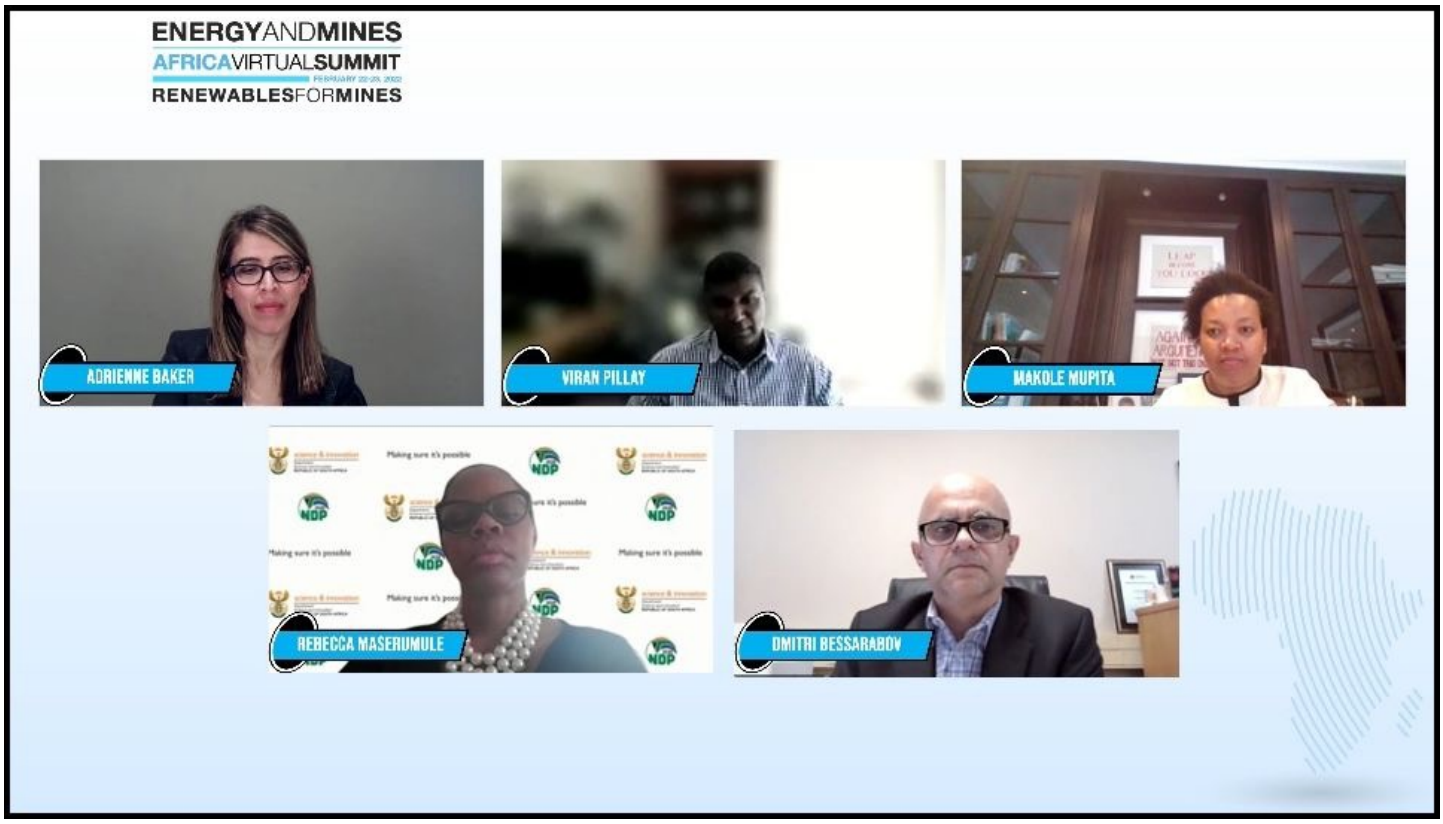
“Green hydrogen for use in mining trucks holds the most potential to achieve decarbonisation in the mining sector,” says Wood Mac.

“Mining trucks can burn up to 134 liters of diesel per hour - what if you just replace that burning fuel with hydrogen? You can do a huge chunk of decarbonisation.”

Anglo American has already got the ball rolling, putting together the first-ever hydrogen mining haul truck. The vehicle started on-site testing in the last quarter of 2021 in South Africa, at the Mogalakwena platinum group mines.

Anglo American is planning a 40-truck roll-out in 2024 with increased solar and electrolyzer capacity





WHY GREEN HYDROGEN FOR AFRICAN MINES?

Chair: Adrienne Baker, Director, **Energy and Mines**
Viran Pillay, Senior Manager Sustainability, **Sasol**
Makole Mupita, Co-Founder & Executive Director, **Mahlako a Phahla Investments**
Rebecca Maserumule, Chief Director: Hydrogen and Energy, **South Africa's Department of Science and Technology (DST)**
Dmitri Bessarabov, Director: DST National Center of Competence, **Hydrogen Infrastructure (HySA Infrastructure)**

With the adoption of green hydrogen still in an early stage in African mining, this panel discussion shed valuable light on its costs, the applications of interest to miners, the barriers to implementation, and the way forward on this technology.

COST

For a mine, the cost of implementing a green hydrogen solution is currently a serious concern. The renewable energy used in running an electrolyzer also has an opportunity cost in terms of its application elsewhere in a mine, for example in electrification.

Further, the mine has to carefully consider whether they would like to pay the premium - the cost differential

between normal and green hydrogen - and this has to be balanced with the long-term sustainability policy of the mine.

"With the current pricing of green hydrogen compared to conventional energy sources, the operating expenses for mining operators will rise," said Sasol's Pillay. In his view, entities implementing green hydrogen need mechanisms to recover the increased opex, either by passing that cost to customers or through incentives from the government.

On the latter, Pillay called for the South African treasury to launch financial incentives to make an economic and business case for green hydrogen. Sops such as special tax treatment, special incentives, and accelerated depreciation, "all of those just help move the dial on the cost."

According to Dmitri Bessarabov, however, every case needed to be evaluated separately. He cited the case of a remote mine in Arctic Canada where the cost to generate electricity was very high given the poor quality of wind and solar resources and it was possible to deliver diesel only for about a month in a year. In such as case, it made sense for the mine to deploy hydrogen.

Life of mine, its location, type of machinery, and their depth of installation, were factors that could render an electrification application infeasible when compared to hydrogen, Dmitri observed.

But cost isn't everything, says Makole Mupita. "I'll look at sustainability, right, I mean the future - we are responsible for our children's future."

SAFETY

Another roadblock on the pathway to broader acceptance of green hydrogen, particularly for mines, was the perceived impact of hydrogen on safety.

"When it comes to mining, I think safety is a really, really important factor," stressed Pillay. In his view, this concern was manageable above ground, but in underground operations, "introducing hydrogen into an already hazardous activity came with its own faults."

"We are never going to put hydrogen underground until we are 100% sure of the safety of the miners and operations," Pillay commented.

However, Bessarabov offered an interesting counterpoint to that, referring to his observations in an unnamed hard rock mine in northern Quebec a few years ago. "I've seen a massive amount of acetylene bottles there, which is as dangerous as hydrogen," he said. "There is no issue with having acetylene that they use for welding, but when it comes to hydrogen, there is a kind of vibe that it is dangerous."

The mining industry should watch rail transportation, Bessarabov suggested. Similar to open-pit mining, hydrogen-fuelled rail had to be even more strict in terms of safety as it traversed public and densely populated areas and tunnels. However, rail transportation with

hydrogen was now a reality with "multiple demonstrations."

This makes a lot of sense for the mining sector, because like rail, heavy-duty mining trucks also, generally, worked on fixed routes. Mining should take inspiration from hydrogen storage technology and fuel cell engines currently deployed in multiple railway companies, for example, by Alstom, Bessarabov suggested.

STRATEGY

Mines embarking on green hydrogen needed to be very clear on strategy, according to Makole Mupita. They needed to answer key questions to assess green hydrogen.

- The use case - what would the green hydrogen replace?
- Do the sustainability concerns justify the cost and premium?
- Self-produce or not?
- If yes, the availability of land and quality of renewable resources such as wind and solar
- If not, whether there is availability to procure?
- Can renewable energy run both electrification and the hydrogen electrolyzer? (It's not an "either-or" situation)

On the last one, Pillay added that a low-barrier strategy was to "drop in" clean fuel solutions into existing infrastructure.

So, excess renewable energy from an electrification application could go to produce hydrogen from an electrolyzer. This hydrogen could be used as an energy storage mechanism versus a battery.

Makole Mupita weighed in with an interesting take in the context of the limitations of the South African grid.

"You've got the land, you've got the resources, especially places where there's a good resource for renewables. You can't do anything with it, because you can't put the energy in the grid," she observed.

In such a case a green hydrogen solution might work simply to avoid waste of resources.

Adrienne Baker the panel chair observed that most miners were currently opting for heavy-duty haul vehicles and mobility. "I think that's the most exciting area perhaps at the moment for miners."

Dmitri Bessarabov echoed that view. "It makes sense to have a heavy-duty fleet of long hauling transport running on hydrogen just because you cannot put batteries on such big vehicles. The cost of the batteries and the weight of the batteries, the usable energy of the batteries - it's just prohibitive."

Besides, mining trucks were generally the same, and a success story on one truck could be duplicated elsewhere.

FUNDING

The big banks are largely absent in hydrogen project funding, according to

Rebecca Maserumule. However, banks like the Development Bank of South Africa, as well as Industrial Development Corporation, which is responsible for the development of the green hydrogen commercialization strategy, are looking to fund projects.

Makole Mupita suggested that partnering with an IPP would help a mining company access the skills required to develop a hydrogen project and make it viable for funding.

However, mines needed to resolve the key question of offtake guarantees. "Because for anybody to fund there must be a buyer."

THE WAY FORWARD

At this point in time, it may be best to start small, like Anglo American. So, the mine could start with a small electrolyzer, and slowly scale up after proof of success, according to Mupita.

"Take a small step and hold a partner's hand," advised Pillay

On partners, Bessarabov cited the example of Anglo's collaboration with a host of companies across the globe on its hydrogen mining truck.

This was a successful 'consortium' approach to accelerate the adoption of hydrogen.