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Global alliance for phasing out coal not fit for purpose, says NGO

Powering Past Coal Alliance accused of failing to follow up on pledges as many countries expand use of coal

An attempt by the UK government to encourage countries and businesses around the world to quit coal for power generation is failing to make an impact, and in danger of being used as "greenwash", an assessment has found.

The Powering Past Coal Alliance, led by the UK and Canada, with 111 members including 24 governments, local governments and businesses, is a key plank of Boris Johnson's strategy for vital UN climate talks to be hosted in Glasgow in November.

Members are required to show they are on a pathway to eliminating coal-fired power plants before 2030 in the case of developed countries, and 2050 for developing states, to meet the goals of the Paris climate agreement.

But the NGO Reclaim Finance has found that some members, including the UK and Canada, are continuing to expand the use of coal, in ways that will increase greenhouse gas emissions and could help to bust the global carbon budget.

Paul Schreiber, the author of the report from Reclaim Finance, said: "The PPCA may be well-intentioned, but it is not fit for purpose. It could be helpful, if done right, but today it is not helpful [to global carbon reductions]. Members are not following up on their pledges. It serves as a greenwashing engine for financial institutions."

He said there were loopholes in the alliance's requirements. For instance, Canada is continuing to develop scores of new coalmines, which will be used to export coal for use in power plants in other countries, despite remaining within the rules by planning to phase out coal domestically.

Schreiber also pointed to the UK's plans for a new coalmine, which is subject to a public inquiry. Ministers argued it should be allowed under the PPCA rules as it would produce coking coal for steel-making, even though the exported coal would increase emissions overseas and could delay the take-up of low-carbon steel-making.

There is also poor enforcement of the existing requirements. Germany has set a coal phase-out date of 2038, well beyond the deadline for developed countries. Mexico is building two coal-fired power plants, and major new coal investments, while Senegal is also considering coal expansion.

A UK government spokesperson said: "The UK is leading the world in tackling climate change and phasing out coal, having gone over 5,000 hours without using coal for electricity last year. As part of this commitment, we launched the Powering Past Coal Alliance along with the Canadian government to advance the transition from unabated coal power electricity generation.

"We intend to bring forward our target to eliminate all coal-fired power stations to October 2024, which could mean that in 10 years, the UK would have reduced its reliance on coal for electricity from around a third to zero."

Some business members of the alliance were also continuing to back coal in various forms, the report found. The US pension fund Calpers had about $8bn invested in coal, according to the latest data available, from September 2019, and the investment house Schroders had more than $5bn in such investments.

A spokesperson for Calpers said: "We invest in companies which use coal, and are through Climate Action 100+, driving towards the net zero goal."

A Schroders spokesperson said: "Our membership of the PPCA reflects our concern about the threat climate change poses and the view that the coal industry in particular is at the forefront of that climate challenge. It's clear that global greenhouse gas emissions must decline, which will require structural changes in many of the most exposed companies.

"We have engaged with these companies and many across the sector extensively over a number of years on their climate change ambitions and strategies and continue to believe that our, and our industry's, influence and voice will be an important driver of the changes needed in the global energy market."

Schreiber called for the loopholes in the PPCA declaration to be closed, and for its deadlines on coal phase-out to be brought forward, in line with scientific advice, to target a global elimination of coal-fired power by 2040.

Smoke and steam billow from Bełchatów power station in Poland, Europe's largest coal-fired power plant. Photograph: Kacper Pempel/Reuters

Latest Orica software predicts vibration and airblast outcomes to protect sensitive structures and maximise blast outcomes

Orica, the world's largest manufacturer of commercial explosives and innovative blasting systems, announced the release of its new Advanced Vibration Management (AVM) software that links blas design, modelling and measurement to conserve sensitive structures.

Continuing its efforts to create safer, predictable and more productive blast outcomes, Orica has added Advanced Vibration Management (AVM) to its integrated BlastIQ™ digital blas optimisation software suite. Delivering value to customers by adding world-class digita expertise and solutions to its existing suite of market-leading products and services built on more than 140 years' experience and innovation in blasting.

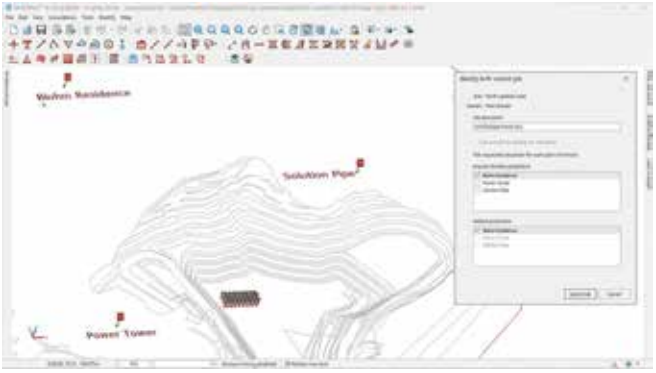
AVM accurately predicts blast vibration, enabling maximum productivity while minimising risk to nearby critical structures. When used in conjunction with the BlastIQ™ suite, AVM allows customers to seamlessly link blast designs, drilled actuals and vibration measurements, and uses sophisticated modelling to accurately predict blasting outcomes Building on the simpler tools historically housed within Orica's SHOTPlus™ Premier design software, AVM offers a step change in vibration and airblast management by using cloud computing architecture to deliver reliable and timely data across multiple measuremen points throughout the operation.

Orica Vice President – Digital Solutions, Raj Mathiravedu said: "Vibration management is critical to many sites' ongoing license to operate and can instantly stop the operation if not effectively controlled. The release of AVM is driven by these needs and is the latest too resulting from our continued investment in developing intelligent and autonomous modelling systems that enable our customers to make informed productivity improvement decisions."

Improve productivity while protecting license to operate

Vibration and airblast are common outcomes from blasting and can be dangerous and disruptive if not managed effectively; in fact, a mine's social license to operate often hinges on well managed vibration limits. The most common route to resolving these issues is to blast at significantly reduced energies, which often comes at a cost to load and haul productivity, and often negatively impacts production and throughput downstream.

Vibration management using accurate modelling, measurement, and site seed-wave analysis is known to improve productivity but is often expensive, time consuming and performed on a discrete basis. AVM's online application provides a simple yet insightfu interface to capture and see the predicted and actual results of vibration monitoring, with the power of cloud architecture to drive the modelling from blast design through to execution.



Access more areas of the operation and more resources

When structures sensitive to vibration and airblast are closely located to an operation uncontrolled blasting operations can cause significant damage. With the use of an advanced prediction algorithm, customers can now access areas of their operations that may have previously been inaccessible or deemed too high risk to blast in. This can allow operations to blast in high risk areas, potentially, extending the overall life of an operation.

AVM is now available globally for all mining and quarrying operations. As customers increasingly look to transform their operations with digitally connected technologies, Orica continues to innovate and lead through new and enhanced technologies to optimise blasting outcomes.

More information on Advanced Vibration Management can be found at orica.com/AVM.

Orica's Advanced Vibration Management (Visualisation).

Clive Palmer project hits roadblock

The Queensland Department of Environment and Science has knocked back Mineralogy's proposed Central Queensland coal project near Great Barrier Reef.

The project was deemed unacceptable on the grounds that its environmental risks would exceed its economic benefits.

The proposal involves a greenfield, open-cut coal mine which would extract up to 10 million tonnes per year of thermal and coking coal, 130 kilometres northwest of Rockhampton.

After assessing the amended environmental impact statement (EIS) from Mineralogy, the Queensland Department of Environment and Science (DES) concluded that "the project presents a number of unacceptable risks that cannot be adequately managed or avoided."

The project was planned to be a joint venture between Palmer-founded Mineralogy subsidiaries Central Queensland Coal and Fairway Coal.

As the mine was set to be 10 kilometres from the border of the Great Barrier Reef World Heritage area, the DES deemed there would be risks related to water management and local ecology.

The DES acknowledged the many attempts the project had made to mitigate the risks involved, as this was the third amendment to the project's original EIS.

"The proponent has made a significant number of changes to their proposed mine plan, proposed additional mitigation and avoidance measures, developed a revised monitoring network, provided for additional offset proposals, and a range of other commitments, including adopting an adaptive management approach," the DES stated in the EIS assessment report.

However, on top of hazardous ecological risks, the report recognised risks associated with land rehabilitation, cultural heritage and transport.

The DES stated that its rejection was "due primarily to the location of the project, but also in part to the lack of effective mitigation measures proposed in the EIS."

The mine was set to create an estimated 222 construction jobs over the 24-year mine life and contribute more than $7.8 billion for the Queensland economy.

Peabody offloads mothballed QLD mine to MetRes

MetRes, a joint venture (JV) between Stanmore Coal and M Resources, has acquired the Millennium and Mavis Downs coal mine in Queensland from Peabody Energy.

The mine is currently in care and maintenance with mining to recommence from July 2021, ramping up to a production rate of one million tonnes per annum. MetRes expects the mine restart to create between 150 and 200 long-term jobs.

An upfront cash consideration of $1.25 million and a royalty agreement will be provided for the acquisition, Stanmore stated.

According to MetRes chairman Matt Latimore, the company hopes to achieve low-cost mining through an underground expansion at the site.

"The acquisition opens the way to extracting full value from the Millennium and Mavis Downs mines by streamlining operations through auger and open cut mining methods followed by underground extension from the existing highwalls to achieve very low-cost mining, and stable production of low-ash, high-quality Mavis Downs metallurgical coal, a well established brand in the global marketplace," he said.

M Resources subsidiary M Mining will recommence rehabilitation works at the site when mining restarts.

Rehabilitation obligations are expected to be around $25.7 million with Peabody agreeing to pay back $12.5 million of rehabilitation costs over two years.

"The acquisition and restart of Millennium and Mavis Downs Mine is a shot in the arm for Queensland's economic recovery and for Central Queensland and we are excited to work with our partners, regional stakeholders, local and state government and long term customers in bringing this coal back to the market" Latimore said.

"This project will produce high quality metallurgical coal which is in high global demand and remains an essential component of the steel making process. Queensland is a reliable and high-quality supplier."

Access to a 500,000-tonne-per-annum long-term rail and port capacity will also be provided under the acquisition.

Millennium and Mavis Downs has produced hard coking coals and metallurgical coals. The site contains a joint ore reserves committee (JORC) resource of 37 million tonnes.

Poland prolongs Turow mine life despite international outcry

The Czech Republic filed a lawsuit against Poland in February, saying Warsaw had violated the bloc's law with an earlier extension of mining at Turów until 2026.

Poland's climate ministry has extended a mining concession for the open-pit coal mine in Turów until 2044, outraging environmental campaigners, who said the move would worsen the climate crisis.

The decision comes as the Court of Justice of the European Union is poised to decide in early May whether the mine, located near the Czech and German borders, must close immediately, following a lawsuit filed by the Czech Republic in February.

The Czech Republic said Warsaw had violated the bloc's law with an earlier extension of mining at Turów until 2026. Meanwhile, Czech residents close to the mine say it has contaminated drinking water and they have suffered from noise, dust and subsidence.

"Extending the concession means a further deepening of the climate crisis," Greenpeace said in a statement.

"Poland's actions show a total disregard for EU law," Zala Primc, campaigner at Europe Beyond Coal, said.

Poland's climate ministry said its decision was in the public interest as Turów supplies lignite, or brown coal, to a nearby electricity plant, which provides around 5% of Poland's power, the owner, state-run energy group PGE, says.

PGE has said a sudden closure of Turów, which together with the power plant is a major employer, could lead to economic collapse in the province and shake "the stability of Poland's power system".

The company, which plans a new 496 MW unit at the Turów power station, said has begun work to reduce dust and noise.

EU countries have agreed to cut their combined net greenhouse gas emissions to zero by 2050. Poland, which generates around 70% of its electricity from coal, was the only EU country that did not commit to the goal when the bloc set it in 2019.

VKG concept of 'Green Cluster'

VGK, one of the ten largest coal mining companies in the Russian Federation, intends to create a 'Green Coal Cluster' in the Uglegorsk District of the Sakhalin Region. The concept of the project was presented by the Chairman of the Board of Directors of VGK, Oleg Misevra, in the framework of the plenary session at the Open Day of the Sakhalin Region for investors. According to preliminary calculations, the implementation of the new concept will reduce the carbon footprint by 64 000 t of conventional carbon fuel and reduce carbon dioxide emissions by 176 000 tpy.

"Countering the threat of climate change is forcing humanity to unite and take drastic measures. These are not only regulations, restrictions, but also initiatives, as well as new technologies. In our case, the 'green turn' is not only justified, but also as organic as possible. We are actively growing and developing, and development today is the introduction of the most effective technologies, based on a lean approach and the use of alternative sources. All this, in all seriousness, allows us to talk about the prospects for the creation of the 'Green Coal Cluster', said Oleg Misevra, Chairman of the Board of Directors of the All-Russian Mining Company.

The Green Coal Cluster concept will include three innovative projects. One of them is already under construction: this is the longest main coal conveyor in the Russian Federation. The project combines modern technologies and advanced environmental standards. The facility under construction will reduce the load on public roads, abandon the transportation of coal by cars, which will reduce emissions of exhaust gases into the atmosphere, and deliver coal in the most environmentally friendly way recognised throughout the world. To date, the facility is working on the assembly and installation of equipment.

Another project is being implemented jointly with the manufacturer of automotive equipment – the BelAZ plant. The development of an electric dump truck with a carrying capacity of 220 t provides for the operation of a mining dump truck at the field, which uses an external source of energy from trolley lines. The use of such transport will lead to a decrease in the consumption of fossil hydrocarbons, a preservation of the climate, a decrease in harmful emissions at the place of operation of equipment and an increase in the economic effect associated with the use of electricity and an increase in the productivity of machines.

The most ambitious project within the Green Coal Cluster is the construction of a wind farm with a total capacity of 67.2 MW in the Sakhalin Region. It will be the most powerful wind farm in the Far East. The wind farm will include 16 wind turbines located in areas with high wind potential. In addition to the difficult terrain, the uniqueness of the project lies in the fact that the wind farm is being built according to the needs of the company to provide power supply to all production facilities. To date, two sites have been identified for the installation of wind turbines, where wind monitoring will be carried out until the end of 2021.

New technical innovation schemes introduced in industry

The coal industry sector of the DPRK has made achievements by waging a brisk technical innovation movement in hearty response to the idea and spirit of the Eighth Congress of the Workers' Party of Korea and the Second Plenary Meeting of the Eighth Central Committee of the WPK.

More than 70 valuable technical innovation schemes have been devised and introduced so far in the Ministry of Coal Industry to help increase coal production this year.

The Tokchon Area Coal-Mining Complex has secured lots of new coal fields by introducing a new effective blasting method invented by the Jenam Coal Mine into other coal mines.

Coal miners of the complex also drew up 20 innovation plans during the first quarter of this year, including the one for enhancing the capacity of compressor and the one for saving raw materials by over 20%.

The Tukjang Area Coal-Mining Complex has increased the coal conveyance rate by 1.2 times by applying several new technologies.

Coal mines in other areas have made progress in the tunnelling, cutting and conveyance of coal by directing efforts to resolving the urgent sci-tech problems.

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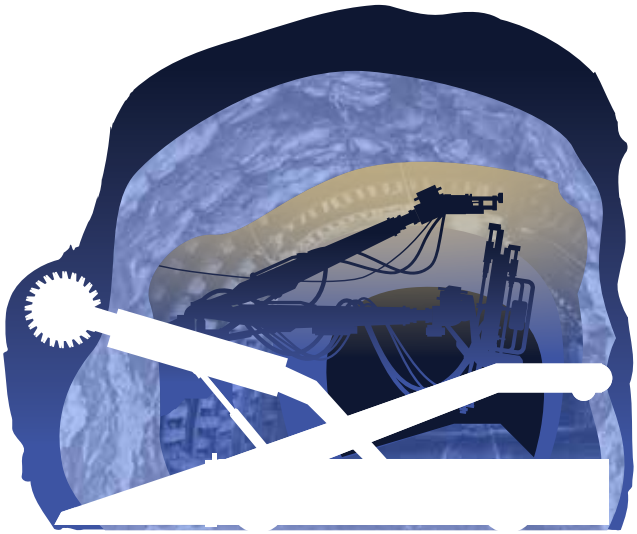

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Anglo American opens Grosvenor to workers

Anglo American workers have started to re-enter the Grosvenor underground coal mine in Queensland for the first time since activities halted following an incident in May 2020.

The company has undertaken a staged re-entry approach and gradually welcome more workers back to site.

The first team, who re-entered, will conduct safety and compliance inspections and restore power and gas monitoring.

Anglo American metallurgical coal chief executive officer Tyler Mitchelson said this would ensure the mine remains safe.

"Following a substantive program of work that included permanently sealing the impacted area of the mine with five large, concrete seals and installing additional gas monitoring infrastructure, we completed a highly rigorous risk assessment process ahead of re-entry, drawing on both internal and external experts," he said.

"We are taking a staged approach to re-entry, with the team initially completing safety and compliance inspections, and restoring power and gas monitoring to ensure the safety and integrity of the mine."

Resources Safety & Health Queensland (RSHQ) approved the re-entry, which has allowed Anglo American to bring back the mine workers.

"I would like to acknowledge the very thorough and detailed approach taken by RSHQ in working with us over the past few months to ensure the permanent sealing process and our risk assessment for mine re-entry reflects leading industry practice," Mitchelson said.

The Grosvenor operation in Queensland.

In May 2020, an ignition event at the Grosvenor coal mine injured five people.

The company had since focussed on safety improvement work by delivering remote operations.

"…These solutions will be embedded at Grosvenor prior to restarting longwall mining in the second half of this year," Mitchelson said.

"The safety of our workforce is our priority and we are continuing to engage closely with them and support all of our colleagues who were impacted by the incident last year."

Anglo American produced 3.3 million tonnes of metallurgical coal in the 2021 March quarter. This was down from 3.8 million tonnes in the 2020 March quarter

The company also produced 4.9 million tonnes of thermal coal in the 2021 March quarter, compared with 6.2 million tonnes in the previous corresponding period.

Australia's NSW Government to buy out entire Watermark mine permit

Australia's New South Wales (NSW) Government is reportedly planning to purchase a mining permit granted to China Shenhua Energy for the Watermark coal mine.

The Watermark coal project involves the development of three mining areas. Credit: Martina Janochová / Pixabay.

Australia's New South Wales (NSW) Government is reportedly planning to purchase a mining permit granted to China Shenhua Energy for the Watermark coal mine.

Shenhua would be paid less than $156m (A$200m) by the government for the licence buyout, the Sydney Morning Herald quoted an undisclosed senior government official as saying.

Shenhua has been working to develop the $745.90m (A$1bn) Watermark Project since 2008. It is located adjacent to the Liverpool Plains, 3km west of the village of Breeza and 25km south-east of the Gunnedah township.

The thermal and semi-soft coking mine's economics have been affected by the suspension of coal

shipments from Australia to China, as well as a deteriorating outlook of the prices.

In a statement, a Shenhua spokeswoman said: "As the mining lease application is still being assessed, it would be inappropriate for us to make any comment at this time."

The project is also being opposed by farmers and local Aboriginal people, who claim that the mine would impact the water table in the region and disturb important cultural sites.

In 2008, Shenhua made an initial $300m payment for an exploration licence near Breeza.

In July 2017, the government agreed to pay $262m to the Chinese company to buy out a 51% stake in the exploration licence.

Alberta halts exploration in mountains while consultations ongoing

The Alberta government has bowed to public pressure and paused coal exploration in the most sensitive areas of the Rocky Mountains while it continues to gather public feedback about mines.

"In response to concerns from Albertans, all coal exploration projects on Category 2 lands will be halted immediately," Energy Minister Sonya Savage said at a news conference. Although the government stopped selling new leases earlier this year, drilling and road-building on existing leases had been expected to continue.

Savage also said a panel struck to gather public input into the United Conservative government's plan to dramatically expand the industry will be able to hear concerns about effects on land and water.

"Of course, Albertans can talk about their concerns on the impact of coal on water and the environment and tourism. We want to hear those concerns."

The panel's terms of reference suggested those concerns were off the table because they were not under the control of the Energy Department. Savage said Friday she has enough jurisdiction over environmental concerns to include land and water in the consultations.

Epiroc awards recognise mining automation and diesel-to-battery conversion

The new diesel-to-battery conversion kits for the Scooptram ST1030 loader are the focus of one of Epiroc's annual awards 2021.

Epiroc AB, a leading productivity and sustainability partner for the mining and infrastructure industries, is recognising mining automation and battery electrification with three annual awards.

The United in Performance Award honors exceptional customer collaboration. This award is presented to Rodrigo Izzo, Carlos Valencia, Pedro Debia and Luis Vera of Epiroc Chile, as well as to mining company Antofagasta Minerals' team at its Los Pelambres copper mine. Through close collaboration, they made two Pit Viper 351 drilling rigs fully autonomous, which has strengthened safety and productivity at the mine. Benefits include allowing the rig operators to control the machines from a safe and comfortable control room three kilometers away from the mining site.

The Inspired by Innovation Award honors Epiroc's most innovative technical development that has had a proven commercial success. It is presented to Fredrik Jormvik, Mattias Pettersson and Andreas Öqvist of Epiroc's Underground division; Ermin Kodzaga, Rickard Hendeberg and Wesley Santos of the Technology & Digital division; and Rohan Andersson and Alex Diamond of Epiroc Australia. They have been instrumental in making Epiroc the first equipment supplier to provide a mixed-fleet automation solution for underground mining, for Newcrest Mining Limited at its Cadia Valley gold and copper operation in Australia.

The inaugural Dare to Think New Award gets its name from Epiroc's new vision. It is presented to Maria Dikmen of the Parts & Services division, Fredrik Martinsson of the Rocvolt team and Underground division, Shawn Samuels of Epiroc Canada, Sathish Thamarai Selvan of Epiroc's engineering center CMTEC in India, and Fredrik Grahn of the Technology & Digital division. They are part of a team of passionate people who have successfully developed conversion kits that enable customers to transform diesel-powered machines to battery-electric versions, thereby improving the work environment and lowering emissions while improving productivity. The Scooptram ST1030 underground loader is the first machine to get the retrofit solution, with more machines to follow.

"Congratulations to the award winners and other contributors to these exciting projects. They truly represent Epiroc's innovative spirit and vision to dare to think new," says Helena Hedblom, Epiroc's President and CEO. "Automation and battery-electric conversion are important parts of our innovation focus to support customers on their journey toward improved safety and productivity and lower emissions."

Greece confirms last plant will be shut in 2025

"We are saying goodbye to the coal age," Greece's energy state secretary told EURACTIV following an announcement that the country's last lignite plant will be shut down in 2025, three years earlier than planned.

Greece's Public Power Corp. (PPC), the country's biggest energy company, said it was abandoning its plan to operate its Ptolemaida 5 lignite plant, which is still under construction, until 2028.

Instead, the plant will switch from lignite to fossil gas in 2025, said PPC, a 51% state-owned company.

The move was announced on 22 April, weeks after PPC surpassed expectations with its first-ever green bond, marking the country's decisive move away from coal.

"The shutdown of all lignite plants by 2025, earlier than the original plan, marks the entry of Greece into the club of countries that fully adopt the principles of clean energy, while sealing the transformation of PPC into a modern energy player in Europe," said Greek State Secretary for Energy Alexandra Sdoukou.

"We are saying goodbye to the coal age and looking forward to a new period of development for the country with a renewable sign and high competitive potential," she told EURACTIV in emailed comments.

In September 2019, Greek Prime Minister Kyriakos Mitsotakis made a pledge to end all dependence on lignite by 2028, saying all but one of the country's coal-burning plants would close by 2023.

But PPC's departure from coal is driven mostly by economics. Two years ago, the Greek government was struggling to find buyers for three coal-fired power plants owned by PPC, a company which was losing one billion euros per year, in part due to its heavy reliance on coal.

PPC had already announced plans to close all of Greece's other existing lignite plants by 2023. With Ptolemaida 5 not scheduled to come online until 2022, campaigners expressed doubts about whether it will burn lignite at all.

"PPC has finally realised it has wasted billions on Ptolemaida 5, and caused untold damage to people's health and the Greek economy," said Mahi Sideridou, from the Europe Beyond Coal campaign.

"The fact that the EU's fourth-largest lignite producer is abandoning coal tells you everything you need to know about the state of the industry. Now PPC needs to turn its full attention to the country's enormous renewable energy potential. Former coal communities deserve far better than to be tied to more fossil fuels, like fossil gas."

Campaigners' attention is now turning to the plant's planned conversion to fossil gas.

"The constant rise of the CO2 prices is ramping up the pressure on coal power plants across Europe, but switching from coal to fossil gas is not the solution," said Dimitris Tsekeris from WWF Greece.

"Fossil gas is in the same position as coal was 15 years ago, and will face a similar crisis of stranded assets in years to come. We need to lock-in sustainable alternatives, not more fossil fuels. Fossil gas cannot be part of this plan," he said.

A huge excavator is seen on operation as smoke rises from a power plant in the background, at the lignite center of Western Macedonia, near the city of Ptolemaida, northern Greece.

South Korea pledges end to state financing of plants

South Korea will halt state-backed financing of coal-fired power plants overseas and also plans to strengthen its emissions reduction commitment under the Paris agreement.

President Moon Jae-in made the announcement at a virtual climate summit hosted by U.S. President Joe Biden. The White House is said to have asked South Korea to withdraw from recent coal projects, but the Asian nation will only halt funding for future plants abroad. The country also plans to increase its current target to reduce emissions by 24.4% by 2030 from 2017 levels, in the second half of the year.

"While there's a global need to reduce the number of coal-fired power plants for the goal of carbon neutrality, the challenges facing developing countries that rely on coal should be taken into account, and appropriate measures should be taken," Moon said in his address to the conference recently. "South Korea plans to support the expansion of green finance that invests in renewable energy facilities both at home and abroad."

Maxam mining group

As a major global specialty tire manufacturer and distributor, MAXAM has a strong reputation for market-leading quality, reliability, and delivered value. MAXAM MINING GROUP (MMG), a dedicated global group under MAXAM Tire, specifically focuses on the mining segment. The MMG's core value is to provide superior support on all MAXAM products through partnerships with high-level dealers in conjunction with the support from MAXAM MINING GROUP. Their goal is to ensure the best product performance and the highest level of overall customer satisfaction while reducing the end-user's operating costs. Gaining a strong reputation in the industry, MAXAM Mining Group continues to innovate and engineer products with the best performance and value.

Most recently, MMG has ramped up its investment in the ultra-large OTR tire segment following the recent introduction of its first-ever 63-inch tire, the MS453. To meet the toughest requirements for haul trucks that require 63" large mining tires, the newly developed MS453 utilises an enhanced casing construction with advanced compounding technology. The MS453 is the result of advanced engineering, extensive research, and global testing. MAXAM designed the MS453 with the goal to provide the best-delivered value, greatest productivity, and the lowest cost-per-ton value for global mining operations.

Featuring a rugged and aggressive tread design that allows maximum tire life for the most demanding mining applications, the MS453 is built to withstand even the most severe challenges on haul roads. Taking feedback from customers and mine sites globally, MAXAM has reinforced the sidewall of the MS453 by enhancing the tread belts and bead construction to provide maximum protection and performance. Similar to the products within the large mining series, the MS453 features a deep tread depth to deliver longer tire life. It also contains a heat-resistant undertread for reduced heat built up, increasing the tire's TKPH/TMPH.

As mining applications continue to evolve, MAXAM's engineering team continuously develops new products utilising leading technology that focuses on performance, safety standards, reliability, and quality. In today's competitive market, mining customers are looking for other viable large haulage tire options. The recently launched MS412 27.00R49 is a perfect reflection of MAXAM Tire's innovative vision on providing performance, technology, and value. Designed to tackle demanding conditions in mine sites globally, the MS412 is the result of cutting-edge engineering and groundbreaking compounding technology.

The MS412 features a high net-to-gross tread pattern that provides extremely low wear rates that drastically increase tire life. MAXAM's engineers have also strategically placed stone ejectors to provide maximum protection from stone drilling, which leads to the cause of premature tire removal and out of service conditions. Engineered with tread grooves that allow for exceptional traction and heat dissipation, the MS412 delivers excellent traction in a variety of haul road conditions. To enable high-speed operation with minimum heat build-up, MAXAM has optimised the

MS412's base compound to help maximise productivity for mining operations globally.

Featuring a strong all-steel casing to reduce cuts and punctures, the all-new MS412 is engineered with increased casing durability to dominate severe hauling conditions. As an innovative group, with years of expertise in the mining industry, MAXAM's engineering team has designed the MS412 with a high lug-to-void ratio for improved wear and impact protection, providing mine sites increased protection and wear on haulage tires.

Delivering a premium E4 haulage tire to the industry, the MAXAM MS412 provides exceptional performance, minimum cost-per-hour, and a high net-to-gross pattern for maximum tread wear. The MS412 is available in one size as noted in the below chart. Available in multiple tread compounds, including the recently released ultra-cut resistant compound, innovated by MAXAM's engineering and R&D team, the MS412 is a rugged solution that maximises the haulage truck's resilience in the toughest mining environment.

MAXAM Tire currently boasts (14) haulage and support equipment models that have applications across multiple industries, bringing relevant and innovative solutions to customers in all segments. Innovative engineering, extensive testing, research, and state-of-the-art manufacturing differentiates MAXAM from its competitors. As the MAXAM MINING GROUP continues to expand globally, its customer satisfaction remains the foundation of MAXAM and therefore they continue to innovate in all aspects of the tire business. Driven by core values that are centered around innovation and commitment to create an exceptional customer experience, MAXAM's people are committed to continued advancement and to exceed expectations. It is what makes the MAXAM difference – being your business solutions provider.

In record time

The total conveying length of the Pipe Conveyors is approx. 6.6 kilometres, the conveying capacity 5,500 tons per hour.

An economical solution was required for transporting large quantities of iron ore from the Chinese port of Langshan to the plant of steel manufacturer Shandong Steel Group & Rizhao Steel Group. The general contractor Shandong Harbour Engineering awarded BEUMER Group with the installation of additional efficient Pipe Conveyors. Project implementation took around eight months. In only four months, the system provider installed the mechanics of the systems with a total conveying length of approx. 6.6 kilometres and a conveying capacity of 5,500 tons per hour.

Shandong is an eastern Chinese region on the Yellow Sea. More people live here than in Germany and Austria combined, while the area of Shandong is only about half the size of Germany. Its name translates to "East of the mountains" and refers to the Taihang mountain range, east of which lies this coastal province, strategically located between the Chinese economic metropolises Beijing and Shanghai. Another advantage is its access to the Yellow River: the region has a dense network of waterways and several important trade and transhipment ports. The steel manufacturer Shandong Steel Group & Rizhao Steel Group is also headquartered here.

For its manufacturing, the company requires large quantities of iron ore which is delivered to the port of Langshan. In order to transport the material to the plant, the company previously relied on a closed Pipe Conveyor, but the capacity was gradually exhausted and was no longer able to handle the transport volume. The managers were looking for an economical solution and approached the Shandong Harbour Engineering Group. The engineering service provider was commissioned as general contractor to create the infrastructure. Now the question was: Should the plant use a well-developed expansive railway and road network or invest in a conveyor system solution?

Shandong Harbour Engineering Group turned to BEUMER Group. The system provider develops conveying solutions for a variety of bulk materials - for example open troughed belt conveyors or closed Pipe Conveyors. BEUMER engineers were also involved in the system, which is already in operation.

PIPE CONVEYORS - DOES IT PAY OFF?

"Of course, we had to prove that this investment was worthwhile", says Zhengwei Zhang, project manager at BEUMER Machinery (Shanghai) Co., Ltd. "In advance, we performed an economic evaluation." This included a feasibility study, an investment calculation, the project schedule and a cost-benefit analysis. Different variables are required to compare the costs of Pipe Conveyors with those of trucks or trains, for example the transport costs per ton, the material volume that needs to be moved within a set period of time, and also the specific investment costs and the tax depreciation plan. "More costs are added for the construction and the supply of the conveyor as well as for the mechanical and electrical installation", explains Zhengwei Zhang. Complex construction work is also often necessary. The initial investment in a

conveying system is usually very high, but the operational costs of a Pipe Conveyor can be considerably lower depending on the application. Important factors include the estimated cost of a ton of material to be moved or, in the case of vehicles, the number of round trips per hour. “Our Pipe Conveyors lead directly to the destination and we can immediately adapt it to the corresponding site structure,” explains Zhengwei Zhang. A significant advantage of BEUMER technology is that it enables horizontal and vertical curves.

Depending on the characteristics of the conveyed material as well as of the system’s geometry, it is possible to implement vertical curves with angles of inclination up to 30 degrees and horizontal curves with a deflection angle of up to 90 degrees. This ability to navigate curves reduces the number of supports and replaces the transfer towers, which results in substantial cost savings for the customer. The system transports the iron ore safely enclosed across various terrains such as roads, residential areas or rivers. During the projection phase of the system, BEUMER technicians use proprietary calculation software to determine the static and dynamic loads - loads, which do not only affect the belt but the steel structure frame as a whole. This is a prerequisite for safe and correct dimensioning of the structures.

ECOLOGICAL AND ECONOMICAL

BEUMER Group provides their belt conveyors with environmentally safe electric drives and low-energy belts. Therefore, especially in these times of climate change and increasing greenhouse gas emissions they are considered a more sustainable option. The motors used are usually adjustable, which permits the loads to be optimally distributed on the drive units under various operating conditions. The closed design of this conveying system also protects the environment from falling transported goods. Another advantage is the elimination of dust development on the running line. This is important because the section between the port and the plant leads through public roads and residential areas.

“Our evaluation of the various transport options enabled us to consider the total costs per ton over time”, says Zhengwei Zhang. “With this application, the Pipe Conveyor will pay for itself quickly, and the system is more environmentally friendly than truck transport.”

OPTIMALLY TAILORED CONVEYING SOLUTION

“Together with the managers in Shandong, BEUMER engineers developed a solution that is optimally tailored to their requirements. The system supplier delivered a conveying system consisting of two Pipe Conveyors. The overall length is approx. 6.6 km, the diameter 500 mm. At a speed of 5.15 m/s, the systems operating together convey up to 5,500 tons of material per hour considerably supporting the already existing conveying solution. In addition, a transfer tower is used.

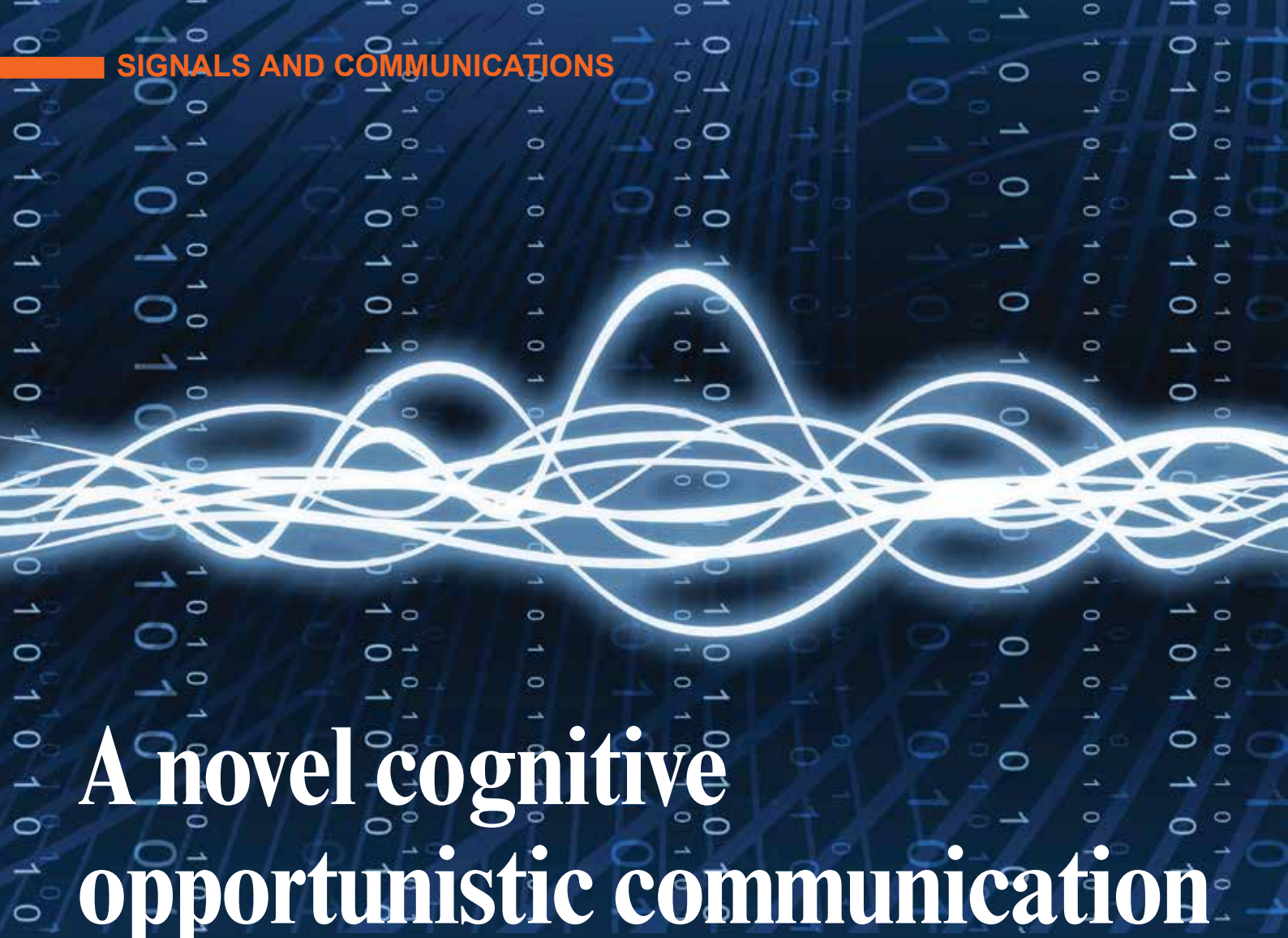
BEUMER Group was responsible for the overall project, which included the design of the system and the entire steel structure. The completely enclosed conveying system ensures an environmentally safe, dust-free and low-energy transport of the iron ore. The system provider started the installation in September 2018 and commissioning took place only four months later. The complete project implementation took only eight months. “We are very satisfied with BEUMER Group’s single-source solution and the handling of the project”, states Liu Qiang, executive director and general manager at Rizhao Port Shipbuilding & Machinery Industry Co.,Ltd, Shandong Harbour Engineering Group. “The two Pipe Conveyors allow us to work in a more economical way and we are optimally prepared for future capacity expansions at our plant.”

The BEUMER solution permits Shandong Steel Group & Rizhao Steel Group to work in a very economical way.

For the entire project, BEUMER Group was able to ensure that the iron ore is transported safely and quietly, without disturbing the residents or disrupting the surrounding nature.

Liu Qiang, executive director and general manager at Rizhao Port Shipbuilding & Machinery Industry Co.,Ltd, Shandong Harbour Engineering Group: “We are very satisfied with BEUMER Group’s single-source solution and the handling of the project”.

Picture credits: BEUMER Group GmbH & Co. KG



A novel cognitive opportunistic communication framework for coal mines

CHINA

Coal production and consumption has been playing an important role in the energy industry, especially in China. It is crucial for the safe and efficient production to monitor environmental parameters, equipment status, personnel information, production situations, and security status and send these parameters to the ground monitoring centre in real time via the ubiquitous mine internet of things (MIoT). A mine roadway, comprised of rough coal, rock, and bolt-beam-mesh, has extensive branches and bending with narrow and long space. At the same time, a mine roadway is full of metal supports, large production equipment, transportation vehicles, and steel rails, resulting in strong multipath effects, serious fading, and significant interferences of radio wave propagation. Particularly, all equipment in a coalface must keep advancing throughout the mining process, which causes dynamic changes of the communication space[1]. Due to the aforementioned mine roadway characteristics, wireless communication systems used in mines face unique difficulties compared to those used on the surface, such as the following: (1) communication nodes may be damaged by coal, rocks, or humans, resulting in intermittent or regional network connections; (2) the time-varying physical communication space forces wireless channels into a time-varying state, resulting in intermittent network connections; and (3) the great amount of dust produced during the coal cutting process and the presence of large, moving metal equipment result in poor adaptation to wireless communication systems, whose main effect on communication systems is also regional or intermittent node connection.

To address the wireless communication problem of intermittent or regional connection in mine roadways, two critical difficulties must be resolved: adaptation ability of communication systems to the changing environmental parameters and the relatively stable transmission ability under an inevitable unstable condition of intermittent or regional connection.

Coal International looks at a recent paper that proposes a novel cognitive opportunistic communication framework for coal mines in China to enhance the ability of the MIoT to adapt to the mine roadway environment and ensure that monitoring signal will not be interrupted by the harsh time-varying transmission environment, supporting, and guaranteeing the construction of digital and intelligent mines. Compared to existing communication frameworks for ground applications, this framework includes components specific to coal mines to address the special communication difficulties met by the roadway. Compared to existing communication frameworks for coal mines, this framework includes models specific to special roadway sites and emergency situations based on opportunistic and cognitive technologies to deal with communication problems introduced by regional or intermittent connection.'

ABSTRACT

The dynamic advancement and harsh environment of coal mines often result in intermittent or regional wireless connection between sending nodes and receiving nodes and then lead to the decrease of transmission success ratio and even failure. To solve this problem, the environmental cognition and best-effort transmission are both demanded. Here we proposed a novel communication framework for coal mines based on a cognitive opportunistic concept to address the wireless network communication problems in coal mines, which consists of the node mobility model in coal mines, cooperative cognition of the time-varying communication environment, and the opportunistic routing of intermittent or regional connection scenarios. To realise this framework, real time neighbour discovering mechanisms and mobility perceiving strategies, called environment cognition, must be deeply investigated to predict the trends of node movement. The obtained results of environment cognition are then used to analysed current channel characteristics in order to determine and set optimum communication system parameters and reduce the probability of intermittent or regional connection. To address those unavoidable situations of the intermittent or regional connection, the opportunistic routing mechanism is brought forward to provide relatively stable data transmission. Finally, as an example of cognitive opportunistic mine communication of this framework, personnel evacuation under an emergency is discussed.

The major contributions are summarised as follows:

1. We reviewed the state of the art of the wireless communication technologies in coal mines and revealed their characteristics and key challenges. Besides, we also analysed the reasons why communications systems used in surface environments cannot be directly utilised in coal mines

2. We proposed a cognitive opportunistic mine communication framework, which can adapt to the dynamic advancement and vulnerability of mining nodes and is thus of great significance to guarantee the successful communication

3. Some key technologies were deeply investigated, such as the node mobility model in coal mines, cooperative cognition of the time-varying communication environment, and the opportunistic routing of intermittent or regional connection scenarios

4. An application example of personnel evacuation under an emergency scenario was explored to demonstrate the effectiveness of the framework the remainder of this paper is organised as follows.

Section 2 surveys some typical wireless communication systems and their challenges in mines and proposes a cognitive opportunistic mine communication framework.

Section 3 details the three key technologies involved in the proposed framework, namely, the construction of the node mobility model, cooperative cognition of the time-varying communication in the mine roadway, and the opportunistic routing of intermittent or regional connection scenarios.

As an exemplary application scenario, Section 4 discusses the application of cognitive opportunistic mine communication for personnel evacuation in an emergency. Section 5 concludes the whole paper.

STATE OF THE ART OF WIRELESS COMMUNICATION IN MINES

Existing investigations into wireless mine communication have generally focused on the propagation characteristics of a wireless signal, network models, network protocols, and communication system development.

PROPAGATION CHARACTERISTICS OF A WIRELESS SIGNAL

Typical research methods in this field are ray tracing, waveguide theory, and experimental testing. Ray tracing is a method to investigate the transmission characteristics of a wireless signal by tracing the path of rays[2], which is often inefficient because of the strong multipath characteristics present in most mines. The waveguide method regards a mine roadway as a waveguide in order to study the transmission characteristics of a wireless signal[3]; however, the complex mine environment often produces significant differences between results obtained by a waveguide theoretical model and those obtained by practical testing. Experimental testing is a method often used to obtain such statistical characteristics as

path loss and delay spread of roadways by conducting field investigations[4]; experimental conclusions are often closely related to the experiment locations and signal frequencies.

NETWORK MODELS

Typical mine network models include chain models and mesh models. The chain model deploys wireless nodes linearly along a roadway corresponding to its linear characteristics[5], but it is more likely to form energy holes. In a mesh model, some nodes such as access points act as backbone nodes, interconnecting with each other to form a mesh network[6]; some access points which have accessibility to the wireless sensor networks are referred to as gateways. Thus, this type of network is essentially a mixed network composed of wireless and wired components which requires support from transmission cables[7].

NETWORK PROTOCOLS

The purpose of protocol design is typically to expand network coverage, improve success ratio of message transmission, and reduce energy consumption or transmission delay. Network coverage is primarily implemented by studying different node deployment methods[8], which must take into account the relationships among the coverage model, the roadway width limit, and node redundancy. Success ratio of transmission and network energy consumption are often the greatest challenges to successful wireless network communication[9]. In particular, some nodes in a chain network model will not work any longer once their energy becomes depleted[10]. Finally, transmission delay is related to the type of data and the method of relay node selection[11].

SYSTEM DEVELOPMENT

Primary types of wireless communication systems in mines include ultra-low-frequency, through-the-earth communication, medium-frequency induction communication, leaky feeder communication, personal handy-phone, ZigBee, and Wi-Fi systems[12]. These systems are typically transplanted from ground systems without consideration of the special difficulties presented by the mining environment. Many systems are unable to adapt to the complex, changing communication environment of mines and may only prove to be effective in a part of a mine or roadway, but ineffective in the overall mining environment[13].

The reason why wireless communication technologies on ground cannot be directly applied to mine roadways is that communication systems must be able to perceive the complex and changing environmental characteristics around them and tell these results to their communication partners in a timely manner, so as to increase the cooperative communication abilities. Traditional wireless communication systems which utilise relatively fixed parameters such as communication frequency, modulation method, and bandwidth are often unable to adapt to the aforementioned dynamic and various changes in a mining environment. Additionally, in a complex environment like the mine roadway which contains many devices

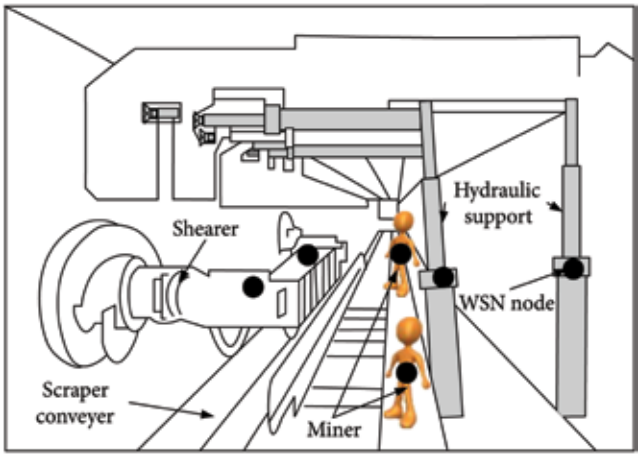


Figure 1: Coalface and its WSN deployment.

as well as various geological structures and roadway interconnections, data transmission and reception between wireless communication nodes must follow a suitable routing protocol to be dynamically adaptive to the environment. Take the coalface, the forefront of coal production, as an example. To enable the coal cutting, roof supporting, and coal transporting, all miners and mining equipment (such as the shearer, hydraulic support operator, and scraper conveyor operator) must cooperate closely. The dynamic advancement of the equipment at the coalface forces the communication space into a time-varying state, making it impossible to lay additional wired communication cables in a timely manner. Under these conditions, wireless communication must be flexible to deploy and easy to extend as the mining face advances. For this purpose, wireless sensor network (WSN) nodes can be deployed on the hydraulic supports, shearer, and miners (**Figure 1**)[14]. These nodes move along with the equipment and miners, leading to a linear (chock-type support) or bilinear (chock-shield support) topology based on the linking conditions. Because of the extensive existence of the reliable wired/wireless networks in tailgates or headgates, the wireless sensor network at the coalface can easily transmit its messages to access points in gateways and then to other regions of the mine or ground information centre. That is, these access points will be the sink nodes of the WSN in a coal mine.

Unfortunately, the information at the coalface cannot always be transmitted to the sink node due to the intermittent or regional connections, which is a frequent situation encountered in mine roadways. For example, coal production may make some network nodes occasionally damaged and sudden accidents can also induce network coverage failure in some areas. The most common method to maximise the network coverage in mine roadways is to increase node density, which can not only result in increased costs of system construction and operation, but also lead to increased network management complexity. Therefore, it is imperative to investigate new paradigms of wireless network design for use in mines.

COGNITIVE OPPORTUNISTIC COMMUNICATION FRAMEWORK FOR COAL MINES

Actually, intermittent, or regional connection does not mean absolute or permanent failure of communication between the transmitting and receiving nodes[15]. The negative effects of unstable link quality will be substantially offset by a communication system with the ability to dynamically cognise environmental features and self-adaptively adjust communication parameters based on the results of cognition[16], reducing the probability of intermittent or regional connection. Considering that node movement creates a meeting opportunity for nodes located in different regions, data can be transmitted to other nodes that are more likely to meet the target node even in the case of intermittent or regional connection; such information can then be stored, transported, and forwarded for delivery to the target node[17]. An opportunistic communication network based on cognition of the mine environment can adapt to the dynamic advancement and vulnerability of mining nodes and is thus of great significance to improve successful communication.

At present, few studies have been reported which investigated self-adaptive mine communication based on opportunistic communication. Ji Luo conducted a study on delay-tolerant communication in coal roadways[11], in which the tramcar in the mine roadway was used as a mobile sink node, and the sensors deployed in the roadway remained stationary; the tramcar moved along the deterministic path in the roadway to directly collect data from sensor nodes, thus avoiding multihop transmission. However, this study only considered the specific circumstances of a moving tramcar and stationary nodes, while practical applications must also take into account the moving nodes which represent underground miners. The reported study also failed to consider the effects of dynamic changes in the physical communication space and did not address the environmental self-adaptation problem in mine roadways, thus failing to address the challenges posed by intermittent or regional connection.

Three key problems must be addressed in order to implement cognitive opportunistic mine communication:

1. The establishment of the node mobility model based on the node movement characteristics and spatial constraints of mines: this model will serve as the basis for cognition of the mine environment and the implementation of opportunistic communication. The difficulties implementing this model include the state transition mechanism and performance bounds of the model, its concordance with actual motion, influential factors, and their interaction mechanism of the model

2. The dynamic determination of optimum parameters for communication links to reconfigure the communication system automatically: this is essential to the environmental self-adaptation of wireless communication systems for mines and to the reduction of intermittent or regional connection. The main challenges are the modelling of the joint optimisation in order to dynamically determine and configure the optimum communication parameters

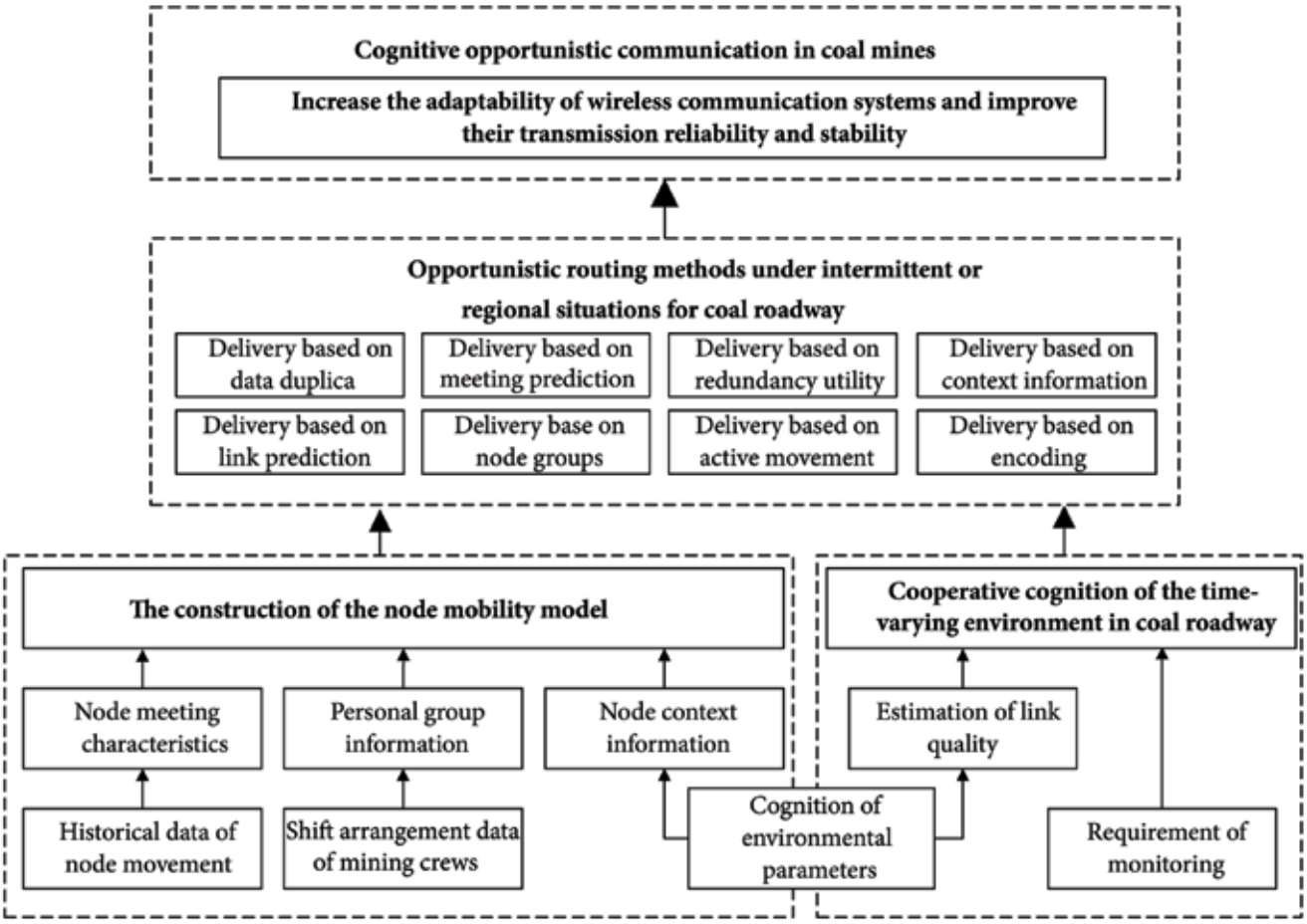


Figure 2: Cognitive opportunistic communication framework for coal mines.

3. The design of opportunistic routing algorithms accurately reflecting the characteristics and requirements of mines based on the influential factors of transmission performance and their operational mechanisms: this is necessary to relatively stable data transmission of wireless communication systems for mines under intermittent or regional communication conditions. The challenge presented by this problem is that there are too many various factors which must be considered when designing such type of algorithms

Here an opportunistic mine communication framework is proposed; see **Figure 2**. First, historical data of node movement achieved by positioning systems are used to determine and analyse node meeting characteristics such as the interval and duration of node meetings. The work arrangement of mining crews is utilised to investigate the groups to which different personnel belong. The cognition results of environmental parameters are exploited to obtain contextual information regarding the node circumstances. The analyses described above as well as the physical roadway structure make it possible to construct the node mobility model. Second, a node timely determines the available channels between itself and its neighbour nodes according to the perceived environmental parameters. Based on the monitoring requirements of the ground monitoring centre and channel estimation results of mine roadway, the communication system parameters are adjusted to implement its self-adaptation to the mine environment. Finally, based on the established node mobility model and the results of communication environment cognition, the opportunistic communication mechanism of mine roadways can be investigated, and effective opportunistic routing algorithms can be designed to implement stable data transmission under regional or intermittent connection conditions.

To address the challenges faced by the proposed architecture, Section 3 will discuss the construction of the mobility model for moving nodes in mine roadways, as well as cooperative cognition of the time-varying communication environment and the opportunistic routing of intermittent or regional connection scenarios.

CONSTRUCTION OF THE MOBILITY MODEL FOR MOBILE NODES IN MINE ROADWAYS

Data transmission in a mine roadway is primarily affected by transmission distance, the node mobility model. and neighbours scanning frequency[18]. Additionally, much data is closely related to the contextual information of nodes and demonstrates strong temporal or spatial characteristics[19]. Therefore, discovery of neighbours, the perception of node mobility, and construction of a mobility model serve as the foundations for environmental cognition. The synchronous neighbour discovery methods are not appropriate for a mine roadway because the assumption of one node transmitting and one node receiving does not necessarily hold true, particularly in a coalface. Besides, it is essential to carefully investigate the scanning frequency of neighbours to make a trade-off between energy consumption and information timeliness.

Mobility models are the basis for movement perception and the design of a routing algorithm. Current studies of mobility models have primarily focused on discovering the distribution characteristics of meeting intervals and durations[20] and the establishment of network sequential diagrams reflecting changes of network topology[21]. Experimental data have also been used to study the characteristics of information transmission paths in order to determine the temporal-spatial correlation between nodes[22]. Traditional mobility models based on random movement assume that both destination and velocity are random; this is characterised as Brownian motion, such as that employed by the random waypoint model (RWP) and random walk model (RWM). This type of mobility model facilitates the theoretical derivation of performance bounds; it is very flexible, and its movement characteristics can be extended by making changes to the model parameters. However, this type of model cannot capture the actual movement patterns of moving objects in mine roadways. The tramcar, shearer, and hydraulic support in a mine roadway move according to a highly regular pattern, but the movement of a miner is both regular and random due to the constraints of their job types and working hours. Existing mobility models cannot fully reflect these characteristics, and further study must be conducted to explore the mobility models of nodes based on the characteristics of mine roadways to provide guidance for the design of opportunistic routing algorithms.

First, the existing positioning system is used to collect the location and time information of the moving nodes in the mine roadway in order to obtain historical datasets of node movement (**Figure 3**). The status distribution and meeting intervals and durations of nodes at a given moment reflect the temporal and spatial characteristics of opportunistic networks, which are of great significance to data transmission. These studies help solve[23,24] (1) which nodes frequently meet the current node and are thus candidates for relay selection; (2) which nodes have social and group connections which may indicate a greater willingness to communicate cooperatively; and (3) how long a meeting lasts, in which an optimal time value will allow complete yet efficient communication.

A mobility model can then be designed based on the obtained statistical characteristics. For example, the movement of nodes in a mine roadway can be modelled as a temporally correlated Markov process, which is then validated by experimental data. If the states of a message located at node and node are called current state and next state, respectively, then its transition from the current state to the next state corresponds to a data transmission scenario. The period of time spent awaiting the transition from one state to another represents the meeting interval, and the period of time spent in the designated state represents the meeting duration. Different states correspond to different mine locations, and state transitions correspond to location migration. Transitions into and out of the same state demonstrate identical movement characteristics, while transitions between different states demonstrate different movement characteristics. A feedback mechanism can be introduced to the state transition process in order to mitigate the fluctuation of motion patterns in different locations. Node mobility can thus be perceived, and node movement can be predicted based on the node mobility model and node discovery mechanism.

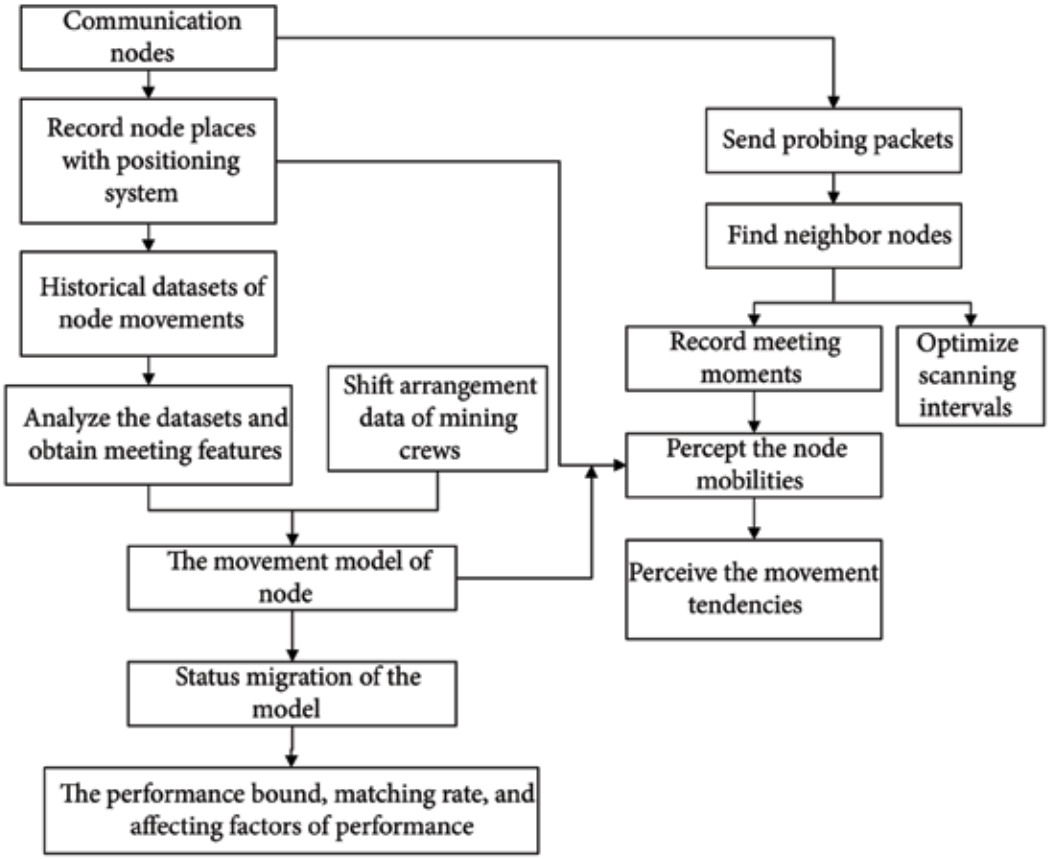


Figure 3: Construction of the mobility model for mobile nodes in mine roadways.

COOPERATIVE COGNITION OF THE TIME-VARYING COMMUNICATION ENVIRONMENT OF MINE ROADWAYS

Due to the dynamic changes in the physical space and the harsh working conditions of mines, the wireless links in mine roadways are subject to sudden, significant changes, which can result in the loss or increased delay of data. Environmental cognition helps enhance the adaptation of communication systems to environmental changes. Once link quality reduces, the communication system can adjust its parameters to adapt to the current surroundings in order to avoid intermittent connection. For this purpose, it is essential to estimate the link quality in real time[25] in order to adjust the communication parameters to optimum values in a timely manner. For example, the power of transmission systems can be improved to increase the one-hop transmission distance in order to improve the success ratio of data transmission under poor link quality or relay failure conditions.

However, higher transmission power also results in greater energy consumption and leads to greater interference to neighbours on the same frequency[26]. A self-adaptive power control algorithm may be designed to reduce energy consumption (**Figure 4**) and to enable nodes to establish and maintain connection using minimum power requirements. Power control and channel selection must be jointly optimised in order to reduce interference[27] and must be designed as a distributive, dynamic algorithm which may employ game theory, or the machine learning method based on local node information such as local signal-to-noise ratio. Both environmental cognition and parameter adjustment require that nodes engage in explicit or implicit information exchange when they meet[28], leading to a cooperative mode based opportunistic cognition and adjustment.

To implement environmental parameter cognition, nodes must effectively perceive the communication environment and adjust parameters based on the environment, user goals, and node capabilities[29]. However, it must be noted that environmental cognition cannot be equated with environmental perception; the latter simply involves parameter acquisition, while the former involves decision-making based on perceived information[30], even in situations in which the acquired environmental information is incomplete.

Next, algorithms can be designed to achieve the collaborative reconfiguration of communication parameters based on link estimation, the current optimum parameters of the link characteristic model, and the monitoring requirements for mines in order to appropriately adjust the communication system parameters such as encoding schemes (i.e., differential binary phase shift keying (DBPSK), differential quadrature phase shift keying (DQPSK), and complementary code keying (CCK)). These algorithms may consist of three engines: an environmental cognition engine, an application interface engine, and a calculation and decision engine. The environmental cognition engine is used to perceive environmental information, the application interface engine receives monitoring requirements from users, and the calculation and decision engine is used to reconfigure node parameters based on the environmental information and the user requirements. Link estimation and scheduling must be characterised by passive scheduling and triggered by changes in communication parameters; active link scheduling can also be implemented based on user requirements.

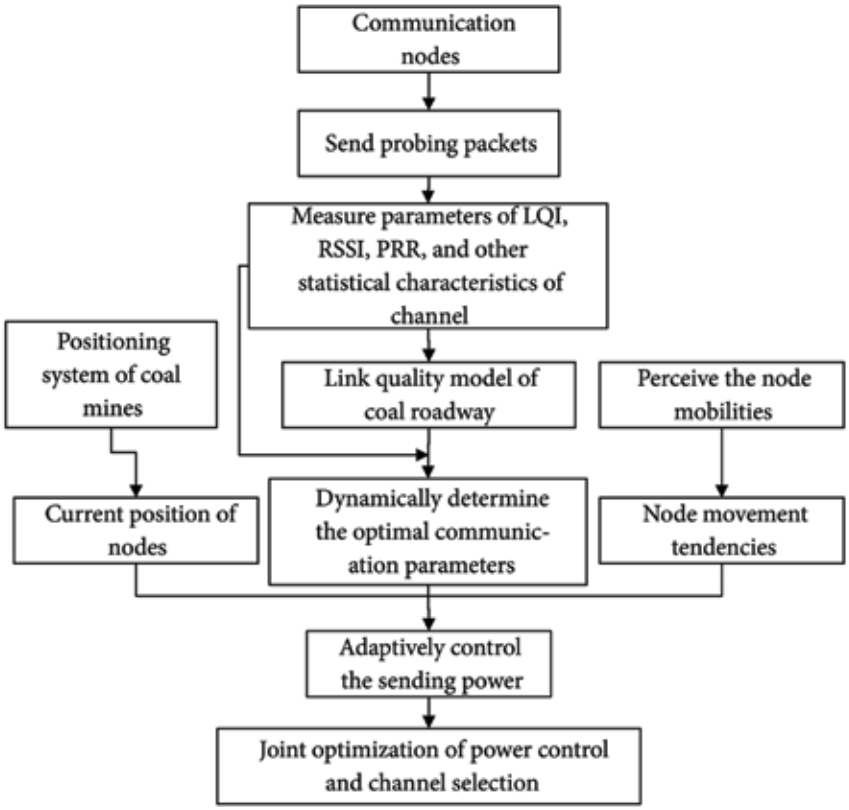


Figure 4: Cooperative cognition of the time-varying communication environment of mine roadways.

OPPORTUNISTIC ROUTINGS OF INTERMITTENT OR REGIONAL CONNECTION SCENARIOS IN MINE ROADWAYS

If the decline of data transmission performance does not result from the link degradation but from link interruption, the studies described above will not be enough to ensure data transmission. As a possible solution, node movement characteristics and the spatial constraints of mine roadways must be explored in order to design an efficient opportunistic routing method. In the field of opportunistic routing, existing studies have extensively focused on the forwarding mechanism based on a message replica. This forwarding mechanism creates a balance between transmission delay and resource consumption by controlling the number of copies[31] or calculates the probability of node meeting based on historical information and link prediction before forwarding the data to the nodes that are more likely to meet the destination node[32].

Node movement in a coal mine consists of highly correlated cooperative movement that seeks to accomplish production goals. In the coalface, a shearer driver operates the shearer to cut coal, and the hydraulic supports advance to support the roof during the mining process. The mined coal is then transported to the belt via the scraper conveyor and then lifted onto the ground after transportation via the belts or tramcars. This overall process involves driving, mining, transportation, ventilation, and drainage and thus requires a great number of personnel and lots of equipment. The movement of the equipment and personnel includes both regular movement (such as that exhibited by the shearer, hydraulic support, and tramcar) and mixed regular and random movement, such as the movement of the operators. Overall, the majority of node movements in mine roadways is characterised as regular movement.

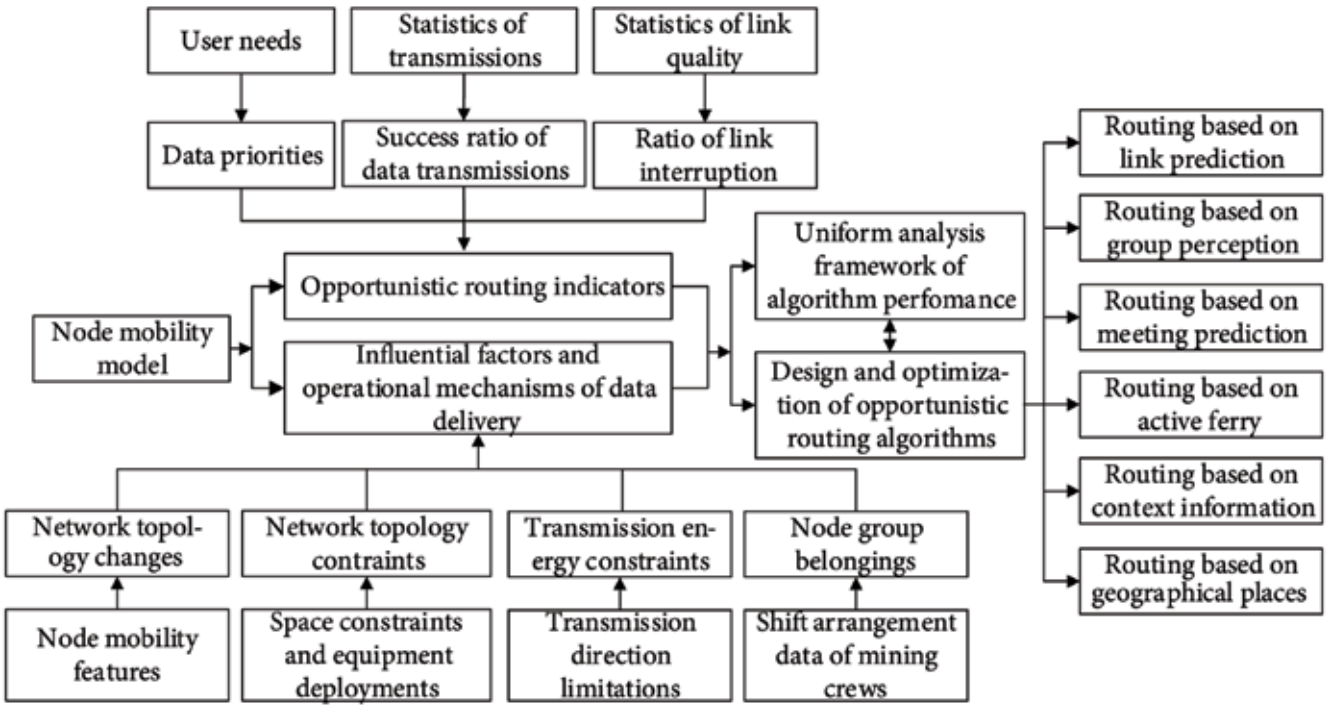


Figure 5: Opportunistic routings of intermittent or regional connection scenarios in mine roadways.

With the help of mobility models, opportunistic routing algorithms can be designed based on meeting prediction, copy distribution, and context distribution mechanisms; see **Figure 5**.

Additionally, nodes in a mine roadway often transmit data in a linear, directional manner. For example, the data transmission of the coalface always heads to the sink node in the headgate or tailgate. Therefore, it is appropriate to design an opportunistic routing algorithm based on geographic locations. The tramcars and personnel which partake in cyclic reciprocating motion provide opportunities for data transmission between nonadjacent equipment and personnel which can serve as the ferry node between disconnected nodes. Furthermore, the established node mobility model incorporates historical meeting information and node meeting characteristics. Based on these various characteristics, different utility indicators can be designed for opportunistic transmission. According to the results of communication environment cognition, a set of relay candidates can be determined for the current node in order to implement opportunistic transmission based on link prediction. The success of message transmission as well as the energy consumed by transmission is greatly affected by the number of nodes in a mine roadway, the number of messages to be transmitted, and message size. Finally, the parameters of the physical layer, link layer, and network layer can be combined[33] to design cross-layer opportunistic routing algorithms.

An Exemplary Application: Personnel Evacuation Based on Cognitive Opportunistic Communication in an Emergency

Cognitive opportunistic communication is of great significance to the mobile acquisition of mine environmental information as well as the continuous monitoring of miners' health information, particularly to disaster prevention and reconstruction of a mine internet of things designed for ordinary activities. As an example, this section discusses the application of cognitive opportunistic communication to the transmission process of disaster information in an emergency, such as a coal mine flood, the presence of excessive gas, and production accidents. In case of an emergency, the sensor node (carried by a person) which first perceives the emergency must quickly transmit the information about when and where the accident took place and the urgency degree of the accident to nearby personnel and instruct personnel to evacuate as quickly as possible, as shown in **Figure 6**.

However, some nodes in the accident region may not be in normal working status as a result of the emergency, making the accident information incapable of being transmitted. However, the sensor nodes carried by moving objects (e.g., personnel or vehicles) can detect the accident information and subsequently transmit the information through cognitive opportunistic communication during evacuation.

1. The first person who perceived the emergency will first evacuate from the area of danger. As more people are met during the evacuation and information is exchanged, more people will evacuate. In this way, information is diffused during the evacuation process

2. A vehicle typically moves in a periodic motion along a determined path at a determined rate in order to transport goods or personnel. If no person is in the vehicle, the vehicle will continue to move until it meets a person to which it will forward information regarding the accident. If a person is present in the vehicle, the person can choose to evacuate by the vehicle continuously or get off and evacuate on foot

Emergencies that occur in a mine roadway often affect one or more areas of the roadway rather than a single place, such as in the case of a coal mine flood or the presence of excessive gas. Therefore, personnel must move toward a designated safe area. For example, as shown in Figure 6, there are four designated evacuation routes. Following route 1, a person can evacuate directly along the upper oblique straight roadway; following route 2, a person can evacuate directly along the lower long straight roadway; following route 3, a person can evacuate along the lower roadway

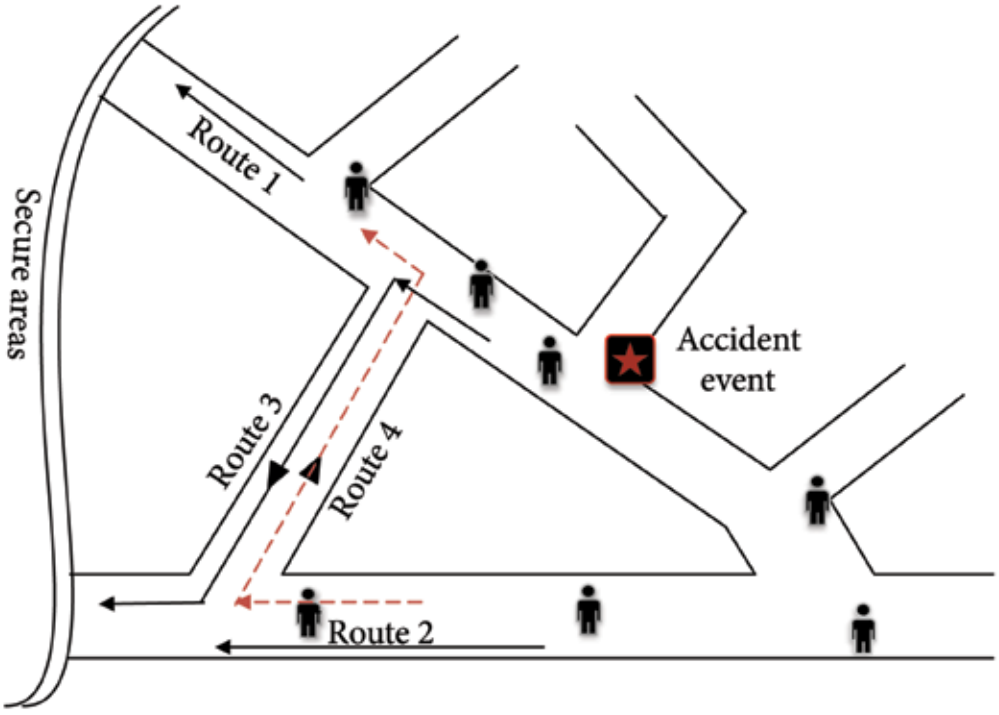


Figure 6: Personnel evacuation under emergency scenarios.

after passing through the upper roadway and the middle roadway; following route 4, a person can evacuate along the upper oblique straight roadway after passing through the lower roadway and the middle roadway. In an actual mine roadway, different roadway combinations may generate many escape routes; a person can evacuate quickly and safely only by following a designated optimum path.

As the popularity of the mine internet of things increases, personal terminals used for perception in mines have developed increasingly diverse functions and strong computing capabilities [34]. A roadway map can be stored in personal terminals and advice about best escape routes can be offered in case of an accident, based on the perceived information of the accident scenario. A circumstance in which all personnel evacuate along the same route should be avoided in order to avert congestion or collision, and the cognitive opportunistic abilities of the communication system can recognise the mine environment in real time in order to plan, guide, and proactively evaluate optimum escape routes and to ensure balanced traffic distribution. This indicates that cognitive opportunistic mine communication is of great importance to accident information spread and evacuation path optimisation in an emergency.

It must be noted that all personnel who follow the feasible escape routes from the accident location to the pithead must receive information about the accident. However, personnel in roadways that are positioned directly opposite the escape paths cannot receive information about the accident because they cannot encounter any moving objects with the event information. This problem can be addressed from the following perspectives:

1. Mine trunk roadways are typically covered by wired industrial networks, while some of these roadways are also covered by Wi-Fi wireless networks and opportunistic communication is typically implemented at the endpoint of a coal mine such as the coalface. If an accident occurs at the endpoint of a coal mine, personnel nearby will see or hear the accident, prompting themselves to shout to warn others of the accident. As a result, all personnel in this region can quickly evacuate, prohibiting a circumstance in which the location of the accident cannot be communicated

2. If an accident occurs in an area covered by a traditional wireless network (such as a Wi-Fi, 3G, or 4G network) resulting in damage to some aspects of the wireless network, personnel in the underground coal mine will form an opportunistic network during evacuation, while personnel located behind the accident location can receive accident information via the mixed network

3. If a person is evacuated to a region effectively covered by a network, the accident message can be transmitted to the ground control centre via the backbone network, which then notifies all underground personnel of the accident situation via voice broadcast or direct transmission of the message to personal terminals. Of course, if an area of a roadway collapses, the miners behind the area of the roadway cannot evacuate and must wait for rescue no matter whether they have perceived the accident situation or not

CONCLUSIONS

The communication parameters of wireless mine communication systems, such as communication participants, signal transmission environment, and node mobility model, greatly differ from those of ground wireless communication systems. Cognitive opportunistic means, therefore, play crucial roles there, because their self-adaptive recognition mechanisms for mine environments and the opportunistic communication abilities keep communication systems informed about the time-changing environmental or communicational parameters. Keeping this issue in mind, we proposed a novel wireless communication framework for coal mines based on the cognitive opportunistic communication of the internet of things, which includes three key elements, namely, the node movement model constructing, the cooperative cognition of time-varying communication environments, and the opportunistic routing of intermittent or regional connection scenarios. Eventually, an example of personnel evacuation under an emergency scenario was explored to validate the usage of this framework. Subsequent studies will involve the theoretical investigation and field experiments based on the movement data collected from mine nodes, as well as the design of practical node mobility models, routing methods, and the system prototype of the cognitive opportunistic communication system for mines.

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Neither the pandemic nor closed borders stopped them. Extraordinary project of a Polish company

Is it possible to take on spectacular foreign projects during lockdown? Can you run a mining complex from 7,000 kilometers away while working online? Yes, you can! Hear about it from Karol Bartodziej, who is involved in a project to implement a unique Mikrus longwall system of a Polish company, FAMUR, for a customer in China.

Is it possible to take on spectacular foreign projects during lockdown? Can you run a mining complex from 7,000 kilometers away while working online? Yes, you can! Hear about it from Karol Bartodziej, who is involved in a project to implement a unique Mikrus longwall system of a Polish company, FAMUR, for a customer in China.

The 2020 pandemic has dramatically changed the reality for many entrepreneurs around the world. Employers had to quickly learn how to manage their teams in the face of epidemiological threats, quarantines, restrictions and lockdowns imposed by authorities in many countries, and sometimes border closures. This difficult situation did not bypass the FAMUR Group when we were in the process of implementing an important and difficult foreign project. Our company's headquarters and factories are located in Poland. Meanwhile, we had to deliver and put into operation the Mikrus (also called "Heilong", which means "Black Dragon" in Chinese) longwall system for a customer in China.

The delivery went well, the unpacking inspection - flawless, and suddenly it happened... a total change of circumstances, a dangerous coronavirus began to take over the globe. Instead of completing the next phase of work, which was to send maintenance and engineering staff to Asia to launch the system, we were faced with movement bans and the need to protect our personnel.

The Mikrus system is a set of machines consisting of a cutting and loading head, a dedicated face conveyor, a beam stage loader, a belt tailpiece (boot end) as well as a power supply and control system. These machines must work seamlessly with the rest of the longwall equipment, which, in this case was supplied by other manufacturers.

This complicated our work even more, as we could not comprehensively program the control system in Poland before shipment. This task had to be done on site. The customer was counting on us and could not wait indefinitely, and no one knew how long it would take before it was possible to cross the border of the Middle Kingdom again.

Thus, it became clear that we had to make every effort to launch our machines... remotely, despite the thousands of kilometers separating us. Since the contract provided for a compatibility test to be performed on the surface before underground operation, we and the customer decided that performing this task remotely was likely to be successful.

REMOTELY? OK, BUT HOW TO DO THAT IN TECHNICAL TERMS?

We started by our company hiring a team of service technicians in China who, although not previously familiar with our products, became our eyes and hands where remote contact was not enough. Step by step, under supervision from Poland, we started the assembly of machines and subsequent commissioning and parameterisation of the control system.

However, this posed a significant challenge. Tuning a machine system often requires uploading a new version of software to PLCs or observing the operating parameters of the system to see if everything is working as expected or to make adjustments. If the network connection goes down during such a task, the programmer's work is in vain. Meanwhile, China is separated from external networks under the government's Golden Shield programme, which sometimes adversely affects continuous data transfer. However, through joint efforts with the customer, the link was stabilised. The first difficulty was overcome.

Despite pandemic restrictions, we worked with the entire necessary team to start-up the various components of the system by communicating online. Paradoxically, this gave us improved direct contact with the most experienced designers in our company whenever necessary.

INSTALLATION, COMMISSIONING AND UNFORESEEN DIFFICULTIES

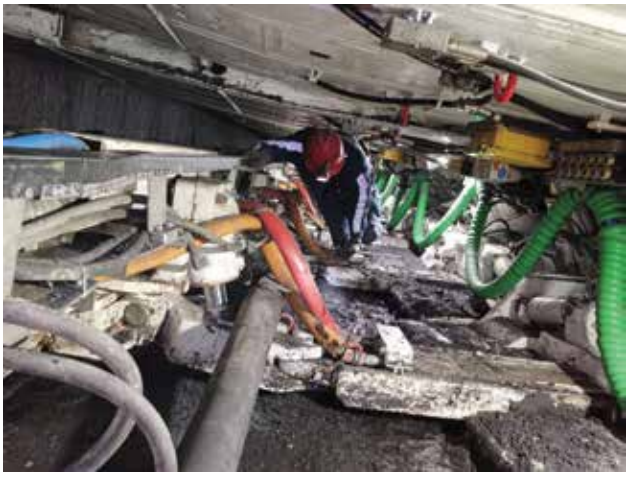
As requested by the customer, we first launched the system on the surface and carried out the relevant tests and training. The second installation – underground – followed shortly thereafter. The first cuts were made in early July 2020. The feeling of satisfaction associated with this view was immense for everyone involved in the project. The complex began to fulfil its primary purpose.

It was not without surprises, of course. In the middle of the longwall length, miners encountered a rock overburden of above-average hardness that had not been detected by previous geological surveys. Ordinary shearers for such low walls have a maximum drum power of 300kW, although the GUŁ-500 cutting and loading head of our Mikrus system has a 500kW motor and this power is transferred to the leading drum. Moreover, the system is automatically controlled, so when it detected an increased load on the drum, it slowed the feed of the cutting and loading head accordingly. In this way, the entire overburden of rock was mined without any overload and in a safe manner for the machine itself.

MIKRUS longwall system in the production plant in Poland, 2019.

MIKRUS longwall system's operator cabin, FAMUR production plant in Poland.

MIKRUS longwall system in the production plant in Poland, 2019.



Working conditions for people in low longwalls. The wall shown in the photo had a working range of 1.40-1.55 m.

The home page of the SmartMine control and visualisation system.

In addition, during the entire period of operation at the headquarters of the FAMUR Group, we conducted 24/7 supervision of our system in China to immediately respond and provide substantive support to the Chinese service in the analysis of the causes of possible downtime.

UNUSUAL WAY OF SUMPING

There were three elements that had the greatest impact on the success of the automatic operation. The first is, of course, the coordination of the movement cycle of the cutting and loading head with the operation of the electro-hydraulic system controlling the powered roof support. The

Presentation of MIKRUS longwall system remote control from the surface.

GUŁ cutting and loading head with medium drums (ø 1.40 m). Commissioning on the surface in China, 2020.

second is the UPZP-1200 belt tailpiece (boot end), which automatically follows the mining progress and is part of the beam stage loader. The third element is the SmartMine visualisation and control system, which enabled not only classic supervision of the current state of the machines but also, thanks to analytical functions, tuning of the drive control parameters to the existing geological conditions, which is crucial for autonomous operation.

One more thing to mention is an unusual cycle of the Mikrus system. Unlike in the case of classic longwall shearer systems, the Mikrus cutting head does not have to cut into the wall at an oblique angle, wasting valuable time at each end of the longwall, but it travels to the roadway instead and cuts into the face perpendicularly. Our analyses show that most classic longwalls lose more than 20% of their working time precisely for the diagonal sumping of the shearer into the next face. When our system is working in automatic mode, the time spent by the head on the return end or the chute, during which the beam stage loader is being sumped and hoisted, is approximately 3.5 minutes, after which the next cut is made automatically. This means real savings for the customer!

LESSON FOR THE FUTURE

The longwall system finished mining on 6 December 2020 and we can say with great pride that it will go down in the history of Chinese mining. It was the first longwall in the country with perpendicular machine sumping and also the first longwall to operate in fully automatic mode, including automatic hoisting of the beam stage loader. During its operation, the Mikrus system showed what it was made for. Not only did it allow us to work in extremely difficult conditions in automatic mode, but it also managed to mine a bed that no other machine could have mined.

It was also an important lesson for our company. Remote deployment and service is the future of the entire automation industry. While this is nothing new in many industries, such a comprehensive implementation is an entirely different matter in the mining industry. Automatic operation of a longwall system requires time-consuming coordination between the machines of the various suppliers of other longwall equipment, so it is a huge task that has usually been carried out side by side by the automation specialists of the individual companies at the destination site.

The experience gained during this commissioning showed us how we could expand the remote diagnostics features to further support the commissioning process. With this experience, we can already confidently offer our products to foreign markets even during periods of hard lockdown or other cross-border restrictions.

Karol Bartodziej
Director of Electrical Segment Development at Elgór + Hansen, the FAMUR Group

Lubrication – Getting it right

In coal mining, like other mining and minerals operations, there are two ways to move material from the pit to the processing plant: trucks or long-haul conveyors. As mines are constructed in more remote locations, there is a trend to move away from trucks and rely solely on conveying systems to move ore. Mechanical breakdowns of conveyors or indeed any other machinery can cause significant disruptions to a mine's normal production. Replacing one of the many drive train components may require an extended outage, costing millions of pounds in lost revenue. For example creating a drive system for multiple conveyor belts requires in-depth know how with the gearbox being a critical component of the conveyor drive and one of the most expensive to replace. Proper lubrication is essential to maintaining long-term performance. The oil has two main purposes: preventing the equipment from wearing prematurely and keeping it cool.

In addition to lubricating, circulating-oil systems perform a range of other functions, including maintaining the lubrication points at a proper temperature, filtering out wear particles from friction points, and preventing corrosion. Most mining facilities rely on flow measurement instrumentation to monitor circulating-oil systems for their long-haul conveyor gearboxes. This application demands a flow meter able to withstand extreme temperatures, dust and debris, and wide fluid flow ranges. Some devices used can be unreliable and difficult to maintain and adjusting the meter settings to suit changing oil conditions can prove difficult for site personnel.

In today's environment, where cost reduction is key, customers rely on equipment to work harder, for longer periods. They are looking to Some flow measurement devices can be unreliable and difficult to maintain and adjusting the meter settings to suit changing oil conditions can be difficult for site personnel. Extend equipment life, but also to spend less on maintenance. As such, there is a need to start looking beyond lubricants that just meet OEM specifications, to products that deliver increased corrosion protection, piston cleanliness and extended oil life.

The main challenges in the transmission are generating sufficient torque force whilst protecting against component wear under extreme pressure. In mining this is vital, with equipment required to work under high loads and at steep gradients. This requires a lubricant that offers the right frictional properties and contains long-lasting anti-wear agents, antioxidants, and extreme pressure additives

OPEN GEARS.

Failure of open gears can see vital machinery grind to a halt. For this type of application, it is worth selecting a specialised grease, as the performance benefits in terms of equipment protection can far outweigh the investment."

Grease application in the mining sector can be a specialist technical area, where selecting the right grease for the

right application can be critical to avoid costly equipment failures and unplanned downtime. This is particularly true for open gear applications, which are exposed to the elements in extreme conditions, and where contamination poses a significant challenge. Wear protection in severe operating conditions Extreme temperatures as open gears are exposed in all climatic conditions, the grease's viscosity and pumpability is critical. In extreme cold, it must remain fluid enough to flow through grease lines to protect components, while in extreme heat it must remain thick and adhesive enough to stay on equipment surfaces. Extreme conditions Contamination ingress is the direct cause of about 40% 7 of open gear failure. Exposure to high levels of dust, dirt, slurry, rain, and snow means open gears require greases that can maintain an adequate lubricant film and continue to flow while flushing out contamination. Extreme pressure and shock. To help keep equipment operating at maximum efficiency, greases must be specially formulated to withstand the high load, extreme pressure, and shock-loading faced by mining machinery on a daily basis. Application Misapplication is the cause of around 40% of open gear failure 8. Even a perfect lubricant cannot protect equipment if it is not applied in the right volume at the right time. Lubrication systems must be maintained and fine-tuned to ensure correct application happens.

MISALIGNMENT

Two perfectly aligned gears have a contact ratio of 100%. If misalignment causes the contact ratio to drop below 85%, the load and stress on the gearing will increase. This overloads the gears and the lubricant film and can result in sub-surface cracks and pitting, which significantly reduces component life and may result in gear failure.

LUBRICATION

No single factor affects the life of a gear drive more than lubrication. Each piece of mining equipment made by different original equipment manufacturers (OEMs) has its specific lubrication requirements. OEMs define the minimum requirements for lubricants or greases, but not all products that meet these standards deliver the same level of performance.

Choosing the correct lubricant or grease often depends on a combination of the equipment's design characteristics, operational parameters, and environment. Factors like temperature, humidity, and location (altitude/underground) all pose different challenges for lubrication.

Effective engine lubrication is critical to protect high-cost equipment, and minimise downtime due to frequent oil changes, maintenance or even component failures.

VISCOSITY CONTROL IN EXTREME CONDITIONS.

Engine wear as a result of metal-to-metal contact can occur at low speeds, high loads, or cold starts. The lubricant helps keep moving parts separated to avoid wear. At engine start-up, particularly in cold climates, the oil must remain thin enough to circulate quickly to protect critical components. Once the engine is operating under full load, the oil needs to remain thick enough and provide the necessary protection to help prevent abrasive wear.

SOOT BUILD-UP

Accumulation of soot in the engine can lead to oil thickening and abrasive wear. This is a particular challenge in underground mines, at high altitude, and when exhaust gas recirculation (EGR) is applied as an after-treatment system.

Extended periods operating at idle load makes an engine particularly susceptible to higher rates of soot generation. The use of API CJ-4 lubricants has been found to help reduce the impact of soot accumulation. Further performance increases are expected with the implementation of API CK-4 engine oils. Corrosion protection: Gases and acids are generated as a natural by-product of the combustion process. The lubricant neutralises these acids to help avoid corrosion. This is particularly important in engines with Babbitt-based plain bearings, which can be very susceptible to acid attack.

LONG OIL LIFE

Oxidation, soot accumulation and oil thickening, and the build-up of acids in the lubricant all contribute to oil aging. High quality synthetic engine oils with the right base oil and additive technology -including antioxidant additives -can maintain performance characteristics for longer in the presence of contaminants and by-products

DRIVELINES

Driveline technology is critical to mining operations; and component life, equipment downtime and oil drain intervals and therefore TCO – can be significantly impacted by the quality of the oil. Equipment often operates for long periods of time at high load, which can put further stress on both the component and the oil designed to protect it. Friction characteristics Powershift transmissions use a series of friction plates to help engage and disengage gears. The lubricant plays a critical role in transmitting frictional force, so its frictional properties are important for effective operation. Too little friction, and the plates can slip making gear changes difficult. Too much friction, and excess heat generation can cause damage to equipment and shortened lubricant life. Long Oil Life Oxidation stability and corrosion protection are also important to maintain oil performance. High quality transmission and gear oils with good oxidation resistance can resist degradation and break-down over time, thereby reducing downtime required for frequent oil changes.

WEAR PROTECTION

Viscosity Control In gear motors, the lubricant must help improve bearing life and give excellent protection against wear and pitting. Transmission oil helps keep moving components apart, such as gear teeth and rolling elements, thereby avoiding metal-to-metal contact and wear. Selecting a product that has the optimal viscosity for the application, along with the required additives to protect against wear and corrosion can have a major impact on equipment life. Viscosity and shear stability are also critical for performance at a range of temperatures.

WEAR PROTECTION

Extreme pressure in differential gears, specific contact

pressures can be so high that the transmission oil is squeezed away, allowing metal-to-metal contact. The use of extreme pressure additives helps prevent the contact areas of the teeth micro-welding together.

The future

ALTERNATIVE FUELS

Some countries are already introducing high biodiesel blends for mining engines. These include Indonesia, which adopted 20% biodiesel in 2016. In the long term, also expect increasing adoption of LNG fuels for mining engines.

Equipment – Mining equipment is getting bigger, so unplanned downtime will have even greater impact in the future. Equipment is also changing to become more efficient, which means higher loads and higher temperatures – working harder for longer. At the same time, oil sumps are becoming smaller, and a lower volume of lubricant must be able to perform equally effectively in increasingly demanding applications. Oil drain intervals are also becoming longer, placing even more stress on the oil formulation.

REAL-TIME MONITORING

Applying sensor technology, such as sensors, to enable real-time analysis of lubricant and equipment performance will play an increasingly important role.

TIGHTENING REGULATION

Equipment Emissions standards are increasingly stringent – for example, with the introduction of Tier IV F which include tighter emissions requirements. Lubricant regulations are also changing for modern hardware; for example, with the new API CK-4 diesel engine oil standards in North America.

TECHNICAL INNOVATION

As technology changes, lubricants, greases, and technical services designed to address key industry problems must change, too. A strong investment in innovation to develop new products for durability, protection and extended ODIs is critical. To foresee the changes, understand the relevance for lubrication, and respond effectively requires a deep understanding of the mining industry.

Polish plan to nationalise plants unlikely to push energy transition

The Polish government has proposed taking over hard coal and lignite-fired power plants, and lignite mines from the country's main state-controlled utilities Enea, PGE and Tauron. The units would be integrated into a new legal entity called the National Energy Security Agency (NABE) by the end of 2022.

This comes amidst increasing awareness of how frail and financially unsustainable the coal sector is in the country. Most recently, coal-mining companies received at least €212m ($256m) in bailouts and the Polish Mining Group, which represents national coal mines, has asked for €1.5bn in government support due to the Covid-19 recession.

The government claims the merger will lift the burden of coal from the state-owned utilities and free up fiscal space for them to develop clean energy sources. Under the plan, the agency would only spend money on existing power plant operations and would not invest in expanding coal power.

However, exactly what the government means when it says the new agency will enable a "gradual and long-term transformation of the power sector" is unclear. No phase-out deadlines have been declared for the plants over and beyond the existing national commitment to phase out coal by 2049.

The lack of decarbonisation commitments is out of step with EU climate goals. For the EU to achieve its 55% emission reduction target in 2030, electricity generated from coal across the bloc has to fall to 55 terrawatt hours (TWh) in the next ten years, says Climact, a Brussels-based environmental consultancy. Poland's new energy strategy for 2040, adopted in February, foresees the country alone producing around 75TWh of electricity from coal in 2030.

Analysis by Polish think tank Instrat, highlighted in Energy Monitor's Weekly Data, shows Poland could decarbonise its energy system much faster than the government proposes.

It presents a scenario where the share of coal in electricity decreases from 72% in 2020 to 13% in 2030 as power plants are gradually decommissioned. Only five units would be kept on standby with limited generation until 2040.

Polish mining companies are already experiencing significant financial losses with demand for coal in electricity generation on a downward slope, underlines the think tank. It projects a decrease from 36 million tonnes (mt) of demand in 2019, to 10mt in 2030 and 5.9mt in 2040.

Steam and smoke rises from the Belchatow Power Station located in Rogowiec in central Poland. (Photo by Omar Marques/Getty Images)

Engineering safer conveyors: art meets science

All new conveyor systems will inevitably succumb to the punishing bulk handling environment and begin the slow process of degradation. The system will eventually require more time and labor for maintenance, shorter spans between outages, longer periods of downtime and an ever-increasing cost of operation. This period is also accompanied by an increased chance of injury or fatality as workers are progressively exposed to the equipment to perform cleaning, maintenance and to fabricate short-term fixes to long-term problems. A total system replacement is cost prohibitive, but to remain compliant and/or meet ever-increasing production demands, upgrades and repairs are unavoidable.

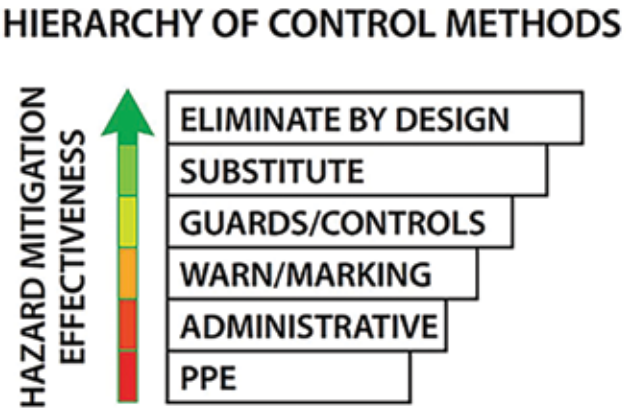
When examining the safety of a system, improving efficiency and reducing risk can be achieved by utilising a hierarchy of control methods for alleviating hazards. The consensus among safety professionals is that the most effective way to mitigate risks is to design the hazard out of the component or system. This usually requires a greater initial capital investment than short-term fixes, but yields more cost-effective and durable results.

THE SCIENCE: HIERARCHY OF CONTROL METHODS

Examining the US Occupational Safety and Health Administration (OSHA) accident database reveals the dangers of working around conveyors[1]. Studies have revealed that the highest prevalence of accidents are near locations where cleaning and maintenance activities most frequently take place: take-up pulley, tail pulley and head pulley.

Designs should be forward-thinking, exceeding compliance standards and enhancing operators' ability to incorporate future upgrades cost-effectively and easily by taking a modular approach. Designing hazards out of the system means alleviating causes with the intent to bolster safety on a conveyor system, but the methods of protecting workers can vary greatly. In many cases, it will be necessary to use more than one control method, by incorporating lower ranked controls. However, these lower-ranking approaches are best considered as support measures, rather than solutions in and of themselves.

PPE includes respirators, safety goggles, blast shields, hard hats, hearing protectors, gloves, face shields and footwear, providing a barrier between the wearer and the hazard. Downsides are that they can be worn improperly, may be



Safety improves as the type of hazard control moves higher up the hierarchy of methods±].

uncomfortable to use through an entire shift, can be difficult to monitor and offer a false sense of security. But the bottom line is that they do not address the source of the problem.

Administrative Controls (changes to the way people work) create policy that articulates a commitment to safety, but written guidelines can be easily shelved and forgotten. These controls can be taken a step further by establishing "active" procedures to minimise the risks. For example, supervisors can schedule shifts that limit exposure and require more training for personnel, but these positive steps still do not remove the exposure and causes of hazards.

Warning Signage is generally required by law, so this is less of a method than a compliance issue. It should be posted in plain sight, clearly understood and washed when dirty or replaced when faded. Like most lower-tier methods, signs do not remove the hazard and are easily ignored.

Installing systems such as *Engineering Controls* that allow remote monitoring and control of equipment – or Guards such as gates and inspection doors that obstruct access – greatly reduce exposure, but again, do not remove the hazard.

Using the *Substitute* method replaces something that produces a hazard with a piece of equipment or change in material that eliminates the hazard. For example, manual clearing of a clogged hopper could be replaced by installing remotely triggered air cannons.

Examples of *Eliminate by Design* are longer, taller and tightly sealed loading chutes to control dust and spillage or heavy-duty primary and secondary cleaners to minimise carryback. By using hazard identification and risk-assessment methods early in the design process, engineers can create the safest, most efficient system for the space, budget and application.

ECONOMIC ANALYSIS OF PREVENTION THROUGH DESIGN (PTD)

Another way of saying "Eliminate by Design" is PtD (Prevention through Design), the term used by The National Institute of Occupational Safety and Health (NIOSH). As a department of the U.S. Centers for Disease Control (CDC), the organisation spearheaded the PtD initiative[3]. In its report, the Institute points out that, while the underlying causes vary, studies of workplace accidents implicate "system design" in 37% of job-related fatalities.

Risk Assessment Matrix				
Probability / Severity	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

Risk assessment applied to design helps create a safer conveyor system.

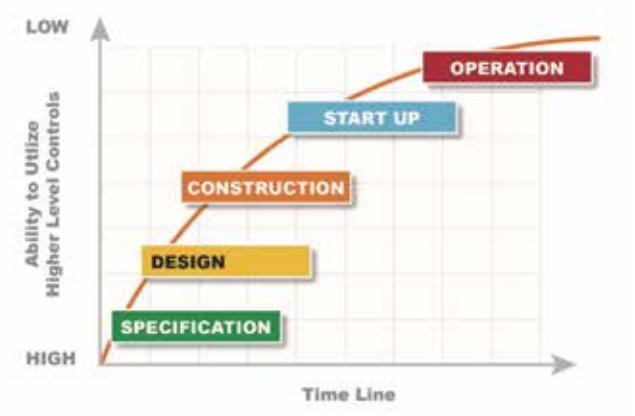
Cost is most often the main inhibitor to PtD, which is why it's best to implement safer designs in the planning and initial construction stages, rather than retrofitting the system later. The added engineering cost of PtD is often less than an additional 10% of engineering but has enormous benefits in improved safety and increased productivity.

The cost of PtD initiatives after initial construction can be three to five times as much as when the improvement is incorporated in the design stage. The biggest cause of expensive retroactive improvements is cutting corners initially by seeking lowest-bid contracts.

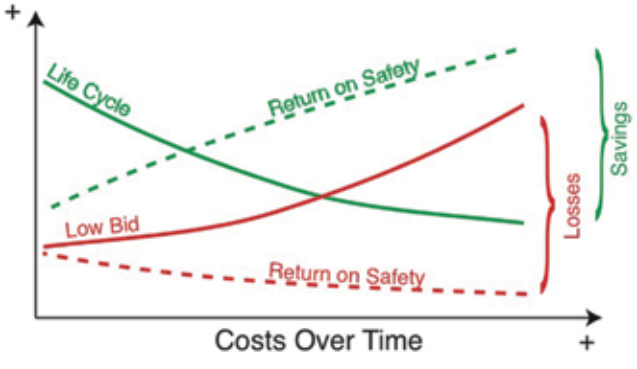
LOW-BID PROCESS AND LIFE CYCLE COST

Although the policy is generally not explicitly stated by companies, the Low-Bid Process is usually an implied rule that is baked into a company's culture. It encourages bidders to follow a belt conveyor design methodology that is based on getting the *maximum load* on the conveyor belt and the minimum compliance with regulations using the *lowest price* materials, components and manufacturing processes available.

But when companies buy on price, the benefits are often short-lived, and costs increase over time, eventually resulting in losses. In contrast, when purchases are made based on lowest long-term cost (life-cycle cost), benefits usually continue to accrue and costs are lower, resulting in a net savings over time[4]."



Incorporating effective hazard control techniques is easier and less costly in the early stages of a project[2].



The return on better design and quality is realised over the extended life and safety of the system.

Red, Amber, and Green List for Designing Better Belt Conveyors	
RED LIst	*Procedures, techniques, products, and processes to be prohibited in the Specification and Design stages of a conveyor project.*
	Prevent loading on the transition of the belt.
	Prevent transition of more than 1/3 trough.
	Prevent loading against the direction of the receiving belt.
	Prevent loading conveyor to 100% of CEMA standard cross section capacity.
	Prevent control and sequencing that allows conveyor(s) to run empty longer than necessary.
	Prevent belt identification stamps in top cover.
	Prevent installing equipment in elevated locations without provision of safe access or tie-offs.
	Prevent Component Selection Based on 'Or Equal' Specifications or 'Price Only' Bidding.
AMBER LIST	*Procedures, techniques, products, and processes to be eliminated or reduced as much as reasonably possible. Only allowed with a change in the specification and notice to project owner/manager explaining potential issues and ability to address them in the future.*
	Avoid reversing conveyors.
	Avoid multiple load points on a single conveyor.
	Avoid designs created with the intention to increase capacity in the future by increasing conveyor speed; design the system to accommodate future needs
	Avoid combined vehicle and personnel travelways or uncontrolled exits from buildings into traffic patterns.
	Avoid a site layout that does not allow for safe and efficient delivery, storage, lifting of major components such as pulleys, drives, and belting.
GREEN LIST	*Procedures, techniques, products, and processes to be encouraged in specification and design stages of a conveyor project.*
	Consider ergonomics in the design and access of frequently cleaned or maintained equipment.
	Consider use of pulleys with diameters larger than minimum required for the specified belting.
	Consider access and clearances according to CEMA recommendations.
	Consider the use of design to reduce exposure to hazards.

Rather than meeting minimum compliance standards, conveyor systems should exceed code, safety and regulatory requirements.

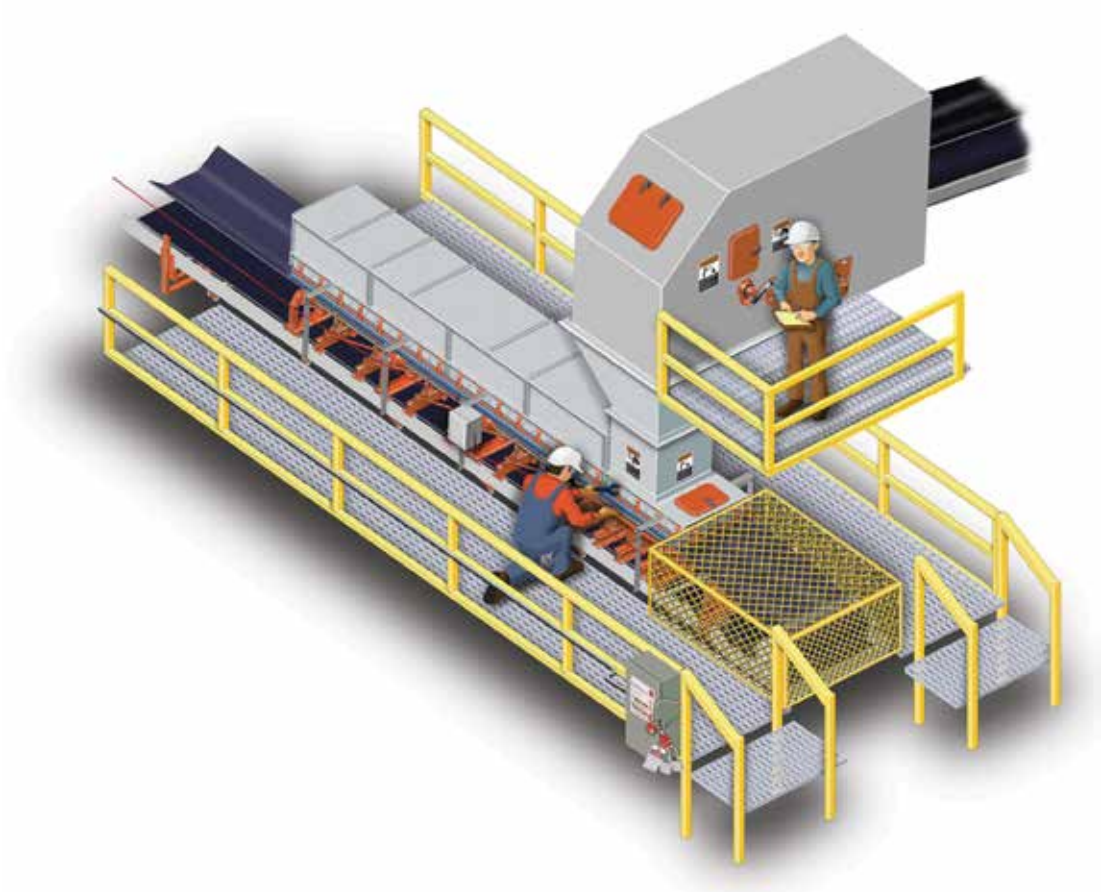
THE ART: DESIGN HIERARCHY

Rather than meeting minimum compliance standards, the conveyor system should exceed all code, safety and regulatory requirements using global best practices. By designing the system to minimise risk and the escape and accumulation of fugitive material, the workplace is made safer and the equipment is easier to maintain.

Life cycle costing should play into all component decisions. Buying on Life Cycle Cost and anticipating the future use of problem-solving components in the basic configuration of the conveyor provides improved safety and access, without increasing the structural steel requirements or significantly increasing the overall price. It also raises the possibility for easier system upgrades in the future.

BEST PRACTICES: THE "EVOLVED™ BASIC CONVEYOR"

Using the Hierarchy of Controls along with the Design Hierarchy, engineers will be able to construct an "Evolved Basic Conveyor" that meets the needs of modern production and safety demands. Built competitively with a few modifications in critical areas, an Evolved Basic Conveyor is a standard bulk material handling conveyor designed to allow easy retrofitting of new components that improve operation and safety, solving or preventing common maintenance problems.



Components of an EvolvedTM Basic Conveyor facilitate operations, maintenance and safety.

Installing or providing for maintenance-minded solutions in the loading zone can greatly improve safety and reduce man-hours and downtime. These components include slide-in/slide-out idlers, impact cradles and support cradles. On larger conveyors, maintenance aids such as overhead monorails or jib cranes assist in the movement and replacement of components. Also, designers should ensure adequate access to utilities – typically electricity and/or compressed air – to facilitate maintenance and performance. Next-generation conveyor designs may even feature a specially-engineered idler capped with an independent power generator that uses the conveyor's movement to generate power for a wide array of autonomous equipment.

Dust, spillage and belt tracking are top concerns for many safety professionals. Field tests have shown that enlarged skirtboards and engineered settling zones promote dust settling and reduce fugitive material. Curved loading and discharge chutes control the cargo transfer for centered placement and reduced turbulence. As the load is centered on the belt, guides ensure even travel through the takeup to promote consistent belt tracking.

Any transfer point is prone to buildup and clogging under the right conditions, be it ambient humidity, material wetness, volume or surface grade. Flow aids such as vibrators or air cannons on chutes can sustain material movement, improve equipment life and reduced the safety hazards associated with manually clearing clogs.

A properly configured conveyor minimises emissions for improved safety and easier maintenance.

CONCLUSION

Engineering safer conveyors is a long-term strategy. Although design absorbs less than 10% of the total budget of a project, additional upfront engineering and applying a life cycle-cost methodology to the selection and purchase of conveyor components proves beneficial.

By encouraging the use of the Hierarchy of Controls at the planning stage, along with the Design Hierarchy at the design stage, the system will likely meet the demands of modern production and safety regulations, with a longer operational life, fewer stoppages and a lower cost of operation.

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New levels of reliability and efficiency

Imagine a world where one operator can control several ultra-large hydraulic excavators at the same time, this is no longer a pipe dream for all the major manufacturers worldwide, and the race to implement new innovative technology is now on.

The past struggles for the mining sector were real, this led to manufactures to spawn some of the most advanced and revolutionary ideas ever thought possible – especially with excavators.

Today Mining equipment needs to be built tough. Size, endurance, and strength play a vital factor in withstanding the harsh condition of the mining industry. It is not easy and not all have perfected the process after several trials relating to the automation of excavators.

In preparation to meet the increasing demand for minerals in the future, mining companies must innovate today. Specifically, proactive, versus reactive, management of mining's highly cyclical and capital-intensive operations is necessary to maintain the lowest possible production costs. Compounding this challenge for miners are rising costs in energy, building materials, and equipment. And no miner is exempt.

Why the urgent need for innovation? Because as demand grows, concurrently, process interruptions carry significantly steeper costs. Additionally, today's mining operations are not at appropriate efficiency levels—mostly due to maintenance issues. To overcome these current operating challenges, the adoption of automation and digital technologies is required.

Innovation and transformation, however, go beyond just reducing maintenance costs and implementing predictive maintenance technology. For mining companies, it is about working differently and working smarter, to achieve more reliable mining operations. Foundational to this goal is the need to develop a digital data strategy across functional siloes and technologies. The potential of data to transform operational effectiveness is irrefutable. However, there is a big jump between collecting data, using, and analysing data and extracting actionable and meaningful insights from that data.

A 1% utilisation of data, for example, is the equivalent of squandering 99% of the data collection investment. Without industry-tailored algorithms and actionable insights to drive measurable business outcomes, the full potential of data-driven innovation cannot be realised. Similarly, balance is key. Data helps drive smarter decisions by balancing the reduction of maintenance costs while simultaneously ensuring improvements in operational efficiency via equipment reliability and availability. Enabling operation-wide optimisation mandates change. This change begins when the shift from reactive, tactical maintenance to predictive, strategic asset management is underway as is the shift to hybrid machines.

While it is true that last year and 2021 has presented some unprecedented global challenges, 2000 became a year of celebration for Kobelco Construction Machinery (KCM). The year marked 90 years since the manufacturer created Japan's first electric mining shovel in 1930, an innovation that would go on to have a significant impact on both the business and the worldwide mining and construction industry.

Kobelco's success can largely be attributed to the Japanese manufacturer's unrivalled reputation for building enduring, long-lasting, low maintenance machinery that can withstand some of the toughest job site conditions. For over 90 years, quality has been Kobelco's priority, and this philosophy has never changed, despite the ever-changing and increasingly difficult economy.

From the development of the first electric mining excavator and the introduction of the first hydraulic machine, Kobelco's history is packed with 'firsts. and set the tone for decades of pioneering technological developments from today's manufactures worldwide.

Kobelco has always been known for its world-class range of cranes and earthmoving products pacifically to the construction industry, but surprisingly it was not until 2017 that the company launched a 38-ton excavator model – SK 380 which was basically an entry level mining excavator mainly used in Quarries, the company has never competed with the heavy brigade of OEMs in the mining excavator market.

As new, creative technologies come on board, manufacturers are improving products and services to ensure better machine uptime, higher machine lifecycle values and unique customer solutions. Customer-driven innovation is about cases where customers' needs guided what firms developed. In the excavator industry, innovation came because of gaps in the market for example when hydraulic excavators were first developed, they had a fraction of the bucket capacity and reach of cable excavators – insufficient for the needs of any of the cable excavator customers. Hydraulic entrant firms had to find another market, so they adjusted the machines to be mounted on tractors, and they called them backhoes. These are perfect examples of customer-driven innovation. Today's machines are capitalising on hybrid technology and automation.

Managing Editor Trevor Barratt takes a sneak preview of some of today's innovations from global excavator manufacturing leaders.

HYBRID TECHNOLOGY - KOMATSU

One has to go back to 2008, when Komatsu launched the very first hydraulic excavator equipped with a fully functional and efficient hybrid system. Today, thousands of Komatsu Hybrid machines are working around the world and the company would claim its technology is still unmatched in the industry with today's customer-driven designs incorporating a hybrid of proven technologies

In 2016 the company officially launched the P&H 2650CX Hybrid Shovel, an innovative loading tool for the mining market. This new machine was the result of extensive customer focus groups outlining the need for an alternative to the 550 to 700-ton hydraulic excavator at a reduced total cost of ownership. The hybrid shovel combines the reliability of P&H rope shovels, the flexibility of Komatsu hydraulic excavators, and the technology of Komatsu electric drive wheel loaders to reduce the total cost of ownership by 10 to 15%.

In 2016, the first P&H 2650CX Hybrid Shovel went to work. Over its 22,000 hours running in the field, it demonstrated a 40 to 50% reduction in fuel consumption compared to hydraulic excavators, while maintaining equal or better production.

A SUSTAINABLE SOLUTION THROUGH ELECTRIC POWER

Komatsu introduced SR (switched reluctance) technology into its surface wheel loader products more than two decades ago and now have more than 150 surface wheel loaders utilising it around the world. The same technology that revolutionised the wheel loader market is being brought to shovels.

SR Hybrid Drive Technology is leveraged on the hybrid shovel to capture regenerative power that is naturally produced. Diesel energy is converted to electrical energy through a switched reluctance generator, which provides power to hoist, crowd, and swing motors. When the 2650CX lowers its bucket or decelerates swing speed, motors become generators, supplying energy to the machine, and shutting off fuel supply. Engines do not burn fuel for about 17% of a typical loading cycle, including dig, swing, dump and return swing, contributing to reduced fuel consumption and longer engine life.

The articulating clamshell bucket uses hydraulic power to open and close.

The P&H 2650CX Hybrid Shovel offers excellent productivity with multiple dig paths for optimal flexibility and an articulating clamshell bucket that provides high initial breakout force.

To maximise efficiency, the machine utilises electric power over hydraulic to enable regeneration. The result is 50-60% less hydraulic fluids needed compared to hydraulic excavators. This translates to additional savings through reduced fluid costs, reduced hydraulic routings and fittings, and a reduced environmental impact.

EFFICIENCY AND PRODUCTIVITY WITHOUT SACRIFICING VERSATILITY

Mobility

A major difference between a P&H hybrid shovel and the P&H rope shovel is how the machine is powered. Rather than being tethered to a high-voltage trail cable, the 2650CX uses twin-diesel engines – available in Tier 1, Tier 2 or Tier 4 Final – rated for 2,386 kW (3,200 HP). With no trail cable needed, the 2650CX has the mobility to easily tram to different areas of a mine site. This also gives the hybrid shovel the flexibility to operate in remote locations or greenfield mines, which may not have electric grid access.

Productivity

The P&H 2650CX leverages the hoist and crowd digging forces of P&H electric rope shovels and adds a third force, referred to as breakout force, i.e., bucket curl. Breakout force is key to flexible digging paths, allowing for horizontal digging along the floor, top-down digging, and selective digging – which is a potential requirement in hard rock, multi-seam coal, or banded iron formations. The 2650CX uses a hydraulic clamshell bucket, eliminating the door-latch mechanism commonly found on rope shovels.

The capabilities of the 2650CX provide exceptional reach and height, compared to hydraulic excavators. This allows for higher bucket fill factors, increased material excavated between moves, and operation in bench heights up to 16 meters (52 ft).

Additionally, efficiency comes from the fixed-boom architecture of the 2650CX. The fixed boom reduces digging mass from hoist motion, requiring less energy during the dig cycle and maximising bail pull throughout the dig profile.

A MACHINE DESIGNED FOR MAINTAINABILITY AND AVAILABILITY

The hybrid shovel was designed by the Komatsu engineering team in Milwaukee, Wisconsin, who are internationally recognised for designing mining-duty machines built for reliability and long-life. Reliability, maintenance, and serviceability were central focuses of the machine design, with engineers drawing on the expertise of mine maintenance and operations teams around the world.

The 2650CX is a modular design built in a controlled factory environment and transported to the mine in 14 shipping assemblies. The modularity of the 2650CX lends itself to quicker assembly and disassembly, as well as easier component installation and removal.

The modular design of the hybrid shovel means quicker commissioning. Major components and routings are installed within each module at the factory and are connected once in the field, meaning no welding is required during field assembly.

PreVail Remote Health Monitoring provides timely machine health and performance knowledge. The system recognises familiar patterns and deviations from normal control limits, and the operator can carry out the right actions at the right time to increase asset utilisation, efficiency, and production.

The hybrid shovel also utilises Komatsu's LINCS II control system, an integrated network control system. The intuitive touchscreen in the cab gives the operator access to live machine data, providing vital statistics and instant, real-time feedback in a graphical format that can be easily configured to personal preferences.

Together, LINCS II and PreVail use powerful communication, command, and control capabilities to transform data and information into refined knowledge for the operations and

The pilot unit is still in operation with the original engines due to an extremely low engine load factor. The engine overhauls are scheduled beyond 30,000 hours.

maintenance management teams. The information can be reported through key performance indicator dashboards, graphical analysis tools, and predictive modelling and reporting tools.

STEADY PROGRESS TO MARKET

Since the pilot unit went into work in early 2016, it has accumulated nearly 22,000 hours. During this time, Komatsu's engineering and field support teams conducted extensive reliability growth testing which has led to essential validation and verification. The machine has been tested in extreme mining environments, including hot Arizona summers and Rocky Mountain winters at high elevation.

While the P&H 2650CX Hybrid Shovel represented a new class of P&H shovels for the mining industry, utilising the latest in technology and innovation, it also leveraged the legacy of the company's proven designs.

Support for Cumbria mine dwindles as council sits on the fence

Support for the proposed coal mine in Cumbria is dwindling, after the council announced that it was withdrawing.

Cumbria County Council has announced that it will remain "neutral with regard to the mine", stating that it is neither for nor against the application in its submission to The Planning Inspectorate.

It represents a major U-turn after the plans for the £165M coal mine were originally approved by Cumbria County Council in October 2020.

Since then, Communities secretary Robert Jenrick has "called in" the decision and asked The Planning Inspectorate to carry out a formal evaluation of the scheme.

In February, Cumbria County Council had already said it would reconsider its decision to give the project the go-ahead in order to take into account "new information" in the Climate Change Committee's Sixth Carbon Budget.

The proposed development is for a large underground metallurgical, or "coking coal", coal mine. However its progress has been hindered by campaigns from environmental activists who fear that the facility could hinder the UK's net zero goals and discredit its position as COP26 host, with the rescheduled event to take place in Glasgow in November.

Friend of the Earth North West campaigner Estelle Worthington said the council's decision shows that the case for the coalmine is not "at its weakest".

She added: "Once again, we see support for this controversial coal mine continue to fall by the wayside.

"This only strengthens our position that it should never have been in the pipeline in the first place. We can fight both the climate crisis and unemployment by directing support to industries such as renewable energy.

"Now, as the time for public comments draws to a close, the case for dirty coal is at its weakest, both locally and nationally. Let's put an to end this climate hypocrisy once and for all and leave Cumbrian coal in the ground."

Straight hole drilling machines for coal mines

The authors prove the demand for drilling machines capable of making long straight holes in rocks with the strength up to 120 MPa. This paper describes the designed, manufactured and tested down-the-hole hammers for rotary–percussion drilling of long straight directional holes. The hammers have been delivered to Berezovskaya Mine for further trial and commercial operation.

Labour content and costs of underground coal mining are to a large degree conditioned by methane drainage, service, and exploration hole drilling. Total hole drilling in mines in Russia and the CIS countries makes tens thousands kilometres. For example, Karaganda Department of ArcelorMittal Timirtau annually drills more than 300 km of underground holes[1]. Drilling equipment used in the coal industry in Russia is both of domestic and foreign manufacture. Unfortunately, the capacity of these drilling tools falls short of the current technologies in coal mining. Actual operation of this equipment has revealed their common drawbacks, namely:

- limited application in hole drilling in rocks with the strength of 120 MPa;
- complicated drilling of straight long holes both in coal and in rocks.

As for the first drawback, rotary drilling equipment used in coal mines is efficient in rocks with the strength not higher than 80 MPa.

As regards the second drawback, in the course of rotary drilling in coal and in rocks using drill bits and rolling cutter bits, essential axial forces and torsion are applied on the drill stem from the side of the rock drilling machine; these forces induce lateral forces, and a drill hole deviates from the pre-assigned direction as a result[2].

From the experience of drilling in coal mines, it is possible to drill straight holes by varying drilling rate by changing rotary speed and feed speed of drill stem. However, in spite of apparent operating efficiency, this approach also has limitations. First of all, straight hole drilling is ensured by reduction in feed speed, i.e., drilling penetration rate, which increases non-productive rig time; second, this method of drilling is ineffective in hard rocks. So, it is required to design drilling machines capable of drilling straight holes either in coal or in rocks of high hardness.

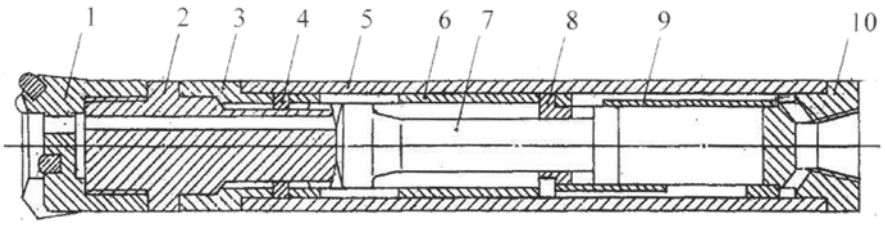

Figure 1: Layout of small-size DTH hammer PNB76: 1-removable drill bit; 2-plunger; 3-bearing box; 4-front split collar; 5-housing; 6-front quill shaft; 7-striking part; 8-rear spit collar; 9-rear quill shaft; 10-adapater connector.

The known method of drilling almost straight holes is rotary–percussion drilling by down-the-hole hammers. In this case, rock is destructed by the hammer head directly impacting the hole bottom. As compared to other techniques, this method allows minimum pull-down pressure from drilling tool to hole bottom, low speed of rotation and minor torque applied to the drill stem. This makes it possible to minimise distortion of the drill stem and to drill almost straight holes.

Deloading of a drill stem is feasible with down-the-hole hammers of minimum diameter relative to the given drilling machine. In this case, forces induced by the impact interaction between the hammer and the hole bottom are applied closer to the hole bottom centre, which reduces torsion transferred to the drill stem.

Direct hole drilling requires uniform impact loading of hole bottom. This is in a greater degree achieved under central-force collision of hammer head and striking part when impact load is more evenly applied on them. Central-force collision enables reduction in transverse vibration of the hammer, which improves straightness of hole drilling.

Also, the experience of drill bit engineering in Russia and abroad has shown that higher accuracy of drilling is achieved with drill bits making longer coring, which ensures better fixturing of the drill bit relative to the hole axis[3].

Based on these considerations, the Institute of Mining, SB RAS, has designed a small-size drill hammer PNB76 (**Figure 1**)[4] with drill bit KNB76 to ensure coring such that to centre the drill bit relative to the hole bottom (**Figure 2**).

Design of an air hammer for small diameter hole drilling is rather challenging for the drill hole diameter imposes strict constraints on the cross dimension of DTH hammers and limits potential of the wanted-size active areas of a hammer head. Aiming to enlarge active area of a hammer head, the proposed design of DTH hammer provides that the hammer head area subjected to pressure is more than the cross-section area of the cavity of the hammer housing. The hammer is of closed type, which ensures higher wear resistance of friction bearing backs and

Figure 2: Drill bit KNB76 of TH hammer PNB76.

improves quality of bottom hole cleaning from drill cuttings not to be overground.

The central-force collision of the striking part and the drill bit improves blow energy transmission due to reduction in cross vibration and relieves stresses in the colliding parts owing to more uniform distribution of impact load in cross sections of the colliding parts. Valveless air distribution and simple design ensues fault-free performance of the hammer. In the proposed layout, air is only exhausted from the power stroke chamber, and there is no exhaust from the idle run chamber. “Spurious” volume non-productively filled by compressed air is diminished in this case, which cuts down air consumption and makes the machine cost-effective.

A trial model of the down-the-hole hammer has been manufactured by Spetsgidravlika (**Figure 3**).

DTH hammer PNB76 has been tested on a brassboard (**Figure 4**).

Figure 3: Trial model of the designed hammer.

Figure 4: Full-scale testing of DTH hammer PNB76.

Based on the positive test data, the Institute of Mining has proposed Berezovskaya Mine to continue jointly R&D on straight hole drilling in a production environment. On request of Berezovskaya Mine, Spetsgidravlika has manufactured three DTH hammers PNB76 with drill bits KNB76 for operation of drill machine SBR400 designed and patented by the Institute of Mining, SB RAS. At the present time, the equipment has been delivered to the customer. It is intended that the hammers will for the first turn been used to drill straight service holes more than 130 m long in rocks with the strength of 120 MPa.

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Characteristics of the hammer recorded during the tests under compressed-air pressure of 0.6 MPa are shown in **Figure 5**.

After processing of the curves using the known procedure[5], performance of PMB76 hammer has been determined:

Drill hole diameter	76 mm
Hammer housing diameter	63.5 mm
Driving pressure	0.6 MPa
Blow energy	40 J
Blow frequency	1500 min^{-1}
Hammer head weight	1.45 kg

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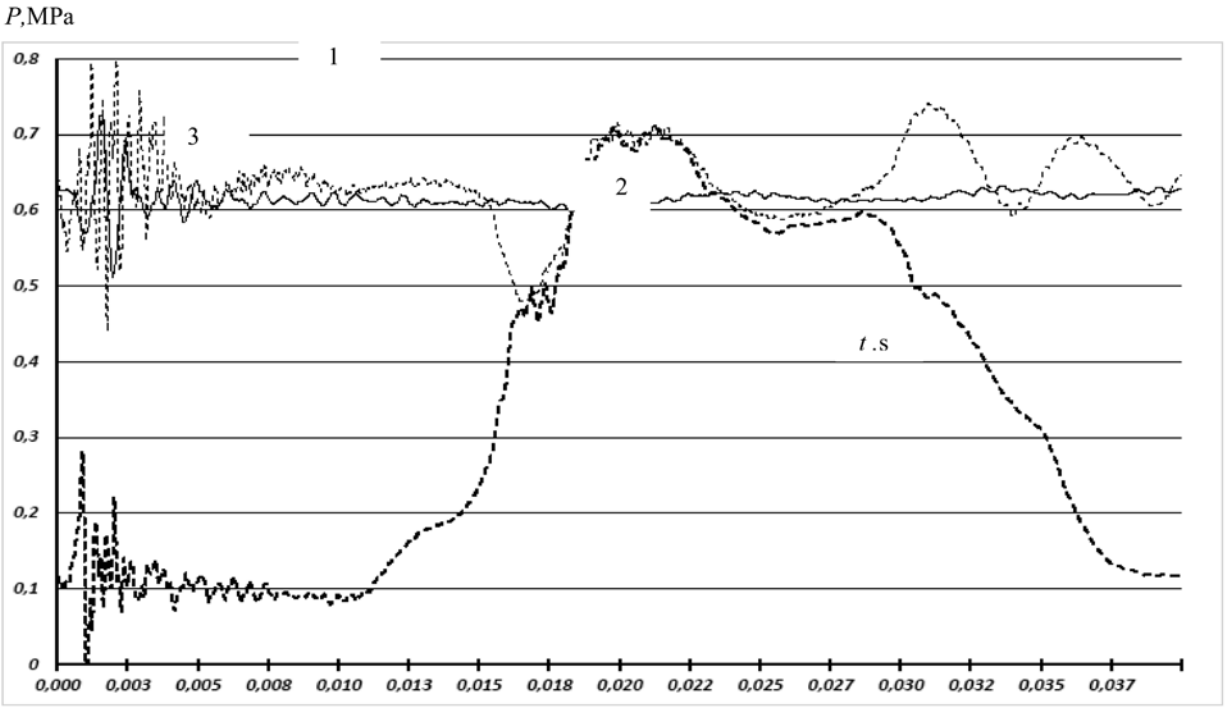

Figure 5: Pressure in the chambers of DTH hammer PNB76: 1-in the main line; 2-in the power stroke chamber; 3-in idle stroke chamber.

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Assocarboni discloses 2020 coal data sector

Some days ago, during its Annual Members Meeting, Assocarboni, the Italian Association of coal operators chaired by Andrea Clavarino, disclosed 2020 data sector. Coal confirmed its leadership in generating electricity: in particular, demand for coal is shifting towards South-East Asia, where emerging economies are in need of a safe and competitive energy source that they have found in coal, as the fuel of choice for economic and industrial development.

SEABORNE COAL TRADE

Seaborne world coal trade closed 2020 in negative, with a reduction of -10% on an annual basis (1,157 million tons, compared to 1,292 million in 2019). For the first time after 10 years of continuous growth seaborne coal trade suffers a setback and interrupts a trend that in the last 10 years had led to a 50% increase in volumes.

Steam coal volumes amounted to 910 million tons (-11% compared to 1,021 million in 2019).

Seaborne coking coal in 2020 totalled 247 million tons (-9% compared to 271 million in 2019).

COAL IMPORT | 2019

The latest Assocarboni data for 2020 also provide a detailed picture on the trend of the global coal import.

China, Pakistan and Vietnam are the countries that contributed the most to the growth in coal volumes during 2020. In the Mediterranean area, imports from Israel, Morocco and Turkey have increased.

China's total coal imports for 2020 reached a volume of 304 million tons, an increase of 1.5% compared to 299.67 million imported in 2019. The initial goal stated by the Chinese government was to maintain imports in a range between 277 and 299 million tons. Total Chinese coal production for 2020 reached a volume of 3.84 billion tons (+ 0.9% compared to 2019). Crude steel production for 2020 reached a record result at 1.05 billion tons, exceeding the 1 billion mark for the first time.

In 2020, Vietnam's coal imports continued to rise rapidly: the country imported 28% more coal on an annual basis, following a higher demand for energy domestically. In particular, total coal imports reached a volume of 55.8 million tons last year, compared to 43.7 million in 2019. This is a truly remarkable result, especially since the import volumes were nevertheless limited by the coronavirus pandemic and the extreme weather conditions in the country in October and November 2020. Vietnamese steel production also grew significantly, reaching 31.0 million tons in 2020, up 52% from 20.4 million in 2019.

A slight increase also affected Turkey's thermal coal imports, which in 2020 recorded an increase of 1%, reaching 19.8 million tons compared to 19.6 million in 2019. Coking imports coal instead showed a slight decrease, by -3%, reaching 5.5 million tons compared to 5.7 million in 2019.

Morocco also recorded a + 2% increase in thermal coal imports in 2020, reaching a volume of 10.3 million tons compared to 10.1 million in 2019.

An increase also affected Israel's thermal coal imports, which in 2020 stood at 8.2 million tons, up 3% compared to 8 million in 2019.

Finally, in Chile thermal coal imports in 2020 recorded a slight increase, reaching 10.1 million tons and marking a + 2% compared to 9.9 million tons in 2019.

COAL EXPORT | 2020

As far as concern exports, according to the last Assocarboni data for 2020, Indonesia's thermal coal exports in 2020 decreased by 13%, reaching a volume of about 400 million tons, due to restrictions caused by the coronavirus pandemic that impacted global demand and all major coal producing countries. India remained the top destination for Indonesian coal, and exports to China recorded a 102% year-on-year increase following bans on the import of Australian thermal coal into Chinese ports. Outside of these two key markets, all the other usual Indonesian coal importing countries (such as Vietnam, South Korea and Malaysia) recorded declines in 2020. For the next twenty years, the Ministry of Energy and Mineral Resources Indonesian has planned a 21% increase in coal production, for a volume of 678 million tons, but this additional tonnage will be used for its internal needs following the choice to support industry and power generation.

Australia's total coal exports fell 7% year-on-year in 2020, reaching a volume of 369.81 million tonnes, up from 396.43 million in 2019. In particular, thermal coal exports fell by 6%, reaching

198.74 million tons (212.48 million in 2019), mainly due to the Chinese ban on Australian imports in the fourth quarter of 2020. Metallurgical coal exports decreased by 7%, reaching to 171.08 million tons (183.96 million in 2019), with a decline that affected most of the main export destinations.

Russia's exports of thermal and metallurgical coal increased by about 1% on an annual basis, reaching a volume of 217 million tons, compared to 215 million in 2019. The higher volumes were as in previous years exported by sea, while around 24 million tons of coal were exported by rail, mainly destined for China and Europe. The production of Russian coal in 2020 decreased by 9% to 401.4 million tons.

The coal market in Italy

Particular attention deserves our country, Italy, which in 2020 reported a decrease in thermal coal imports, with a volume of 5.3 million tons (-29% compared to 7.5 million tons in 2019) and in imports of metallurgical coal and PCI, which reached a volume of 2.35 million tons, with a decrease of 22% compared to 3 million in 2019.

Coal phase-out should be progressive over time and closely connected to structural operations in the replacement production capacities and in the transmission, distribution and energy storage systems, in order to not compromise the competitiveness and safety of the Italian Electric System.

Moreover, in a world which will continue to produce electricity from coal, the mentioned Italian phase out by 2025 will bring modest benefits to the climate change reduction, as the CO2 emissions due to Italian coal-fired plants account for 0.04% of the global CO2 emissions.

The giants of mainland Asia, India and China, but also other Asian economies such as Japan, South Korea and Taiwan, have based their national energy plans on coal and continue to plan coal-fired expansions using the best technologies available today.

In Europe, a country like Germany, that has always used very high percentages of coal to cover its national energy needs, is preparing for coal phase out over a longer time than in Italy: in the next twenty years, only the older plants will gradually be closed, while the most efficient power plants will remain in operation and will be dismissed by 2038. However, this program will have a considerable cost, estimated in a 40 billion euros' compensation for the loss of about 20 thousand jobs and promote the conversion of the plants.

In conclusion, we believe that the Italian Electricity System should increase the share of renewables and we hope that the country will be able to correctly address the gradual procedures for the closure of the plants, as already done in other European countries.

- Coal confirmed its leadership as leading fuel for electricity generation also in 2020, accounting for 38% of overall production.
- For the first time after 10 years of continuous growth, seaborne coal trade suffers a setback, reaching a volume of 1,157 million tons.
- An increase in seaborne trade is forecast for 2022, driven by markets in Southeast Asia, where growing demand for coal from Bangladesh, the Philippines, Malaysia, Pakistan and Vietnam will keep import volumes high.
- China, Pakistan and Vietnam are the countries that contributed most to the growth in coal volumes during 2020, despite the pandemic.
- In the Mediterranean area, imports from Israel, Morocco and Turkey are on the rise.
- While Europe in 2020 generates electricity mainly from coal (13.3%) and nuclear (24.2%), cutting the costs of electricity bills by an average 30%, Italy is lagging behind being the only Country in the world without nuclear power and with the lowest share of coal use (10%).
- Decarbonisation is a global issue that will always be more related to the emissions of non-OECD countries. Italian coal power plants account for 0,04% of the global CO2 emissions, a value unable to produce positive effects on the climate, but with a strong negative impact on the safety and competitiveness of the Italian Power System.
- Our benchmarks (manufacturing Countries like China, Germany, Japan, India, South Korea and Taiwan) will continue to use a mix of coal and nuclear to produce electricity even beyond 2025, year in which the phase-out of coal in Italy will be concluded.

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Surviving decarbonisation through technology

The coal industry is betting it can survive the decarbonisation of electricity and industry and keep fossil fuels in the mix by leaning on carbon-capture technology, the head of the World Coal Association told Reuters.

Such methods are a key part of the Paris Agreement on climate change, said the organisation's chief, Michelle Manook, and will help keep coal relevant as governments and companies quicken efforts to cut emissions that are warming the planet and polluting the world's densely populated cities.

The Paris Agreement, signed in 2015, calls on the world to cut emissions as soon as possible to limit global warming to 1.5 degrees Celsius above pre-industrial levels, a threshold scientist say can prevent the worst impacts of climate change.

The agreement calls on countries to use all available technologies, such as carbon-capture and storage (CCS), in which emissions are stored underground or used in industrial processes.

"Go back to Paris," Manook said in a passionate defence of coal. "Go back to the International Panel on Climate Change and they have been really clear and consistently saying that we are not going to get there without CCS."

But the fuel that has powered industrial revolutions around the world for more than two centuries is increasingly getting pushed out as banks and insurers, under pressure from shareholders, stop financing new mines and coal-fired plants.

Policies that exclude coal are not helpful, Manook said, adding that "CCS is a proven technology. We know it can be applied."

The lignite (brown coal) power plant complex of German energy supplier and utility RWE is reflected in a large puddle in Neurath, northwest of Cologne, Germany, 2020. Wolfgang Rattay/File Photo

But CCS is expensive, as shown by the first commercial application of the technology on a power plant. Canada's SaskPower spent about $1.2 billion retrofitting CCS equipment on a relatively small unit at its Boundary Dam power station that started operations in 2014. Manook said that the costs would come down with economies of scale and that governments needed to provide strong policy support to give companies the confidence to invest in such projects. SaskPower has said costs would be up to 30% lower on the next retrofit at Boundary Dam.

New Bonfiglioli Drive Diagnostics App

Fault resolution at the push of the button

The Italian drive specialist Bonfiglioli releases its new Drive Diagnostic App, aimed at supporting day to day operations of field technicians with Bonfiglioli frequency inverters and servo drives. In the case of a fault shown in the drive, all the user has to do is enter the fault code indicated by the inverter in the App and it will immediately display the connected cause, together with useful information regarding how to solve the issue.

In addition, for the situation where the problem is more complex, the App provides contact information for the Bonfiglioli support team, putting the user in contact with the best Bonfiglioli drive experts to solve the issue immediately.

Finally, the App includes a section dedicated to most frequently asked questions to facilitate daily operations with Bonfiglioli inverters. The new App can be used for the Bonfiglioli frequency inverters and servo drives series: Agile, Active, Active Cube, and Active Next Generation. The *Drive Diagnostics App* available for iOS and Android, is completely free of charge.

Where does Australia's metallurgical coal go?

A Minerals Council of Australia (MCA) report has revealed that more than 60% of the world's seaborne coal exports come from Australia, with second place hardly keeping its head above water.

The report detailed the quality and importance of Australian coal and was the second in a series called 'Best in Class: Australia's Bulk Commodity Giants'.

Written by industry expert Anthony Le Bas, the report, titled 'Australian Metallurgical Coal: Quality Sought Around the World', details how more than 96% of Australia's metallurgical coal is exported overseas, with India, China and Japan three of the key markets.

MCA chief executive officer Tania Constable emphasised the importance of the report and its subject matter in a global context.

"Metallurgical coal is a critical component for steel making and Australia's quality attracts customers from around the world from Asian countries such as India, China, Japan, South Korea and Taiwan all the way to the EU," Constable said.

Australia is easily the largest exporter of metallurgical coal in the world, with exports worth more than $40 billion. After our 184 million tonnes exported annually, the next largest exporter in 2019 was the United States with 50 million tonnes.

The report stated that in 2019, India accepted the most metallurgical coal imports from Australia, at over 45 million tonnes, while China sat just above 40 million tonnes.

Australia's workforce relies heavily on the production of metallurgical coal and Constable highlighted just how important it is.

"Australia's world-leading metallurgical coal mines provide jobs for thousands of Australians in regional areas and contribute significantly to the local and national economy, and these areas are well placed to continue producing metallurgical coal for years to come to support global growth and infrastructure development," Constable said.

While the report said only 30% of global steel is made using an electric blast furnace (EFC) as compared to 70% in a blast furnace (BF), both the report and Constable acknowledged how the need for low-carbon technologies in the coal and steel making industry is becoming a higher priority.

"MCA member companies are already taking action to further reduce emissions from the use of metallurgical coal," Constable said.

"The accelerated deployment of existing low emissions technologies and greater research and development of new and emerging technologies will be required to ensure the world is able to achieve the emissions reduction goals of the Paris Agreement."

Eskom inks Duvha supply agreement

Eskom said recently, it has given final consent to South32 SA Holdings' request for the sale of its majority shareholding in South32SA Energy Coal Holdings (Pty) Ltd (SAEC) to a company owned by Seriti Resources Holdings.

The coal supply agreement (CSA) between SAEC and Eskom required South32 to obtain Eskom's consent for any change in the ownership of SAEC, which supplies most of the 2,875MW power station's coal requirements.

As part of the transaction, and due to the strategic importance of securing the coal supply for Duvha, the parties agreed on a modification of the CSA until 31 December 2024. The modification of the CSA also secures the continued use of SAEC's infrastructure at the mine so alternative coal supplies can be delivered over conveyor into the power station.

In June 2019, SAEC had invoked the hardship clause in the CSA, citing significant financial losses as a consequence of selling coal to Eskom below its cost of mining. Eskom's hardship review and due diligence confirmed the mine was loss-making, with increased risk of failure.

The CSA modification was approved by the National Treasury on May 1, 2021.

The modification gives Eskom sufficient time to seek alternative coal supplies, if required, and to resolve coal delivery infrastructure constraints at the power station.

The CSA modification will also prevent massive job losses at the mine, while securing coal supply for Eskom at an affordable price, said the utility.

"Of critical importance to Eskom is to secure the continued delivery of coal for the Duvha power station, and this agreement provides that security of supply at a price that is affordable to Eskom," said André de Ruyter, group CEO of Eskom.

"Prior to this transaction being concluded, Eskom conducted an independent due diligence exercise on Seriti led by a firm of attorneys. Eskom is satisfied the new owners of SAEC have the capacity to fully discharge their obligations to Eskom in terms of the CSA," he said.

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