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# MINING & QUARRY WORLD

# 2022 Editorial Programme









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#### Keestrack is ready for the future 100 to 250 t /

Powering electric plug in driven crushers & screens via the grid or by one engine unit

#### Despite significant

international restrictions caused by the corona pandemic, Keestrack Group looks back on an overall satisfactory business year. Positive feedback from distributors and many new products announced for the future indicate a sustainable improvement in business for the coming year.

"Keestrack was effected, just like many other international manufacturers of construction machinery with the effects of the corona pandemic," says Marcel Kerkhofs, Marketing Manager at the Belgian headquarters of the Keestrack Group. "However we are very positive and optimistic about the future, as we keep on innovating and introducing new products onto the market. Keestrack keeps focussing on mobile electric-plug in and hybrid driven crushers and screens to reduce emissions and operating costs.'

In 2022 we will be - once more - expanding our range to include important additional machine solutions and completely new product lines, "says Frederik Hoogendoorn, Managing Director. The family-run group expects to increase its

worldwide turnover by 20%, which goes hand in hand with the expansion of its own workforce of currently more than 1000 employees and the international distribution network with more than 116 dealers and service partners in 100 countries.

#### **Evolution**

One of the key products that Keestrack will be presenting in 2022 is the completely new designed Keestrack I4e tracked mobile reversible impact crusher. Thanks to the innovative RIC (Reversible Impact Crusher) technology, this machine can be used very flexible in the secondary crushing of rock and recycling building materials (eg. Asphalt). The specific design of the reversible horizontal impact crusher with a large variable crushing chamber, powerful rotor (Ø 1100 mm; 4 blow bars) and electronically monitored hydraulic gap adjustment (+80 to -220 mm with new tools) allows feed sizes of up to 250 mm and ensures consistently high-quality end products of up to 0/2 mm in closed circuit. Secondary and tertiary crushing can be now combined in one highly mobile solution, which makes the Keestrack I4e a real alternative to mobile cone crushers or vertical impact crushers, especially with regard to its outstanding production capacities from



h. According to Keestrack, the system offers also lower wear. better quality of the end products (grain shape) and significant energy savings in typical applications (eg. sand production 0/4 mm: approx. -30% compared to cone crushers; -30 to -40% compared to

VSI impact crushers). This is also due to the advanced diesel-electric drive concept of the compact system (transport dimensions: 15.05 m x 3.00 m x 3.23 m), weighing 41 tonnes including the single-deck after screen with return conveyor. As with other Keestrack large crushers (Cone crushers H4e / H6e/H7e, Jaw crusher B7e), the drive unit with 447

kW diesel engine and 300 kVa generator is designed as a removable drop-off module. Electric drives for the crusher (160 kW), feeders and conveyor belts as well as the system hydraulics enable particularly cost-efficient and emission-free plug-in network operation. Three specific patents illustrate the innovative potential of the new Keestrack I4e concept.

#### Save by combining

Compared to conventional diesel-hydraulic units, dieselelectric driven plants directly save up to 40% of fuel. While working in production trains, the attributable fuel consumption may even decrease by 70% when the hybrid screeners are powered directly via the plugout supply of an upstream or downstream diesel-electric crusher. When plugged in to the grid savings are





even bigger (depending on the local electricity price) as both operational costs and maintenance cost will decrease drastically. To fully exploit this potential Keestrack offers today besides the e-driven equipment also the tracked engine units. With these tracked engine/generator units several electric machines can be powered. As the e-driven Keestrack

equipment can be used, either plugged in to the grid, or by the Engine unit with on board gen-set, Keestrack first introduced since a few years the drop off module (diesel engine with integrated genset). Which could already feed several e-driven machines.

One step further is the introduction of tracked engine/generator units. These supply connected Keestrack crushers, screeners and stackers directly with electricity in case there is no plug in connection from the grid available. This way the economic advantages of the complete production train will rise to its full potential and when looking into the future Keestrack mobile crushers and screens can be sold even without an engine unit.

# Komatsu and PIMS Group work together to extend life of mines

A new agreement between Komatsu, a global mining equipment manufacturer, and PIMS Group, a North Queensland mining services operator, could help set a benchmark for extending the life of multiple Queensland coal mines.

PIMS Group was recently awarded a five-year contract to convert the idled open cut Millennium and Mavis Downs coal mines, west of Mackay, Queensland, to an underground operation, which could ultimately result in an estimated 1.2 million tonnes of incremental coal extraction each year. Komatsu will sell PIMS Group new mining equipment for the project, and will provide a comprehensive maintenance, parts, rebuild and engineering support service to ensure the companies' joint objectives are effectively supported. Komatsu will provide

a full-time preventative maintenance team at the mine sites to help maximise the operation of the eight pieces of equipment now on order, including two 12CM27 continuous miners, four 10SC32 shuttle cars. one feeder breaker and one multibolter. Delivery of the

Komatsu machines is due in mid-2022 to coincide with PIMS Group's conversion of the Mavis Downs site to underground operation, which will be followed soon after by conversion of the Millennium site.

Millennium and Mavis Downs are owned by MetRes, a 50:50 joint venture between Queensland miners Stanmore Resources and M Resources. M Mining, a subsidiary of M Resources, is the joint venture manager and operator.

Rob Rogers, Vice President of Underground Soft Rock for Komatsu in Australasia, said the success of the three-way venture with PIMS Group and MetRes depended on total confidence of each partner to reliably deliver in its area of expertise. Rogers said the arrangement aligns well with Komatsu's focus on 'creating value together', an initiative intended to secure long-term customer solutions, particularly to the benefit of society and communities.

The MetRes rejuvenation alone has the potential to create up to 100 mine construction jobs and result in more than 125 direct fulltime mining jobs.

# Protest against closures in Orakzai

Residents staged a protest against the closure of coalmines in Ublan area in lower part of Orakzai and asked the district administration to lift ban on coal mining forthwith.

The residents belonging to the Bezotkhel tribe in the lower part of Orakzai tribal district said that it was beyond understanding as to why the district administration imposed a ban on coal mining.

Addressing the protestors, elders including Malik

Ghulam Habib. Zarmela Khan, Malang Jan, Muhammad Mir. Malik Asharaf, Malik Yousaf and others said that assistant commissioner Lower Orakzai had sealed the leased coalmines of Bezotkhel tribe in Ublan area without assigning any reason.

They said that it was an injustice with the local residents, which would be resisted at all costs.

They urged the district administration to lift the



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According to MetRes Chairperson Matt Latimore, a partnership and risk-sharing approach, together with the potential for substantial local employment opportunities, had been paramount in PIMS Group winning its bid to operate the infrastructure of both mines

MetRes has initially worked to reopen the mines using auger and open cut methods, with production of first coal already achieved in September 2021

According to MetRes, underground expansion will be economically achieved through the mines' existing highwalls, yielding low-ash, high-quality metallurgical coal used in the production of steel globally.

Rehabilitation of the open cut sites will coincide with

the switch to underground operations. With underground activity, Millennium and Mavis Downs share a current predicted additional mine life of 12 years, producing 13.9 million tonnes of metallurgical coal.

PIMS' contract with the mines' owners is the largest undertaken by the North Queensland group. It is seen as the forerunner for extending the operating life and remediation of aboveground sites which have so far been presumed to be near the end of their productive life.

**PIMS Group Chief Executive Richard Mills sees** this operating model being utilised throughout existing Queensland coal operations, providing substantial economic and employment benefits.

ban on coalmining. So they could earn a living for their families.

The elders also asked

the district administration to settle the boundary dispute between the Muhammadzai and Bezotkhel tribes.



# Germany lays a path for quitting, but the US may not follow

In the coal heartland of Germany stands a monument to the source of its economic might: a giant mine more than a half-mile deep that once produced the largest amount of coal in the world.

Built at the beginning of the Industrial Revolution, the Zollverein mine cemented Germany's place as a coal behemoth. And its legendary Shaft XII was hailed as a feat of technology due to its high level of automation.

By 1986, however, it had become more expensive to extract coal in Germany than to import it from places like Russia and the United States. The mine was decommissioned, and the facility was eventually turned into a cultural center.

Now Zollverein stands as a sprawling museum complex for coal's history and is a dedicated UNESCO World Heritage site. The iconic image of Shaft XII's pithead is scattered throughout the city of Essen as an unofficial trademark of the Ruhr region.

The transformation of this region remains a work in progress. But it is often held up as an example of how a country that has built its fortunes on the world's most polluting fossil fuel can untangle its addiction.

For the United States, the model here offers lessons for transitioning to clean energy. But two pillars of the Germany experience – money and planning – seem increasingly out of reach as climate policy unravels in Washington.

#### Planning for an exit

Germany remains the largest coal consumer and producer in Europe, despite its plans to reach net-zero emissions by midcentury. In 2020, the government enacted a law that makes 2038 the final year for coal use. Now there are plans to reach that goal by 2030.

Germany's coal transition has focused on providing economic support to workers and coal-dependent regions. It has helped build up other industries and diversify regional economies to provide jobs as coal disappears.

That framework was developed by disparate voices who came together to negotiate the transition. Trade unions, environmentalists, coal executives and lawmakers agreed to the phaseout. It was a hard-fought compromise.

Environmental activists said the phase-out date was too late, while other critics said too much compensation was going to the companies that had caused the problem to begin with.

It could be harder for the United States to navigate a similar path, particularly with President Biden's signature climate legislation set to collapse under opposition from coal-state Sen. Joe Manchin (D-W.Va.).

"Germany has a lot of built-in advantages over the United States because of the social and economic choices they made after the end of [World War II]," said Lee Anderson, government affairs director for the Utility Workers Union of America (UWUA).

"When we learned that their government had brought together all of the suspects – industry, labor, communities – and spent something like 18 months putting together a national plan that covered how they were going to phase out coal over the course of two decades, the American imagination fails. You can't conceive of such a thing happening in this country," he said.

Anderson was part of a small group of union representatives and advocates from the US that visited Germany in 2020 to see how that country was handling its coal transition. They visited mine sites and reclamation areas, and met with affected communities.

Anderson said they brought that information home and started baking it into policy documents aimed at emulating what Germany was doing.

An analysis UWUA published with the Union of Concerned Scientists last May argued that the Biden administration would need to invest up to \$83 billion over the next 15 years to support coal workers and communities as the country shifts to a low-carbon economy.

It called for five years of wage replacement for displaced workers, and continued health care coverage and education benefits for workers and their children. The idea was that more support and better planning could ease the pain of an impending coal exit.

"The transition is happening. It's just happening haphazardly and without foresight and without thought, and that is the most difficult way to approach it, from a community perspective, but especially for the workers," said Jeremy Richardson, a former senior energy analyst at Union of Concerned Scientists.

The proposals in the analysis were crafted into legislation that made their way into negotiations on the reconciliation package, said Anderson. The \$1.7 trillion package, known as the "Build Back Better Act," faces collapse following Manchin's announcement of opposition last month.

"There are a couple of really important pieces in the 'Build Back Better Act' that would really, really help communities and workers," said Richardson, who has roots in West Virginia's coal mining towns. "It's really a tragedy that it's in jeopardy."

#### 'This won't work'

Germany's coal exit is still underway. Its initial phase focused on what it terms "hard coal," the type typically mined in US coal states like Wyoming and West Virginia for use in industry and electricity generation.

The last hard coal mine closed in 2018, but lignite or "brown coal," a type of wet coal that emits far more carbon dioxide when burned, will continue to be mined until the end of this decade, when Germany will end coal use entirely, according to a proposal by Germany's new government.

Coal generates about a quarter of Germany's electricity, down from half at the turn of the century, and employs around 25,000 people directly, according to the German Trade Union Confederation.

The US has also seen its reliance on coal-fired power fall to about 20% of the energy mix with 28% of current capacity set to be retired by 2035, according to the Energy Information Administration. The mining industry now employs around 40,000 workers. But Germany has been

more willing to pour money into the transition.

A case study by Resources for the Future and the Environmental Defense Fund says large-scale government investments and industrial policies are "central aspects" of Germany's approach.

As part of the earlier phaseout plan, German lawmakers passed legislation setting aside more than €40 billion (\$45.2 billion) over the next two decades to help areas that will lose jobs and income as coal dries up.

"That's the benefit of a well-managed transition process, because then you don't only look at merely replacing the jobs in coal with other jobs, but you really take this as an opportunity to further develop an entire region and provide better public services, provide more green spaces, make it more attractive for tourism and the people living there," said Rebekka Popp, a policy adviser at E3G in Berlin.

Germany's strong labor laws and social safety net have also helped ease the transition by ensuring workers get unemployment benefits, retain health care, have access to vocational training and job placement centers, and can opt for early retirement.

That's something the United States could struggle to replicate.

"Realizing that you need to plan ahead and need to plan for a future with less coal or without coal, that really helps," said Timon Wehnert, a senior researcher at the Wuppertal Institute in Berlin.

A phaseout is necessary if countries are to meet increasingly ambitious climate goals. Under the Biden administration, the US aims to slash its emissions in half by 2030. Germany's target is a 65% reduction.

But Germany won't be able to hit that mark without accelerating its coal phaseout date from 2038 to 2030. The new government proposed that new timeline after the departure of Chancellor Angela Merkel last month.

That's creating concerns about fairness for miners.

"It is necessary that the new government gives a clear sign that no one is left behind," said Frederik Moch, head of the department for structural policy, industry and services at the German Trade Union Confederation.

Just before the new government took office in December, it released a governing plan stating that no one will be left without a job due to the coal phaseout and no additional compensation will be paid to companies.

It also aims to expand renewable energy capacity from half at present to 80% of the power mix by 2030.

"We can't replace 25,000 workers in coal with new jobs in the renewables sector in these regions. This won't work. So it is a question of what other industries, other areas can develop and build up new value chains there," said Moch.



#### **Compounding impacts**

The solutions will differ by place, and Germany has put an emphasis on tailoring solutions to local communities based on their input.

The same will be needed in the US

In one area, outdoor recreation may be the best answer. In another it may be manufacturing for clean energy components, said Richardson of the Union of Concerned Scientists.

"It's just figuring out the kinds of things that can connect these communities to what the new opportunities are – and that has to be place-based," he said.

There are provisions in the infrastructure bill passed by Congress in November that could help by carving out money for broadband internet expansion or reclaiming and redeveloping abandoned mine land.

The Biden administration also created an interagency working group to help revitalize coal and power plant communities. It has identified \$45 billion in federal funding that those communities could tap for infrastructure investments, environmental remediation and community development.

But much more will be needed.

Boone County, W.Va., was once the highest-producing coal county in the state. It saw a sharp decrease in production more than a decade ago. Jobs and tax revenue followed. The sheriff's office is now facing a staff shortage due to budget cuts.

"There is this compounding impact, not only to the workers themselves but to the communities and the regions where they are situated," said Jessica Eckdish, vice president of legislation and federal affairs at the BlueGreen Alliance, which organized the trip to Germany in 2020.

"The reason to make those investments now is to support the workers and communities where this is happening now, but to try and get ahead of those impacts down the line as well."

# Adani Group to ship first cargo from Australia

Adani Group is preparing to ship the first coal cargo from Australia's most controversial mine, after battling a seven-year campaign by climate activists and defying a global push away from fossil fuels.

The Carmichael mine in outback Queensland state is likely to be the last new thermal coal mine to be built in Australia. the world's biggest coal exporter, but will be a vital source of supply for importers such as power plants in India.

"The first shipment of high-quality coal from the Carmichael mine is being assembled at the North Queensland Export



Terminal in Bowen ready for export as planned," a spokesperson for Adani's Australian subsidiary Bravus Mining & Resources said in a statement. The statement did not say where the shipment was headed, except that "we have already secured the market for the 10 million tonnes per annum of coal that will be produced at the Carmichael Mine".

When Adani bought the project in 2010, it envisioned building a 60-million-tonne-a-year mine with a 400km rail line for around \$16 billion, one of several projects planned in the then untapped Galilee

It shrank the mine plan in 2018 to 10 million tonnes a year following a sustained "Stop Adani" campaign by green groups which scared off lenders, insurers and major engineering firms.

"That sharpening of the plan has kept operating costs to a minimum and ensured the project remains within the first quartile of the global cost curve," Adani's Australian CEO Lucas Dow told Reuters in emailed comments.

The company has not disclosed the cost of the smaller mine and a 200km rail line it built tying into an existing railway, but the project has been estimated at \$2 billion.

"It is quite a celebration because this is going to be the last true greenfield thermal coal mine in Australia," said Lloyd Hain, managing director of consulting firm AME Group.

Climate activists. concerned about carbon emissions and potential damage to Australia's

Great Barrier Reef, both from global warming and dredging at Abbot Point port, brought several cases challenging government approvals for the mine.

Their campaign turned into a lightning rod at Australia's last election in 2019, in a jobs versus the environment fight which saw the coalsupporting conservative coalition government re-elected when it was expected to lose.

While activists succeeded in delaying the project for seven years and even leading Adani to change its local name to Bravus, they are not claiming victory. "It's a shame that the

mine's still going to go ahead. But just because the mine's open doesn't mean all the coal in the ground is going to come out. We will continue to campaign to keep as much in the ground as possible," said Andy Paine, who chained himself to Adani's rail line several weeks ago.

# Romania's production increased by 17.5% in the first 11 months of 2021

Romania's net coal production in the first 11 months of 2021 totalled 2.958 million tonnes of oil equivalent(toe), 17.5% (440,800 toe) higher than in the same period in 2020, according to data centralized by the National Institute of Statistics (INS).

During the period, Romania imported 440,600 toe of net coal, 38,700 toe (9.6%) more than the amount imported last year in the same period.

The National Strategy and Forecasting Commission estimated

coal production for 2021 at 3,020 million toe, up 9.9% on 2020, and imports of 370.000 toe. down 12.1%. For 2022, the CNSP forecasts production of 2,935 million toe, down 2.8%, and imports of 270,000 toe, down 27%.

According to the National Energy Strategy, total coal production will decrease from 32 TWh in 2030 to 12 TWh in 2050, continuing the trend of decreasing coal in the energy mix (45 TWh in 2020). For the year 2030, the

modeling results in the

Optimal Scenario chosen show that coal energy will decrease slightly to 15.8

TWh and will have a share of 20.6%.





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# Coal is still king

For all the talk about the demise of coal, it's important to note that coal generated 35% of the world's electricity in 2020, more than any other fuel. Even in the US, coal was expected to generate 23% of the nation's electricity in 2021 – up from 19% in 2020.

In addition to electricity generation, coal is critical for industry, making the cement, iron, and steel needed for modern civilization, including even wind turbines and solar panels. Without coal, the industrial revolution would not have occurred. Without coal, a carbon-free energy transition – forced or otherwise – is simply unrealistic.

Coal supplies the world with 27% of its total energy needs, second only to oil (which supplies 31%). China and India alone consumed 66% of the world's coal in 2020, and coal supplies at least 55% of their total energy needs.

#### **Coal Generation**

In the US, coal is regaining market share from natural gas, whose generation is expected to drop to 36% in 2021 from 39% the year prior. Incidentally, coal's increased generation from July 2020 to July 2021 is four times larger than that of wind and solar generation combined for the same period.

US electricity generators are returning to coal because they have the existing plant capacity and it is an abundant, affordable, and reliable domestic source of electricity. The US is blessed with the largest share of the world's coal reserves (23%), eclipsing second-place Russia (15%) and third-place Australia (14%).

Around the world, coal is still the dominant source of electricity generation.



Though it has just 13% of the world's coal reserves. China generates more than 60% of its electricity from coal. India, with 10% of the world's coal reserves, generates more than 70% of its electricity from coal. Similarly, Poland, the second-largest coal producer in Europe (behind Germany), generates 74% of its electricity from coal. Even Japan generates 30% of its electricity from coal and has no plans to phase it out any time soon.

#### **COP26 Framework**

At the recent United Nations climate conference in Scotland (COP26), US Special Climate Envoy John Kerry boasted that the US will end the use of coal-fired power by 2030. Fortunately, Kerry has been wrong more often than he has been right, and he has no actual authority with respect to power generation.

India was quick to point out that providing their citizens with affordable and reliable energy requires the continued use of coal, and successfully urged other nations to commit to slowing coal power generation, rather than deliberately transitioning away from it.

India is not alone in that sentiment. South Africa gets more than 80% of its electricity and nearly onefifth of its liquid fuel from

coal. The nation is one of the top 10 coal producers in the world and has spent the equivalent of 6% of its annual gross domestic product on two huge coalfired power plants that will become fully operational in the coming years. It is the most coal-dependent country in the Group of 20, or G20, major economies. At COP26, the US, Germany, France, the UK, and the European Union all pledged to mobilize \$8.5 billion over the next three to five years to help South Africa replace coal with renewable energy and find new livelihoods for mining communities. South Africa, however, said it needs more than \$26 billion from wealthy nations to transition its power system from coal to renewables.

Also, at COP26, China, India, and other developing economies demanded that wealthy nations pay them \$1.3 trillion annually for climate projects starting in 2030, half of which would be dedicated to subsidizing renewable energy in the developing world, with the other half earmarked for protecting other countries from the effects of global warming. For China to achieve its net-zero emissions targets in 2060, investments of as much as \$2 trillion a year through 2060 would be

necessary. That includes more than tripling its current pace of renewable energy installations. According to China's Premier Li Keqiang, China cannot easily pivot away from coal until it has enough other alternatives to ensure reliable power. He hinted that even his country's pledge to cap its carbon dioxide emissions by 2030 could be torn up sooner rather than later.

These are examples of the benefits of affordable and reliable coal power, and the likely costs to transition away from it. Much of what gets reported in the news. or hyped by climate alarmism about coal, is simply wrong. Until technologies that haven't even been dreamed of yet come along, an affordable, predictable baseload future led by cleaner-burning coal is preferable to a wildly expensive, unrealistic carbonfree future. In other words, the rumours of coal's death have been greatly exaggerated.

Thomas J. Pyle is the president of the Institute for Energy Research, an energy think-tank, and the American Energy Alliance, a not-for-profit that engages in grassroots public policy advocacy and debate concerning energy and environmental policies at both the state and national level. He served as head of transition for energy under President Donald J. Trump.

# **Oracle teams up with Sui Southern Gas Company**

London-listed Oracle Power has signed a nonbinding memorandum of understanding (MoU) with Pakistan's Sui Southern Gas Co (SSGC) to develop a synthetic natural gas (syngas) project utilising coal from Thar, the company said The MoU establishes the basis for Oracle and SSGC to explore and carry out feasibility studies for the potential development, owning, operating and sale of syngas from Thar coal to the Pakistani state-owned company.

would be integrated into SSGC's transmission and distribution network which delivers indigenous natural gas and regasified LNG to domestic, commercial and industrial consumers.

"Our Thar Block VI project is an asset with immense potential value for Pakistan, particularly in the context of natural gas shortages and the intense price pressures associated with the import of LNG," Oracle CEO Naheed Memon said. "We look forward to updating the market further

with the development of these studies as we

Syngas produced

# Georgia's imports from Kazakhstan triple

Georgia's coal and coal products imports from Kazakhstan from January through November 2021 amounted to \$719,030, which is an increase of 205.9 %, compared to \$235,010 over the same period of 2020, Trend

reports via the National Statistics Office (Geostat). The volume of coal and coal products imports from Kazakhstan in the reporting period of 2021 also increased by 28.4 % – from 2,490 tons over the same period of 2020 to 3,198 tons.

Thus, Kazakhstan ranked 2nd among main coal and coal products exporters to Georgia over 1st 11 months



of 2021, following after:

- Russia (\$7.2 million)while Turkey ranked 3rd
- (\$576 890)

Georgia's coal and coal products import from January through November 2021 amounted to \$8.6 million, which is a decrease of 36.2 %, compared to \$13.5 million over the same period of 2020.

Georgia depends on imports for all its natural gas, oil is imported mainly in the form of refined oil products (diesel, 40.7%, and gasoline, 40.4%).

The energy mix is relatively diverse compared with other countries in the region.

In 2019, natural gas was the 1st fuel in the energy mix (45.4%), followed by oil (27%), renewables (20.4%) and coal (4.7%).

The share of renewable sources in Georgia's electricity mix is among the highest in the world (74.7% in 2020). jointly look to unlock the value of this strategic resource for the benefit of all stakeholders and in accordance with national demand," he added.

The companies expect the feasibility studies to be completed by Q4 2022. Upon successful completion of feasibility studies, they intend to negotiate and enter into definitive agreements for the sale and purchase of syngas and evaluate any possibility of investment and support by SSGC in the syngas project.



# Majority of promised aid is yet to reach German regions

Only a fraction of the promised financial aid for coal regions has been distributed, triggering worries that a just transition is being put at risk, reports newswire dpa in an article carried by WirtschaftsWoche magazine. The federal government has earmarked a total of 40 billion euros for assisting the coal exit, of which 26 billion are going to be direct investments by the federal government and 14 billion euros will be paid out as financial aid to coal-producing states that are set to lose jobs and industry. However, an information request to the government by the Left Party revealed that only 4.8 million euros were distributed in 2021, less than 1% of the budgeted amount of 508 million euros.

According to the ministry for the economy and climate (BMWK), a total of 251 projects costing 4.3 billion euros have been

"submitted and confirmed" within the financial aid framework. However, only 13 projects which will reach a volume of 96.6 million euros, have so far begun. Dietmar Bartsch, co-chair of Die Linke, called for the process to be speeded up in order to ensure coal-producing regions, particularly those in the east, are not left behind. "If not even five million euros actually flow out of the federal budget in 2021, then we will experience the worst possible start to the structural change," he said. "Whoever wants to get out of coal by 2030 must manage the structural change and create the necessary jobs by 2030."

Germany's new government has pledged to pull forward the coal exit "ideally" to 2030 from its current 2038 target date. The plans have triggered fears in affected regions that jobs in the coal industry can't be replaced with new offerings on time.

# Build Back Better is crucial to boost climate action without leaving coal miners behind

Joe Manchin threw a wrench into discussions of the Build Back Better (BBB) Act by indicating he does not currently support its passage – imperiling the bill's future and delaying the urgent funding it would provide to support families reeling from the COVID-19 pandemic and take crucial climate action.

In response, the United Mine Workers of America (which represents, among others, West Virginia's coal miners) issued a statement noting BBB would provide critical support for workers as the inevitable decline of coal industry jobs continues, as well as create new opportunities for jobs in the clean energy-based economy, to which the world must transition guickly to prevent the worst impacts from climate change.

The U.S. coal industry has been declining for years; over the last decade, market forces such as low natural gas prices and rapidly expanding solar and wind energy (as well as the expanding use of automation in coal production) have turned coal mining into a shadow of what it once was. At the end of 2020, there were only 43,180 coal miners remaining in the United States, and communities from West Virginia to Montana to Kentucky are feeling the economic pain of coal's decline (as well as its lingering pollution). As these workers - many of whose families have spent years or even generations in this industry look toward the future, they deserve assurance that they won't be abandoned by their employers and left with no economic opportunities. But a transition that

supports fossil workers and communities is not going to happen on its own. We

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need intentional policies that invest in these workers and communities.

The hundreds of billions of dollars of investment in clean energy and climate actions included in the BBB bill will be a net win for the economy and American jobs; the Economic Policy Institute projects that it will support 3.2 million jobs over the 10-year budgeting period. The BBB act would ensure that federal investments go to communities that disproportionately bear the burden of pollution and those that are dependent on the fossil fuel sectors that are in decline

The Build Back Better bill includes a range of provisions that would support miners in West Virginia and beyond. It would give a four-year extension to a fund through which coal companies support miners who have contracted black lung disease; without BBB, this fund will be cut in half on Jan. 1. The BBB act would make key investments in fossil fuel communities, including \$5 billion for the Department of Energy's Energy Community Reinvestment Financing Program to support lowcarbon investments in energy communities, and \$5 billion for the Economic Development Administration to develop regional economic growth clusters and award grants for economic development in energy transition communities and others with a history of economic distress. It would also provide additional tax incentives to encourage the building of clean energy and advanced energy manufacturing facilities in energy communities including those impacted by the closure of coal mines and coal-fired electricity



generating units – where they will generate local revenue and serve as a new source of employment for former miners. And it would penalize companies if they deny their workers the ability to unionize, thus helping to protect workers' right to organize and collectively advocate for higher wages, better benefits and safer working conditions. In addition, other

climate provisions in BBB can help disadvantaged communities across areas historically dependent on fossil fuel production, such as the entire Appalachian region. Examples include investments in improving water infrastructure to provide clean drinking water, improving stormwater and wastewater infrastructure (including \$225 million to help families struggling to pay their water and wastewater bills), and replacing lead water service lines. The BBB bill also includes environmental and climate justice block grants that can help clean up pollution from shuttered or abandoned fossil fuel sites and create a Clean Energy and Sustainability Accelerator, which will invest in clean energy projects across the country while delivering 40% of the benefits of investments to disadvantaged communities. These investments are long overdue and can go a long way to improve the public

health and economic vitality of regions that have borne the brunt of fossil fuel pollution for decades.

Further, BBB provisions propose not just to create jobs in the clean energy future, but to ensure these newly created jobs are highquality, support families and are accessible to a diverse and growing workforce. To access the full value of BBB's signature, emissionsreducing tax incentives, designed to drive the deployment of clean energy and electric vehicles, employers must meet wage and apprenticeships standards. Specifically, employers must pay wages that meet or exceed a locally determined, position-based floor during construction, and in some cases after. They must also ensure that a certain percentage of total labor hours support qualified apprenticeships. We are already seeing

what the collapse of the coal industry looks like when there are no protections in place – but it doesn't have to be this way. Among its massive other benefits, passing the BBB act will help manage this essential economic transition to create a zero-carbon world – without leaving coal miners and other workers behind.

Dan Lashof is the director of World Resources, United States.

# Glencore insists new mine will not crush its climate change plans

Mining giant Glencore says its plan for a new metallurgical and thermal coalmine in Queensland can be accommodated within its climate strategy.

#### The Anglo-Swiss

multinational insists its proposed Valeria coalmine in Queensland will not upset ambitions for netzero carbon emissions by 2050.

Glencore is undertaking a range of studies and assessments on Valeria to support the state and federal approvals process for the project.

"The development of any coal project, including Valeria, will take into account Glencore's climate change strategy and stated emission reduction targets.

Glencore has committed to reducing emissions by 15% by 2026, halving emissions by 2035 and being a net-zero total emissions business by 2050.The Valeria Coal Holdings project within the Central Highlands is expected to produce up to 20 million tonnes per annum for 35 years. The open cut

metallurgical and thermal coalmine, 27km northwest of Emerald and 270km



would require a 300-bed accommodation camp, access road, rail line, water supply pipeline, power and communications infrastructure.

west of Rockhampton.

Environmental activists are already gearing up to oppose the mine, although Glencore is yet to reach a final investment decision. Lock the Gate

spokeswoman Ellie Smith said the six pit open cut mine would destroy more than 10,000 hectares of land near Capella – a key agricultural region where wheat, sorghum, and beef are produced.

The rail line and other infrastructure would impact a further 12,000 hectares, including prime farmland and important habitat for at least 17 threatened species or ecological communities, including the koala and greater glider, she said.

"If the Morrison and Palaszczuk governments approve this project, they will have no hope of meeting their stated emissions reduction targets. That means yet more extreme weather for Queenslanders," she said. "There is clearly no

justification for approving this coal mine."

# **NEWS, PLANT AND EQUIPMENT**



# Mechel announces results of this year's mining equipment revamp

Mechel, one of the leading Russian mining and metals companies, reports that its mining facilities this year received a total of some 270 equipment units, including more than 80 large-scale machines and assembly units.

The most sweeping technical revamps and retrofits involved Southern Kuzbass Coal Company, which received more than 100 new equipment units, including heavy-duty trucks, bulldozers and service equipment. All automobiles use an online dispatch system implemented by Southern Kuzbass Coal Company, which ensures improved performance and work efficiency. The new machines take part in transporting overburden, as well as moving coal from the mines to the washing plants and shipping points. Southern Kuzbass Coal Company's washing plants launched a total of 39 new equipment units.

Yakutugol Holding Company launched 74 new equipment units, including heavy-duty trucks, an excavator and gondola railcars for transporting loose cargo. Due to complicated geological conditions at Neryungrinsky Open Pit, this year the company made sure to revamp pumping equipment to pump ground waters and prevent flooding at mining areas. Neryungrinskaya Washing Plant installed two new centrifuges to eliminate excessive water from the coal concentrate and three magnetic roughers. The plant also continued with the sweeping upgrade of its mud pump stock.

Ninety equipment units, including heavy-duty trucks, excavators and a boring rig, were bought for Korshunov Mining Plant. This equipment is used to transport ore from Korshunovsky Open pit, mining at Korshunovsky and Rudnogorsky Open Pits, even in extremely low temperatures. Korshunov's washing plant launched new pumps as well as a press for curing conveyors. The plant also received new hydro separators.

"We invested approximately 4 billion rubles into acquiring new mining equipment and mechanisms, and next year we plan to invest 8 billion. We are faced with a strategic task to restore stripping pace, increase mining and washing volumes. This new equipment will enable us to reduce outages caused by repairs, and boost output at our facilities in Irkutsk Region, Yakutia and Kuzbass. Considering steady demand and favorable price trends on commodity markets that we see over the past several guarters, it is very important for us to ensure production growth," Mechel PAO's Chief Executive Officer Oleg Korzhov commented.





ound on most mining and construction sites, wheel loaders are one of the most powerful pieces of equipment to be found within mining, their significance and existence within mining has also led to ongoing development.

Their primary function is for loading or moving materials both above and beneath the surface of a mining operation, the required number of loaders and trucks is a strategic mine planning decision that can maximise production efficiency and minimise capital and operational costs.

It has been reported by Off-Highway Research that wheel loaders have risen by 75% over the last decade from 1.3 million machines in 2008 to 2.23 million a year in 2017 and beyond this figure to our present day.

Coal International takes a brief look at the history and recent developments of the wheel loader.

Like many pieces of equipment, it is hard to articulate who was the clear creator of the wheel loader as many adaptations similar to what we know developed from farmers fitting scoops to their tractors to help move materials. Although it is believed that Ed Wagner & Sons Contractors created the world's first articulated loader in 1936 (called Scoopmobiles), it is Volvo who is credited for the invention of the first wheel loader in 1954. They named it the H10, the inspiration came from a reversed tractor. By the early 1970s larger loaders had been produced by Volvo which had a new lift arm system and a safer and more comfortable cabin. The industry is constantly evolving, and new ideas and patents are continually being published. In the period between 1989 and 2014 Yanmar, Komatsu and Caterpillar had all filed different patents for wheeled loaders.

In open-pit mines with suitable conditions, the use of wheeled loaders can highlight the following advantages:

 The tire front loader has fast walking speed, short working cycle time and high loading efficiency. According to the introduction of mine calibration data, the front installed speed of bucket capacity of 5 ~ 8m 3 can reach more than 35km / h, which is 30 ~ 90 times faster than electric shovel. Each working cycle only takes 40 ~ 45s, and the average production capacity of the shift can reach 3500





~ 4000t, average labour productivity can be increased by  $50\% \sim 100\%$ .

- 2. The weight of the tire front loader is lighter, which is equivalent to  $1/8 \sim 1/6$  of the quality of the same bucket capacity excavator, which saves a lot of steel. The manufacturing cost is only  $1/4 \sim 1/3$  of the excavator. Excavators are cheap, which can reduce investment in production equipment and reduce the proportion of fixed assets.
- The tire front loader has strong climbing ability and good manoeuvrability. It can perform loading operations on the slope working surface that is not allowed by the excavator, especially in new mine sites lacking electricity.
- 4. The depreciation period of the tire-type front-loading machine is only 1/4 ~ 1/8 of the excavator. It can be replaced with new and more advanced equipment after 5-6 years of work, which is convenient for mine management and maintenance and is conducive to the upgrading of equipment.
- 5. The tire front loader is easier to operate than the excavator, which can shorten the driver training time. At the same time, one loader only needs one driver to operate, which can save manpower, material, and financial resources.

However, compared with the excavator, the front loader also has some disadvantages in production:

1. The tire-type front-loader has a lower digging capacity than an excavator. When the blasting quality is not good

# WHEEL LOADERS I

and there are many large pieces, its work efficiency will be significantly reduced; it is necessary to loosen the viscous materials before conducting the shovel operation and other Auxiliary work.

- 2. Compared with the excavator, the size of the working mechanism of the front loader is smaller; due to the limitation of safety conditions, it is not suitable to work on the working face with a high explosion.
- 3. The tires of the front loader wear quickly and have a short service life. In recent years, although measures have been added to protect the chain link or use pad cushions to reduce tire wear, the tire life is only about 1500 hours, and tire costs still account for a substantial proportion of production equipment costs (about 40 % ~ 50%, even as high as 60%).

Many years of production practice at home and abroad have proven that wheel loaders are suitable for the following aspects:

- 1. It is used for loading, pushing, and discharging, lifting and traction in the construction of open-pit mines and stripping, railway foundation construction and road construction.
- 2. It is used in small and medium-sized open-pit mines instead of excavators and cars as the main mining, loading, and transportation equipment of the mine; it can be operated in conjunction with automobiles and can also load ore rocks to crushing stations.
- 3. In some large open-pit mines, cooperate with the excavator to perform mining and loading operations and other auxiliary operations under complex conditions

## WHEEL LOADERS

(such as selective mining, end of working face, scattered pile explosion, excavation of trenches, etc.).

4. It can be used for mining, loading, and transporting joints with large slopes to complete difficult mining work. There are two types of common front-loaders, tire-type, and track-type, with their own characteristics. Although the crawler front loader has large traction and shovel, superior performance in off-road and climbing, etc., it has low speed and inflexibility, and sometimes requires a trailer to transfer the operation site, and the construction cost is high. Therefore, track-type front loaders are rarely used in open-pit mines. Wheel loaders are the most commonly used in mines around the world. Therefore, their production volume is large and production technology is also developing rapidly. The largest bucket capacity has reached 40m<sup>3</sup>.

#### **DEVELOPMENTS OF THE WHEEL LOADER**

In underground mines, specialized wheel loaders (LHD) are used for loading fragmented rock, hauling the material through narrow tunnels, and dumping it for further transport on trucks or hoist systems. The loading task remains a challenge to automate. To fill the bucket efficiently, an operator, or an artificial intelligent agent, must coordinate the forward drive, steering, and the bucket's lift and tilt in response to visual cues, and the perceived force resistance and vehicle motion.

To test whether deep reinforcement learning is a viable approach to automating this task, a simulated environment was constructed with a 3D multibody model of a loader and narrow drift with virtual piles of fragmented rocks using AGX Dynamics for Unity and ML-Agents. The vehicle, an Epiroc Scooptram ST18, was equipped with a depth camera, and force and motion sensors. A multiagent system was trained using the reinforcement learning algorithm Soft-Actor-Critic and a curriculum setup. First, a mucking position agent learned to predict the most efficient position to dig into differently shaped piles. Next, a mucking agent was trained on how to control the vehicle to fill the bucket at a selected dig position. Finally, the agents were trained together. The agent's policies were represented by a feedforward neural network with convolutional layers for handling the high-dimensional observation data. The rewards the agents learn to maximize were designed to maximize bucket filling with minimal energy consumption and avoiding collisions and wheel slip.

The learned policies were able to adapt to previously unseen pile shapes, achieving a success rate of 99% with an average bucket load of 13.2 tonnes. The productivity and energy efficiency were better than the values reported for human operators in the scientific literature, but it remains to evaluate if these results transfer to the physical environment.

#### WHEEL LOADER MONITORING SYSTEM FOR MINING

After 18 months of successful field trials conducted across three Western Australian mine sites, MineWare has launched its Argus Wheel Loader (WL) system

This is an OEM independent wheel loader monitoring system that lifts productivity and reduces cost per tonne in real time.

Argus WL delivers real-time feedback to the wheel loader operator via an intuitive touchscreen to make material handling and loading jobs safer, faster, and more accurate.

MineWare Vice President of Marketing and Sales Roy Pater said Argus WL extends MineWare's portfolio of monitoring systems as customers continue to digitise their operations and leverage real-time information across more of their ground engaging equipment.





"Building on the success of our world-leading Argus and Pegasys monitoring systems for electric rope shovels, hydraulic excavators and draglines, Argus WL was developed based on a growing demand from our customers to improve efficiency, effectiveness and payload accuracy across their large wheel loader fleets," he said.

"Argus WL does this by weighing each bucket in real time, without the need to stop and calculate payload before dumping the load. This we understand from our customers is an unacceptable practice required from other similar systems today, losing valuable production time to repeat this with every bucket load.

"Argus WL was a natural progression for us, meeting the industry's need for a system purpose built for large wheel loaders used in mining that would lower production costs, reduce machine stress and improve safety."

Pater said the multi-purpose nature of the system was a key point of difference with Argus WL offering advanced functionality in truck detection, structural monitoring, as well as payload optimisation in real-time.

"The real-time nature of Argus WL really stands our system apart as it gives operators direct feedback for them to make smarter loading decisions to optimise truck loading and payload management," he said.

"Argus WL guides operators to move the right amount of material with every load, helping mines to reduce payload variability, meet production targets and predict the operations forecasts more reliably, when analysing machine productivity by shift and operator."

Developed on an open IoT platform, the interoperable system works on any OEM machine and integrates seamlessly with third party production software. 1/2

Pater said Argus WL leverages MineWare's 15 years of experience in ground engagement equipment monitoring, productivity improvement and payload optimisation to create a purpose-built system, made for mining.



# WHEEL LOADERS



"Talking to our customers, we knew that the best way to improve their wheel loader productivity was to empower their operators with better access to real-time, actionable information and give them a single platform that integrates with their existing software," he said.

"Argus WL takes productivity monitoring for wheel loaders to a new level, by working smarter, not harder, to get the job completed successfully."

A wheel loader is without doubt the most versatile piece of equipment used in many industries but the task of fully automating the machines despite the implementation of modern technology has still eluded many experts mainly due to the complexity of bucket-environment interactions, even three decades of research efforts towards automation of the bucket loading operation have not yet resulted in any fully autonomous system. Automation of the bucket-filling step in the loading cycle of a wheel-loader has been an open problem for many years.

Despite numerous trials. there still remains key challenges in automation and tele-remote operation of earth-moving machines and research seems to be lagging behind. Realtime video transmission over wireless is difficult, but may



present a way towards improving the remote operator's quality of experience

Tele-remote operation of mobile earth-moving equipment is needed along the development of fully autonomous machines. Some underground mines have already deployed tele-operated load-haul-dump machine where loading is done on tele-remote while hauling and dumping is autonomous. However, many industries including quarrying will benefit if more general solutions for teleoperated heavy equipment are available

Tele-operation requires decent quality audio-video links along with control data, monitoring data and feedback data. Since even the most advanced wireless network can get overloaded, it is important to use the network's bandwidth efficiently by choosing the most suitable protocol suite for teleremote operations. In tele-remote operations, since several cameras are needed to give sufficient visual feedback, the video streams account for almost all the network bandwidth used. Although wireless transmission is plagued by path losses, multipath propagation, and interference causing throughput and delay variation, wireless networks are still essential for tele-remote operations.

Volvo Construction Equipment (Volvo CE) has been involved in a Swedish research project that demonstrated that by applying the latest technology within communication and automation, underground mines could become more efficient and safer. In the Pilot for Industrial Mobile Communication in Mining (PIMM) project, Volvo CE developed and evaluated its remotely controlled wheel loader four hundred metres underground - while the operator commanded the machine from a comfortable office on the surface. This was made possible with the help of other companies and organizations including Boliden, Ericsson, Telia, ABB, RISE SICS and LTU - which joined forces on the project to explore what the next generation of mobile communication technology, 5G, could mean for business models and communications in a mine.

#### **TESTING IN REAL ENVIRONMENTS**

The PIMM project installed the latest technology for mobile communications in Boliden's Kankberg underground mine, in Sweden, to evaluate how it performed in a challenging application under tough, industrial conditions. In a mine, network delays could have major consequences for safety and productivity. At this stage, the remotely controlled wheel loader is part of a research project, and it is not commercially available.

"Volvo CE's mission statement for the project was to prove that the technology we're developing internally is applicable in a customer environment," says Erik Uhlin, Advanced Engineering Program Leader. "We wanted to highlight that industrial applications in mobile networks aren't just something out of science fiction - they're real. Testing was conducted while production was taking place and that was demanding - but it meant that we were working with real problems, in a real environment. The project was a great success. The collaboration between all the partners resulted in us showcasing that a future underground mine could not only be more efficient, but also safer."

#### SUCCESS THROUGH COLLABORATION

By collaborating with partners, Volvo CE gained knowledge and experience of data links via mobile networks for real time control. The mobile network that Ericsson built for the Kankberg mine featured the latest in wireless technology. The system was so fast and dependable that it enabled the wheel loader to be controlled from above ground.

"The benefit of working with other technology-based companies is huge," concludes Uhlin. "There was a great openness and willingness to collaborate that further increased what everyone got out of the project. All the partners openly shared their advanced technology and knowledge within digitalization and automation, and it was because of this collaboration that the project was a success."



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# Solar energy in the Mining Industry



ertain mining operations have unusual demands when it comes to power supply. So, there are many companies that are now supplementing their mining operations by using solar energy. There is no doubt that this form of energy is a cost cutter and

helps to save the other sources of energy from running out.

#### RELIABILITY

We all know that most mines operate round the clock, so the mining operators would expect constant availability and high reliability from the various power systems without any shortfalls. Solar plants with battery banks can store a lot of solar energy. Other solar technologies can also be used to generate steam which in turn runs a turbine and produces electricity. These power plants can work well in isolation and can provide services without any problems. The best part is that as a mining operator you do not have to depend on natural gas or diesel. If you are carrying out mining operations in remote places it may be logistically difficult and expensive to transport fuel. Natural gas also has significant financial and logistical challenges.

# THE IMPORTANCE OF SOLAR ENERGY IN THE MINING INDUSTRY

Certain companies that provide solar energy to the mining industry can integrate fossil fuel, photovoltaic panels, and Concentrated Solar Power (CSP) seamlessly. The CSP technology used in mining operations can offer 90% capacity factor. To achieve 100%, you may consider using diesel generators to supplement the shortfall. This is by far the most cost-effective way to power mining operations. If you run a small mining operation then you could consider using PV solar to bring down the cost of energy and cut down on the emission of Co2 and you will also reduce dependence on the use of diesel.

# SOLAR ENERGY IS INDEED A BOOM TO THE MINING INDUSTRY

There are many companies out there that provide solar energy to power mining operations but not all of them are reliable. Caution needs to be adhered too about the company you decide to hire. Make sure you carry out a thorough due diligence and research the company you are working with who will design and install the system.

There is no doubt that the sun can generate huge amount of energy and it is used not only to power homes and appliances, but the mining industry is making effective use of it. The mining operators will no longer have to depend on the other sources of energy.

#### SITUATION

As the largest economy in Latin America and the ninth largest in the world, Brazil is a Southern Hemisphere economic powerhouse that relies heavily on mining. Gold, copper, tin, iron, bauxite, and gemstones top the list of items extracted from Brazil's mines and directly drive its economy.

To ensure its expansion and growth, the Brazilian mining industry is increasingly turning to solar power to support its mining operations. Powering these can be a challenge – a mine has inherently high energy consumption due to the heavy equipment, lighting, and safety and ventilation required. Add to that the fact that mines are usually in very remote locations and pose safety concerns with either no or unreliable grid access. Often mines must rely on noisy, emissions-producing diesel generators with their significant fuel and maintenance costs to supplement their on-site electrical consumption.

Replacing diesel generators and augmenting unreliable grid power with local renewable energy sources has the potential to reduce mining operation greenhouse gas emissions as well as costs, by reducing or eliminating production delays due to load shedding and power outages. Which is why mine operators across Central and Latin America, and especially in Brazil, are increasingly turning to solar electricity to take advantage of the regions' abundant sunshine and harvest the electricity required locally, cleanly, and more cheaply.

#### PROJECT

One firm specializing in renewable applications for mining is Trailers RD-Minas, a company based in Belo Horizonte, Brazil. Trailers has 17 years of design, manufacture, and assembly experience in developing solutions for mining companies in the areas of dispatch, data networks, cameras, and lighting. Their engineered solutions are renowned for improving worker safety and performance while also reducing maintenance costs.

To develop energy systems with the long-term dependability and performance demanded by mining operators, Trailers specifies Morningstar solar controllers in their projects, specifically the TriStar MPPT-60, TriStar Meter-2, Pro-Star MPPT-40 and SunSaver-MPPT-15 solar controllers. In fact, Morningstar components are installed in over thirty separate Trailers mining, construction, road, and airport sites throughout North America, South America, and Africa, in projects including mobile radio repeaters, mobile surveillance cameras, and mobile light towers.

#### SOLUTION

Mobile radio repeater trailers provide customers with realtime view of the status of their solar panels, batteries, operating cycle, and position, at remote locations. This facilitates maintenance and avoids unnecessary shifting and/or allocation. These specially designed and constructed trailers feed into the AC network and are mounted with a generator, air conditioning thermal insulation and battery banks. A typical trailer's chassis might accommodate 8, 14 and up to twenty deep cycle batteries rated at 110Ah to provide sufficient autonomy in remote applications.

For on-site lighting, mining operations use mobile light trailer towers with high efficiency LED spotlights powered by batteries recharged with solar panels and sometimes a wind turbine-powered generator (an option offered for regions with sufficient high wind). These lighting trailers are automatic, and do not require an operator to turn on at night or turn off in the morning. When fully automated, a tower can operate for 28 hours without incident of sunlight, over a day of autonomy. They are ideally suited for use in mining, maintenance stations, workplaces and other locations that require illumination for safer work at night.

# SOLAR ENERGY

Unlike conventional diesel lighting trailers, Trailers RD-Minas' designs do not require fuelling, filter replacements, belts, lubrication, and other maintenance items – or even frequent bulb replacements since the LED spotlights can last about 50,000 hours.

It has been said that all the riches in the Earth originated in the Sun – and if so, then there's poetic justice in tapping directly into the sun's power to extract them more efficiently, safely, and cleanly. Minas' engineering combined with Morningstar's technology is rapidly improving one of the world's oldest industries to ensure that Brazil and other developing countries maintain their economic momentum.

Morningstar Corporation features examples of products used by customers across a wide variety of environments and systems, to highlight their flexibility, performance, and dependability. Installation best practices and preferences can vary across diverse regions and applications, and the examples shown here are for general interest and not







## **SOLAR ENERGY**

intended as a guide. Always consult local codes and refer to product installation manuals for correct requirements.

Rio Tinto and Sandfire are committing to solar energy, helping drive efficiency and sustainability.

Together, the world's active mining operations consume four hundred terawatt hours of electricity per year. Because mines are often isolated from electric grids, providing this power typically means trucking in fuel at great expense over rough, dangerous roads. Determined to cut expenses and improve reliability, mines around the world – including Australia's Weipa and DeGrussa operations – are looking to the power of the sun for energy solutions.

Reliance on diesel fuel to power on-site electric generators has, for many years, been recognised as a problem. In Australia alone, mines and other remote industrial facilities self-generate around 1.2 gigawatts of power on average by burning diesel fuel. That fuel is subject to all the price uncertainty associated with petroleum, on top of the expense inherent in trucking it to remote destinations. Supply breakdowns are also common, resulting in lost productivity.

"The mining industry has clearly reached a tipping point, with a growing consensus that renewable energy at mine sites, both grid-tied and off-grid, is doable and, in many cases, desirable," Navigant Research observed in a recent report.

Although renewable energy in various forms has been widely used for decades now, it has typically been too expensive to appeal to price-conscious mine managers.

Advances in technology have brought costs down in many cases, though, leaving mine operators in particularly well-

suited places eagerly turning to technologies like solar power. In Chile, for instance, the country's complete reliance on imported petroleum and the deep-blue skies of the mine-studded Atacama Desert have meant that solar has made sense for some time already.

At the Codelco copper mine, a high-tech thermo-solar plant provides around 80% of the mine's overall electric power needs, producing electricity right through the night by releasing energy trapped in specialized heat-storing batteries. That saves the mine from needing to transport diesel up a winding road over a rise of more than 2.5 kilometres.

If the clear skies of Chile's Atacama Desert make the country an especially eager adopter of solar power for mining, Australia is not far behind. Two of the country's most significant mines, the Degrussa copper mine operated by Sandfire and Rio Tinto's Weipa bauxite mine, are also making the move.

With 1.7 megawatts of solar power having just recently come online at Weipa, Rio Tinto was the first mine operator in the country to enjoy solar on such a large scale. That initial phase will be supplemented by more solar panels in the future, bringing the total generating capacity to just under seven megawatts.

Further work will also include the addition of storage batteries allowing the facility, like that at Chile's Codelco mine, to produce power through the night to support round-the-clock mining. Overall, project directors expect to cut down on the mine's usage of diesel by 600,000 litres annually, with 20% of all daytime power needs being satisfied by photovoltaic solar panels.

When it is completed, the recently begun project at Degrussa – nine hundred kilometres from Perth – will be





even more significant. It will eventually top out at more than ten megawatts, taking care of over half of daytime electricity requirements and cutting back on diesel usage by five million litres per year. Lithium-ion battery banks will store up to six megawatt-hours of power, with the whole project being financed under a 6-year power-purchase agreement.

Although attractive for a number of reasons, both projects have been made more appealing by support from the Australian government. The Australian Renewable Energy Agency, or ARENA, has funded the Degrussa work to the tune of \$20 million, accounting for over half of overall funding. The Weipa work has already drawn on \$3.5 million in ARENA funding and will up the total to \$8 million before the final phase is finished.

Even with clear skies and the difficulty of transporting diesel seeming to recommend solar, it can take some encouragement of other kinds to tip the balance.

Ultimately, of course, solar power must stand on its own inherent merits, whether in the mining sector or elsewhere. Panel prices are still dropping and efficiency improvement will help, as will the development of better storage solutions to rely on when the sun goes down or becomes obscured. Between these developments and the lessons that will be learned through ambitious projects like those now underway in Australia, it seems that solar power will feature more prominently in mining operations around the world.

Australia's largest hybrid renewable microgrid – the 56MW solar, wind and battery project developed by EDL at the

# SOLAR ENERGY

Agnew gold mine in Western Australia – has had its official launch, some six months after its completion during the Covid-19 pandemic.

The ground-breaking microgrid combines five wind turbines (18MW), a 4MW solar farm and a 13MW/4MWh battery energy storage system, to provide an average of between 50-60% of renewables for the mine in WA's northern Goldfields region.

The renewable components of the off-grid system are backed up by a 21MW gas/diesel engine power plant and managed by an advanced microgrid control system that has, in favourable conditions, achieved up to 85% renewables at the mine.

The ARENA-backed microgrid project was developed and is now operated by EDL under a 10-year agreement to supply power to the Agnew gold mine, which is owned by the company Gold Fields.

The project started by adding the solar to the gas and diesel plant in 2019, and then installed the wind turbines in early 2020, making it Australia's first mining sector project to use wind power as part of a large hybrid renewable microgrid.

A similar non-resources project is currently being developed to meet just under half of the energy needs of the Western Australia coastal town of Esperance, using a mix of 4MW of solar, two 4.5MW wind turbines, a 5.5MW/1.9MWh lithiumion battery system and gas generators.

The WA resources sector has served as an important testbed for innovative renewable energy and battery based

## SOLAR ENERGY

microgrid power solutions, including a hybrid solar and battery system being put together by Juwi Renewables for the Gruyere Gold Mine, which Goldfields also owns alongside Gold Road Resources.

Goldfields vice president Australasia, Stuart Mathews, said on Thursday that the Agnew project was a testament to what could be achieved by taking courageous decisions and demonstrating true leadership.

"This is important to all of our stakeholders, including our employees, who want to see tangible outcomes in relation to our environmental, social and governance priorities and sustainability vision," Mathews said.

"With demonstrated success in construction and now operation, this project has provided a framework to take innovative energy solutions further across Gold Fields' mine sites both in Australia and around the world."

EDL CEO James Harman said the Agnew microgrid had highlighted engineering excellence at every stage – from its inception to its innovative integration of five energy technologies, to its navigation through a bushfire and a global pandemic.

"Credit must go to Gold Fields for its vision and belief that we would successfully deliver this complex project; and credit must go also to the entire project team, including EDL and all our contractors, who worked tirelessly to safely deliver the Agnew Hybrid Renewable Project on time and on budget.

"Since we completed the microgrid in May 2020, and pulled the switch, it has been powering Gold Fields' Agnew Gold Mine with clean, reliable renewable energy," Harman added.

"EDL's hybrid renewable journey has not stopped with this landmark project. As the energy transition continues at pace, our goal is 100% renewables, and we look forward to continuing our work to make this a reality."

Earlier this year, the CEOs of five major mining companies - including Gold Fields – pledged to shift their operations to renewable energy, and to help accelerate the broader decarbonisation of the industry, as part of an unprecedented collective agreement.

As Renew Economy sister site One Step Off The Grid reported, South32, OZ Minerals, IGO, Gold Fields Australia and Barminco co-signed a statement of intent committing to the electrification of their mine sites, paving the way for the phase-out of costly and heavy-polluting diesel generation.

The pledge was made in conjunction with the establishment of the Electric Mine Consortium, founded by a group of 14 companies in response to climate change and in a bid to harness the economic and social benefits of clean energy, large-scale storage and battery electric vehicles.

#### WHAT ARE THE CURRENT AND UPCOMING INNOVATIVE **MATERIALS?**

A typical solar cell consists of semiconducting materials such as p- and n-type silicon with a layered p-n junction connected to an external circuit. Sunlight illumination on the panels causes electron ejection from silicon. The ejected electrons under an internal electric field create a flow through the p-n junction and the external circuit, resulting in a current (electricity). With a swiftly growing market and the development of creative applications, R&D on innovative solar energy materials is at its peak to achieve maximum solar-to-electricity efficiency at low cost. Three types of highly investigated semiconducting materials of today are crystalline Si, thin films, and the next-generation perovskite solar cells (PSCs).

#### **CRYSTALLINE SILICON**

Crystalline silicon (c-Si) is the most used semiconducting material in solar panels, occupying more than 90% of the global PV market, although the efficiency is significantly under the theoretical limit (~30%). Solar cells made of alternative low-cost and high-efficiency materials are emerging.

The National Renewable Energy Laboratory (NREL) is driving the development of high-efficiency crystalline PVs,



which includes III-V multijunction materials (with target efficiency of >30%) and hybrid tandem III-V/ Si solar cells. Their six-junction III-V solar cells have reached an efficiency of 47.1% under concentrated light. Moreover, Sibased bifacial technology can harvest solar energy from both sides of the panel, with 11% more efficiency compared to standard panels.

#### Thin Films

Second-generation thin-film solar cells are appearing as one of the most promising PV technologies due their narrow design (350 times smaller light-absorbing layers compared to standard Sipanels), light weight, flexibility, and ease of installation. Typically, four types of materials are used in their construction: cadmiumtelluride (CdTe), amorphous silicon, copper-indium-gallium-



An Oxford PV solar module

selenide (CIGS), and gallium-arsenide (GaAs). While to concentrate light beams by 200 times while reaching an CdTe has a toxicity concern due to the cadmium, efficiency of 30%. the CIGS solar cells are turning out to be the more promising high-efficiency and economic options for both Another recent development is the designing of prototypes residential and commercial installations, with efficiency up of thermoradiative PV devices, or reverse solar panels, to 21%. that can generate electricity at night by utilizing the heat irradiated from the panels to the optically coupled deep Perovskite Solar Cells space, which serves as a heat sink.

Among the next-generation solar cells, hybrid metal halide perovskite solar cells (PSCs) have garnered a great amount of attention due to their low price, thinner design, low-temperature processing, and excellent light absorption properties (good performance under low and diffuse light). PSCs can be flexible, lightweight, and semi-transparent. Notably, perovskite thin films can also be printed, leading to scalable high-throughput manufacturing, and a recent roll-to-roll printed PSC has reached 12.2% efficiency, the highest among printed PSCs.

Notably, combined perovskite and Si-PV materials have shown a record efficiency of up to 28% under laboratory conditions, as demonstrated by Oxford PV. While stability and durability have remained a major concern, a recent low-cost polymer-glass stack encapsulation system has enabled PSCs to withstand standard operating conditions. Although PSCs are still not commercialized, they hold significant economic and efficiency advantages to drive the future of the solar energy market ...

What are the breakthrough integrative solar cells technologies?

Apart from innovative materials, creative methods of harvesting maximum solar energy are also emerging. For example, Swiss start-up Insolight is using integrated lenses as optical boosters in the panels' protective glass

# SOLAR ENERGY

Interestingly, along with innovative materials, integrative applications other than standard rooftop installations are also rising and are currently in their infancy. For instance, solar distillation can harvest solar energy while utilizing the dissipated heat from panels to purify water, if there is an integrated membrane distillation attachment.

Another transformative technology of the future could be solar paints, which include solar paint hydrogen (generates energy from photovoltaic water splitting), quantum dots (photovoltaic paint), and perovskite-based paints.

Furthermore, transparent solar windows are highly innovative applications, and Ubiquitous Energy has achieved a solar-to-electricity conversion efficiency of 10% with their transparent materials. A demonstration from Michigan State University, a pioneer in this technology, can be seen in this video:

With the rapid development of low-cost, high-performance semiconducting materials, space-saving thin films, and easily installable technologies, the solar energy market is expected to boom in the next five years. Despite the setback caused by the pandemic, the anticipated cost reduction of 15% to 35% by 2024 for solar installations is encouraging and could make this renewable energy more affordable.

# Strata control in underground coal mines



he term "strata control" refers to controlling the strata to maintain stability around the mine openings underground where operations are or will be taking place. It does not cover such subjects as subsidence or strata remote from the workings.

Strata control is the science (some would suggest art) of utilizing various techniques to prevent or control failure of the strata around mine openings at least for the period where access is required. For various locations in the mine this period may be for the life of the mine (which can be considered as permanent), such as the main mine accesses from the surface, or for a matter of less than an hour, such as a lift off a coal pillar with a continuous miner.

The need for strata control may extend into a goaf area for a short distance, to the goaf edge, however strata control within the goaf is of no interest.

In order to analyse strata reactions, properties such as strength (tensile and compressive), modulus of elasticity, Poisson's ratio, etc. are required, as well as details of the stress fields to which they will be subjected. If these are not known or cannot be measured it will be necessary to assume values with excessively conservative designs likely to result.

A detailed knowledge of any geological structures is also required as these can affect both strata properties and stress fields locally. Strata control techniques which are used include:

- · Mine design relating to dimensions and shape
- · Mine design relating to mining direction
- Sacrificial support external to strata
- Reusable support external to strata
- Strata reinforcement
- Retention of failed strata

Coal International looks at some of these techniques.

#### MINE DESIGN RELATING TO DIMENSIONS AND SHAPE

The aim of this aspect of strata control is to make the strata self-supporting as far as possible, or if not, to minimize the extra support work required.

With regard to opening size, this involves designing minimum practical widths for whatever operations are conducted and could involve modifying the design of equipment to fit into smaller openings. It is more common to install extra support to stabilize an opening that is suited to available equipment rather than design and manufacture equipment to suit the opening. It is likely that the economics of the latter alternative are seldom examined closely.

Mining sequences can be designed to allow intersections to be mined across existing roadways and minimise breakaways which are always bigger excavations. Equipment still needs to be able to turn the corners.

Opening size is always going to be a compromise between a desire to minimise excavation and maximize stability versus minimizing ventilation resistance and maximizing the available workspace.

The height of excavations also needs to be considered – is it better initially to mine less than the final working height in a thick seam for the benefit of more stable ribs? In the event of rib failure openings effectively become wider to the depth that the failure extends into the rib.

With regard to pillar design, the aim is usually to design pillars large enough to remain stable under increased vertical load caused by redistribution of the load previously carried by the extracted coal. Note that there may be several stages to this load redistribution as first and second workings are undertaken.

There are some cases where pillars are actually designed to yield (i.e., at least partially fail) in order to relieve stress on adjacent roadways.

During second workings with continuous miners, remnant pillars or stooks may be designed to remain stable for only a noticeably brief time and then be allowed to fail in the longer term (in fact this may be desirable to improve caving).

With regard to pillar stability, it is not only the plan area which is of importance but also the height to width ratio – a tall, thin pillar is more likely to fail than a short, fat one. The length and/or width required for a stable pillar is therefore going to increase as the working height increases.



# STRATA CONTROL

The shape of an opening also affects its stability. A circular opening is the most naturally stable shape and has been used at mines, notably for shafts and drifts. While a circular profile may be more stable a flat floor is required for most purposes – there is little point in removing strata in the lower portion only to re-fill it again afterwards. An arch shape provides the benefit of a circular profile in the upper section while retaining a flat floor. The drawbacks of an arch section are:

- Because the width of an arch narrows towards the top, an arched roadway may need to be mined wider and/or higher than a rectangular roadway to obtain the dimensions required for given equipment to pass.
- Typical continuous miners have wide cutting heads to maximize production (coal being soft enough to not require excessive cutting power). Mining an arch section, particularly in stone requires a narrower head machine to excavate the profile and meet potential power limitations.
- In laminated or banded strata, the curved portions of roof often fall away in part, so the shape tends to a rectangle of its own accord.
- An arched profile would be incompatible with the current design of longwall gate-end supports.

For these reasons, nearly all mines cut rectangular profile openings, apart from in shafts and drifts



#### MINE DESIGN RELATING TO MINING DIRECTION

This relates mainly to horizontal stress fields. Stress fields are seldom equal in all directions and in a horizontal plane it is usual for there to be a highest stress direction, the "major principal stress", perpendicular to the lowest stress, the "minor principal stress". In general, a roadway driven parallel to the direction of the major principal stress will be more stable than at any other angle, the worst direction being perpendicular to the major principal stress.

It may be desirable to lay out the mine such that most of the headings or at least the main headings are in the best direction and accept that cut throughs may require heavy support or may be sacrificed at times. Alternatively, it may be desirable to mine at an angle in between to get the best conditions possible in both directions.

The effects of stress redistribution on gate roads at the ends of a longwall face and the possible use of goaf areas to "shadow" the gate roads from high stresses is described under the Longwall Strata Control section. This is part of using mine design relating to mining direction to assist in strata control.

Finding best directions may be a case of trial and error in the initial stages of a mine's life and there may be other restrictions on using this knowledge (the layout may already be committed by the first area mined, stress fields can change over a lease, other factors may be more important, etc). Where possible however it should be a consideration in mine design.

#### SACRIFICIAL SUPPORT EXTERNAL TO STRATA

This relates largely to passive support placed in openings to prevent movement of the strata into the opening. It includes the oldest type of support, timber props and bars, and a whole variety of material placed in openings between roof and floor – timber chocks, roadside stone or pumped packs, cans, cementitious blocks or props, steel bars and legs, steel arches, etc. It could also include items such as steel straps or mesh, but these are used in conjunction with strata reinforcement and will be included in that section.

Some of these, notably timber props, provide minimal resistance to roof movement and really only serve to prevent

failed material from falling. Others are able to provide a fair degree of resistance but require a considerable amount of roof/floor movement before high resistance is obtained and are very dependent on the installation standards applied.

The use of this type of support is now limited to:

- Where a degree of failure has occurred or is occurring, and rapid resistance is required to prevent further failure or to retain already failed material in place.
- Where a roadway is only required in the short term and space restrictions are not a problem e.g., a longwall tailgate immediately outbye the face.
- Where a roadway can be closed off, to prevent a possible failure extending into a roadway that is in use e.g., across a cut through which leads into a goaf area.

The advantage of these supports is that they are cheap and can be easily and quickly installed if they are suitable for the proposed application.

Once these supports have taken load they will be deformed and/or crushed and will not usually be suitable for re-use even if they can be safely recovered.

There is a type of support which fits in this section being "sacrificial" in the sense that it is never re-used, but which is often a long term or life of mine installation. This includes such support methods as concrete or steel lining in shafts, sometimes drifts and at times at particular locations which are life of mine workplaces. Sometimes such linings are designed to withstand high stresses and are true supports preventing major strata failures, but more frequently the linings serve the purpose of retaining strata in place so that minor failures do not develop into major ones. Preventing small pieces of rock material falling a long vertical distance is also an important safety function in shafts. The smooth finish of most types of lining has added benefits in reducing resistance to ventilation flow, improving the attachment of shaft or drift services (pipelines, cables, etc) and possibly facilitating cleaning, especially in drifts carrying a conveyor.

#### STRATA REINFORCEMENT

#### Cement and Resin Reinforcement

The reinforcement of strata by injecting several types of resin or cement material into it is now routinely adopted in adverse ground conditions. It is usually quite a slow process, and some resins can be a health hazard requiring personnel access to be restricted during pumping. Therefore, their use cannot be incorporated into the normal mine development process.

The main use of this type of reinforcement is to pre-grout strata where stability problems are predicted e.g., where geological structures are expected, or to grout around areas where a major failure has already occurred to assist in recovery of control. The latter method is quite common where the roof has been lost on a longwall face. The reinforcement process involves drilling into the strata then pumping the resin or cement material into the hole under pressure, forcing the material into any spaces in the strata and gluing it together. Some of these materials form high expansion foam which also creates its own pressure thereby improving penetration of the strata.

At times, these materials are used to fill a cavity where a major failure has occurred. In such cases they are not being used so much to reinforce the strata as to replace the strata so that operations can recommence.

Care is need in the use of these materials as:

- The pressure applied during injection of grouts can itself cause strata failure.
- Resins generally are a two-part mix, and the chemical reaction is exothermic. Fires have occurred during placement. There are usually restrictions on the amount of resin which can be pumped into any one hole, and they are not suitable for placing in bulk in cavities.
- Some resin materials are carcinogenic before the reaction has taken place so access to work sites and on the downstream ventilation side is restricted.

#### STRATA REINFORCEMENT- ROOF BOLTS

Strata reinforcement is used in almost every mine today to some extent, most commonly in the form of roof bolts. The earliest roof bolts were steel rods with a split end with a steel wedge inserted. The rod was installed into a hole drilled in the roof and hammered in so that the wedge forced the steel to grip the sides of the hole. A nut at the outer end was tightened against a washer and steel plate installed against the roof to apply some tension and, with similar rods being inserted across and along a roadway, the result was that strata beds in the immediate roof were clamped together to form a stronger beam. The bolting pattern density was increased until the roof then became self-supporting. Such bolts were often installed through timber bars to spread the support over more area and to aid in retaining broken material. At times steel cross members were used instead of timber, the bolts being installed through brackets or "saddles" to hold them in place.

Over time the split and wedge bolts were replaced by



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improved methods of anchoring, eventually using fastsetting, two-part resin cartridges, the resin being mixed by the rotating bolt as it was inserted in the hole. These bolts were initially anchored at the end of the bolt (referred to as "point anchor bolts"), and although tension was applied during the installation process, a lot of movement occurred before the bolts became really effective.

It was found that better results were obtained if sufficient resin was used to completely fill the hole drilled in the roof and anchor the bolt over its entire length (referred to as "full column anchors") and these are now universally used for primary roof bolting. The full column anchor also has the advantage of protecting the bolt from corrosion in corrosive conditions.

Roof bolts were often used in conjunction with steel straps in place of timber bars, the straps being stronger and better able to mould into uneven roof, but still were mainly of use in retaining broken roof. Most mines now use mesh sheets which completely cover the roof, held in place by the bolts. They have minimal support function but prevent injuries from falling material.

Other developments which have followed on from normal roof bolts mostly relate to the length of reinforcement placed in the roof. The maximum length of a normal bolt is the working height less the height needed for the roof bolting machine. Initially if longer bolts were required they were made in sections which could be screwed together.



The difference between an over-tensioned and undertensioned rockbolt as a result of under-drilling the support holed.



Later developments saw flexible bolts (essentially lengths of wire rope), able to bend enough for installation but stiff enough to push up the hole. Various designs of such bolts are now available. They are mostly installed vertically or slightly angled over the rib. They are too long for resin to be placed in cartridges and the normal method of anchoring involves pumping a grout up a tube inserted with the bolt. Sometimes a resin point anchor is installed initially, allowing the bolt to be tensioned before being fully grouted.

A slightly different application for flexible bolts is a "truss". These consist of two flexible bolts installed at an angle over opposite ribs of a roadway with long "tails" left in the roadway. The tails of each pair are joined together at roof level and tension applied, so that there is a degree of horizontal compression applied to the roof strata. The aim is to pre-stress the roof to assist in preventing failure, although in many cases trusses have been installed in already failed roof to act like a basket to retain the broken material in place (still a valid strata control function).

The above comments refer to roof reinforcement, but many mines use bolts in the ribs to prevent rib failure, usually in conjunction with mesh. Rib bolts do not need the strength required for roof support, their function being often to retain broken material in place more than to prevent rib failure. Some rib bolts have to be installed in ribs which later have to be mined, with a consequent need to remove the bolts before the coal is put into the coal haulage system, which can be difficult. Various "cuttable" bolts have been developed to allow mining to continue regardless of the presence of such bolts.

On some occasions where floor heave is a problem, bolts are also installed in the floor to help to control movement. Such bolts need to be cut-off or installed completely below floor level to avoid tyre damage if vehicles are required to use the roadway. They can also be a trip hazard if proper precautions are not taken.

#### SYNTHETIC RESIN CARTRIDGES

The resin compositions consist of two pack reactive polymer systems in which individually stable components interact rapidly when mixed and set to form a hard-cured product. This type of system is well known in the plastics, coatings, and adhesive industries but only a few are suitable for the conditions encountered by the mining industry.

First applications of synthetic resins to the reinforcement and protection of anchors were based on epoxy resins that were established in the construction industry. The clear advantages of unsaturated polyester resins were quickly recognised and virtually all prepacked resin capsules systems for in-hole mixings are based on these.

Technically, polyesters are unique in combing the ability to gel and cure rapidly, even at low temperatures, with tolerance to poor mixing and wet conditions. In most countries polyesters also show economic advantages over competitive products. Resin anchor cartridges are widely available to the mining industry from a variety of suppliers. All consist of a filled polyester resin composition with an activating catalyst packed in a single cartridge, designed to be placed in a pre-drilled hole and broken and mixed by the action of inserting the bolt or dowel.

The compositions may be formulated to provide appropriate characteristics particularly with reference to the ease of insertion of the dowel and the speed of setting. Initial set times range from a few seconds to more than one hour and strength development after initial setting is rapid.

An alternative pre-packed capsule system is based on polyurethane resins. This offers the advantage of foaming in -situ to form a resilient resin grout which is of particular interest for coal face reinforcement, in conjunction with wood dowels. The system is far less adaptable and tolerant to misuse than the polyester-based products and is therefore not widely used.

#### INJECTION RESINS

The requirements for injectable resinous grouting compositions are different and although epoxy and polyester resins have been used for this purpose other systems based on water dispersible resins are preferred, polymer emulsions and urea-formaldehyde resins are widely used, often modified by the incorporation of inorganic cements.

These compositions are designed for batch mixing first prior to injection and are suitable for placement with simple pumps, into fractured rock structures or into long holes for forward reinforcement of disturbed strata. Simple cleaning of mixers and pumps with water enables unrestricted underground use of such products.

Polyurethane injection resins initially were developed by the German mining industry for its longwall face reinforcement as was also the case in France to a lesser extent.

#### **RESIN FOAMS**

Some of the resin compositions used for strata injection are designed to foam in-situ to improve the penetration of fine fissures, to improve the compressibility of the set grout and to provide cost economics. The polyurethane systems are particularly well adapted to modification in this way.

#### **RESIN MIXING AND MAXIMISING LOAD TRANSFER PROPERTIES**

The entire subject of maximising the load transfer properties of resin-encapsulated roof bolts has been widely researched based largely on both in situ short encapsulation pull-tests and laboratory pull or push tests. The general outcome of this work, in Australia, is that, in order to maximise loadtransfer strength and stiffness, the roof bolting system should be fully encapsulated, and the annulus between the bolt and surrounding strata should be as small as possible. When considered in isolation, the logic behind maximising load transfer makes sense and remains the current norm in the Australian coal mining industry.

However, there is a fundamental problem with the 15:1 ratio (mastic-to-catalyst) resins systems that were almost universally used in the Australian coal industry, as they are prone to poor resin-mixing towards the top end of the bolt. The load-transfer was further reduced by "gloving," which is when large pieces of plastic film corrupt the integrity of the resin bond between the bolt and the surrounding strata. A combination of both poor resin mixing, and gloving was found to give very low load-transfer properties, the existence of which is hidden from view during normal mining operations and cannot be easily audited or directly monitored. No practical solution is offered in these works to overcome these problems using an industry standard 15:1 resin system.

#### **RESIN PRESSURE DEVELOPMENT DURING BOLT INSTALLATION**

Resin pressure development during bolt installation and the significance to roof reinforcement can be considered based on a combination of the following: resin pressure measurements made during bolt installations by several researchers, theoretical treatment of the key parameters that logically influence the development of resin pressures, common fracture patterns observed within the bolted interval and are commonly known as the Griffith Crack Theory.

In recent times there has been published test data showing the clear links between less-than-theoretical bolt encapsulation achieved with various changes made to the bolting setup (e.g., resin volume used and varying hole diameter).

However, in reality, as the bolt is pushed up into the resin capsule, the rock bolt can function as a piston, the borehole in the rock as the cylinder and the resin as a pressurised fluid. The annulus between the rock bolt and borehole allows the pressure in the resin to be relieved as it flows down the side of the bolt. The pressure within the drill-hole is often referred to as 'resin back-pressure.' The thrust applied to the bolt causes the resin capsule to swell, split and the film to be pressed against the wall of the drill-hole, resulting in gloving of the rock bolt.

Gloving is incomplete destruction (either partial or total) of the resin capsule film at the time of rock bolt installation. This can result in a low friction plane of weakness along the resin/rock interface, which can potentially impact on the anchorage strength of the rock bolt. It has been theorised that resin back-pressure could lead to hydraulic fracturing

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Pre-insertion



Swelling and splitting of the pressurised capsule.



Film deposited on wall of borehole. Resin lost into fractures.



Theoretical ressurisation of resin capsule leading to gloving and hydraulic fracturing of the rock mass.

of rock within the top section of the borehole during bolt installation. The figure above highlights this cause.

As discussed earlier the main objective of any roof bolt is to support the rock mass above the miner and are crucially the main protection for all personnel working beneath them, ground falls have historically been responsible for nearly 50% of all fatalities in underground bituminous coal mines

It is imperative that during the life of any mine that roof bolts are monitored, due to the variety of roof bolts and methods of fixing.





#### **CABLE BOLTING**

Cable bolting is another technique that offers additional support to the rock during mining and tunnelling projects. Cable bolts are long, grouted reinforcement tools that help support and stabilize the rock mass above the profile of a tunnel.

Mining companies have been using resin cartridges to inject resins around bolting for rock reinforcement. Though the process is effective, technological advancements have led to a recent creation: a pumpable resin system.

Though a pumpable resin system is new to the mining industry, it is quickly gaining popularity for its rock reinforcement abilities. Resin cartridges and pumpable resins are reliable systems for cable and rock bolting reinforcement.

#### PUMPABLE RESIN SYSTEM FOR BOLTING

The idea of pumpable resins for rock bolting is not new, but the system was not available until recently. It took a few years for the chemical technology to catch up to the idea.

The purpose of pumpable resins is to combine the effectiveness of cement-like grout with the curing speed of resin. It typically takes between 12 to 24 hours for cementitious grout to cure and harden around a rock bolt, during which mining professionals cannot enter the mine. Resins, however, take a few minutes to set.

Regardless of a mine's ground conditions, a pumpable resin system is highly effective for anchoring rock bolts longterm. Because resins are fluid in movement and solidify when motionless, it is possible to install resin around a bolt overhead without requiring additional borehole sealing.



#### **BENEFITS OF PUMPABLE RESIN SYSTEM**



#### QUICK INSTALLATION CYCLES

Deep mining with bad ground conditions requires quick action when it comes to rock reinforcement. For that reason, the new pumpable resins are systems in regular use in several major mine developments.

Cementitious grouting around a rock bolt takes up to 24 hours to solidify and stabilize the area. Since work cannot resume in the mine until the curing ends, mine developments can quickly get off schedule.

Resin cartridges significantly reduce the installation time by taking up the load in 10 to 15 minutes. However, a pumpable resin system and a self-drilling bolt can get the job done in three minutes or less.

Though both options offer quick cycle times, pumpable systems are preferred because they work for all ground conditions and rock quality.

#### **ENHANCED MINING STABILITY**

Improved long-term rock stability is another benefit of this system. The resin penetrates even the most minor cracks around the bolt and borehole. The improvement occurs because the resin quickly consolidates the ground.

Even if a borehole diameter is larger than expected, an operator can pump the resin until they fill the entire space.

#### **USABLE WITH HOLLOW AND CABLE BOLTS**

Pumpable resins have multiple applications. Besides installing them around a rock bolt, it is also possible to use pumpable resins with cable and hollow bolts or self-drilling anchors.

Self-drilling anchors are open in the center with a drill bit on the tip for creating boreholes. The system works well in poor ground conditions, and the pumpable resin will accept the load in minutes, not hours.

#### DRAWBACKS OF A PUMPABLE RESIN SYSTEM

Because the system is still relatively new to the underground mining industry, there are few disadvantages to using pumpable resins. However, they do require some form of adaptability for workers and machines.

The market currently has some equipment available that includes a pumpable resin system within the rig. The



machinery can be expensive because the system is new and in demand. It is possible to retrofit old equipment to handle the system at a lower cost than a new machine.

Training is another must for pumpable resins. Mining operations will need to train workers to use the new equipment and understand the system's technical aspects. Some machine designs allow for quick learning and easy use.

#### **BENEFITS OF RESIN CARTRIDGES**



#### **USABLE FOR ALL GROUND CONDITIONS**

A bolt installation can be more difficult under bad ground conditions, but it is possible. As long as the borehole is stable, operatives can install a cartridge to form longlasting grouting.

#### SIMPLE INSTALLATION CYCLE

The bolting system works for placing a bolt in any position or angle in the mine or tunnel ceiling. After creating holes, the cartridges are injected into them.

To initiate an immediate stabilizing chemical reaction, simply insert a bolt and rotate it to mix the components inside the cartridge.

#### **RELIABLE BONDING CAPACITY**

A thin plastic film separates the grouting resin from its catalyst material. When the two components mix within the hole, they create an intense mechanical interlock with the bolt and surrounding rock.

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It takes minutes for the mixture to cure, forming a reliable bond to the surrounding rock with heavy loading capabilities.

The measurements of the resin and its catalyst are carefully calculated. The chemical nature of the compounds and their quantity allow for quick mixing while reducing how much resin pours out of the hole.

#### DRAWBACKS OF RESIN CARTRIDGES



A rock bolt grouted with a cartridge is a popular way to reinforce bolts in underground mines because it has a faster installation cycle than traditional reinforcement methods.

However, unstable ground conditions can make it tricky to install the cartridge in a hole. The cartridge must go in the hole before rock bolting can occur, and the bolt will rotate to combine the resin.

If the ground is too loose, the hole could collapse after removing the drill bit, making the cartridge installation more difficult, if not impossible.





An overbreak around the hole could also affect how much resin makes it into the hole. A grouted resin cartridge holds specific amounts of material, requiring precise hole measurements.

Even minute shifts in or around the borehole could need more resin than the cartridge contains to properly seal the rock bolt, significantly reducing the load the bolt could hold.

In underground coal mines, lots of roadways are driven to meet the requirements of transportation, ventilation, and miner walking. With coal mining depth increasing, coal output growing, and mining areas expanding, the geological and mining conditions have changed considerably.

Many countries, such as Germany, UK, France, Poland, Russia, the United States and Australia, conducted research on the theories and techniques of roadway strata control according to the local geological conditions.

Germany recently had some of the deepest coal mines in the world, and the leading strata control technology for deep roadways and roadway support technology, combined supports with yieldable steel arches and rock bolting, and backfilling beside the roadways and behind the steel arches are well studied and have been widely applied.

Most roadways in German coal mines have an arch crosssection with a large cross-section area about thirty m<sup>2</sup>. On one hand, large roadway cross-section is used to meet the requirement of ventilation; on the other hand, even if large deformation happens, the reduced cross-section still meets the requirements of normal production

There are three mainstream support patterns, as shown. Because the mining depth increases continuously, the proportion of roadways reinforced only by rock bolting (a) decreases year by year, that of roadways supported by combinations with yieldable steel arches and rock bolting (c) increases rapidly. Recently, the rock bolted roadways accounted for only 3%, the roadways supported by yieldable steel arches (b) accounted for 65%, and those supported by combined patterns accounted for 32%. Roadway support patterns in German coal mines. a rock bolting b yieldable steel arch c combined support.

The steel supports used in German coal mines can be divided into four types according to their shapes:

- 1. U-shape steel arches (open in the floor);
- 2. U-shape steel arches with a yieldable inverted-arch component in the floor;
- 3. ring steel supports;
- 4. rectangular steel supports.

The first type is applicable to various gate roads, the second type is applicable to haulage roadways, the third type is



applicable to development roadways, and the rectangular support is applicable to the open-off cuts. In Germany, the importance of backfilling behind the supports is stressed especially in the interaction relations between supports and surrounding rocks. Backfilling behind the supports makes the steel supports fully contact with rock surface, increases the stiffness of media transferring resistance forces from steel supports to surrounding rocks, and improves the performance of the steel supports. Testing results showed that backfilling can increase the bearing capacity of steel supports by more than one time.

A lot of research in the rock bolting technology had been conducted in Germany. Resin capsules were invented in 1958, as a result, then resin bolts have been widely used in the world. To meet the need of deep roadways with large deformation, various extensible rock bolts were invented, involving the bolts made from the rebar with high elongation rate and those with slip components. The rock bolting is seldom used individually in German coal mines due to the large mining depth. In general, rock bolting is used with yieldable steel arches to form combined support system. In German coal mines, the standard rock bolt is made from the fully rolled threaded rebar with a diameter of 25 mm, and a



# STRATA CONTROL



tensile strength of seven hundred-eight hundred MPa. The standard cables have a diameter of 23 mm. There are two patterns of the combined support system, as shown in the figure below.

Combined support patterns in German coal mine roadways. a rock bolts and steel arch b steel arch and rock bolts

#### TRADITIONAL STEEL SUPPORTS

Traditional steel supports can be divided into rigid and yieldable types according to their working performances (as shown in the figure on next page).

#### **DRILLING AND BOLTING PLATFORMS**

The installation of any type of strata control requires machinery that fulfils a range of criteria.

The right choice of machines can boost productivity and ensure the safety of all personnel involved in the operation. One such piece of machinery used in underground mining is the roof bolter. An underground roof bolter's bolting rig employs pneumatic or hydraulic power to install rock bolts in underground mines and tunnels. The machines vary significantly in size, from compact handheld devices to



Types of traditional steel supports. a trapezium rigid support b yieldable steel arch c yieldable horseshoe-shaped support d yieldable ring support.

heavy-duty machines that move on tracks irrespective of their shape or size.

Safety is one of the most important considerations for the use of these machines. Underground roof bolters are used to prevent mining accidents by securing the roof of the mine and making them self-supportive. Within this article a range of drilling and bolting platforms are shown, this is by no means an exhaustive list of machinery, however, it will highlight the capabilities and efficiencies required for such a task.

#### Komatsu ZB21

The **Komatsu ZB21** is a highly efficient underground drilling and bolting platform that delivers excellent performance in various applications, and can be quickly converted into a jumbo.



The machine can install four major bolt types and offers excellent coverage. The Komatsu ZB21 can fit into small mine sections conveniently and offer unmatched vertical and horizontal reach.

#### Epiroc Boltec 235



**Epiroc Boltec 235** is a heavy-duty underground roof bolting rig that is best suited to medium-sized mining operations.

The hydraulic-controlled machine is designed to provide flexible and reliable bolting options for underground mining operations. It offers compatibility with multiple rock bolt types and optimized bolt installation.

The machine features stable bolting with fast and consistent bolting cycles, ensuring a safe and protected working environment.



#### Sandvik DS311

Sandvik DS311 is one of the most compact and competent mechanized rock bolters available in the market today. The machine offers innovative solutions to underground rock bolting operations.

It offers excellent coverage in small to medium underground mining areas. With its superior ratio of rock bolt length to drift height, the Sandvik DS311 is the ideal electro-hydraulic machine to fulfil all types of underground mining operations' bolting needs.

#### Joy Multibolter

The **Joy Multibolter** (now owned by Komatsu) is a mobile bolter available in four models capable of handling 2.0 to 5.4 meters of nominal operating ranges.

The multiple-drill head bolter is platform-based and suited primarily for continuous 'place change' applications in the underground mining industry.



# STRATA CONTROL

The machine has an ergonomic and productivity-oriented design that offers flexibility in operation and reduces operating costs while maximizing operator safety.

The four models of the Joy Multibolter offer different seam heights coverage and cover a wide range of work conditions. Up to six semi-automatic roof bolters can be used according to the bolting pattern and underground mining conditions.

The Multloader offers wet and dry drill versions with vacuum dust collection for maximum convenience.

Rock bolting has become an integral part of underground mining – and not just for rapid development through poor ground. Coal International, examines some of the developments which are driving this aspect examines some of the developments which are driving this aspect of rock support still further into everyday mining practices. Such innovations apply to coal operations and production, just as much as they do to hard-rock mining.

> Many technical initiatives employed in mining are actually derived from civil engineering. Such initiatives and their subsequent development and refinement are then further "fermented and distilled" to a point where they also become an acceptable and accepted mining method. Whilst surface bolting was first documented as being used to retain sidewalls in civil engineering works, it is debatable whether its migration underground was necessitated by more complicated subterranean engineering work or whether mining simply adopted the technique for underground bolting as its own.

> Either way, bolting has now become a sure-fire way to restrain strata which would otherwise spall and fail. Whilst many would argue that the method is most frequently employed where rapid development is required, where the strata are

prone to dramatic parting or where long-term support for overly large opening have been excavated. The reality is that there is no single situation which favours bolting to the exclusion of all other scenarios. Bolting is used in long-term drifts, rapid development openings, longwall production, stoping in hard rock, frequently as a pre-treatment before mesh-and-shotcreting, and as a belt-and-braces "just in case" measure.

#### THE ACID TEST

Because rock bolts are required to prevent the movement of rock masses which may run into hundreds of tonnes, they have - as one would expect - traditionally been made of steel. Cheap, robust, semi-flexible and more likely to stretch than snap, steel roof-bolts have been the main-stay of the bolting industry since its infancy. Unfortunately, the environments in which these bolts operate are frequently highly corrosive. There are two remedies: (i) provide an "isolating" coating to the bolt, or (ii) make the bolt from a non-corrodible material.

Coating a steel bolt in a non-corrosive material or providing an acid-resistant resin whilst effectively "wrapping" the bolt, are two of the most obvious answers to ensuring long-term competence of rock bolts in a corrosive environment.

Indeed, the highly aggressive environment found within Barrick Gold's Goldstrike Complex and the Rodeo Mine, had largely dissolved the previously installed mesh after only 6 days, whilst a previously installed rock bolt (despite having an "acid resistant coating") could easily be pulled out by hand after only 30 days placement.

Underground samples showed that the water was highly acidic and electronegative at pH values of around 1.5. For 72 days, DSI evaluated OMEGA-BOLT samples with a special Obduro AP Coating in solution with a pH value of 1.5. this contained – but was not limited to – a sulfuric acid concentration of 14%. In contrast to other bolts, which began to corrode after only one day, the OMEGA-BOLT did not show any reaction at all to this highly acidic sample.

A second test sample solution with pH levels of 1.8, also contained other acids in addition to a sulfuric acid concentration of 13% and was also highly electronegative. Again, the Obduro AP Coating did not show any reaction after 15 days. Even a fully coated washer that sat in the solution for four hundred days did not show any damage at all. In contrast to this, a traditional uncoated rock bolt that was assessed reacted violently with the second test sample only a few minutes after exposure.

The tests were conclusive and clearly demonstrated that not protected against acid corrosion. In contrast, DSI's Obduro AP coating was neither damaged by sulfuric nor hydrochloric acid. Of course, one drawback of coated bolt is that they require careful handling prior to and during hole insertion, as there is a possibility that a hastily inserted bolt can damage the coating and the integrity of corrosive covering will have been compromised.

An alternative to employing a coating is to use a noncorrodible bolt: this is a relatively recent innovation. Such bolts, usually made from (or containing an outer-core of) glass fibre have since proved their worth time-and-timeagain. Not only are they light to carry, do not breakdown in a corrosive environment and effectively maintain strata in-situ, but furthermore where rapid development or in situations where the strata deteriorate or moves within a brief time of being exposed, they are highly effective. One such application occurred at Newmont's Leeville gold operation during planned rehabilitation work where suitable ground control necessitated products that were capable of operating with highly corrosive water with a pH of three

The highly corrosive environment in which default, steel-based ground support systems corrode within a very short period of time, was not the only topic that was problematic: high temperatures underground posed an additional challenge.

The result was a combined ground control system consisting of DYWIDAG GRP hollow bar rock bolts (some of which were self-drilling) and DYWI inject resins. Glass fibre reinforced tendons feature excellent corrosion protection and low weight, have a high tensile load-bearing capacity, and can be easily cut by mechanical excavators or shearers if necessary.

Trial installation tests were conducted using two different types of injection resins, plus accelerator. The first injection resin was DYWI Inject SILO 8044, a 2-component silicate resin with excellent adhesive properties that cures quickly. Due to the prevailing characteristics of the surrounding rock mass, some DYWIDAG GRP rock bolts were also injected with the 2-component polyurethane injection resin DYWI-Inject PURE 8034 plus accelerator DYWI Inject PURE X 8034. In contrast to cement grout, this injection resin ensures fast curing for immediate support even in areas that are subject to mine water inflow. The installation procedure necessitated the use of a high-pressure pump for injecting the resins.

#### **ENCAPSULATION TRIAL OF RESIN CARTRIDGES**

In addition to their non-corrosive characteristics, fibre-glass bolts have two further advantages: they can be fitted with "use-once-and-forget" drill bits, so that the bolt (and the bit itself) can remain in the hole that has just been drilled. This is particularly useful when trying to drill through strata that can shift, swell or close-up - which makes inserting a separate bolt to its full length, a hit-and-miss affair.

Of course, such bolt-and-bit combinations are not confined to fibre-glass rods, their usage is most frequently associated with steel rods. Many observers credit Hilti with perfecting this "One-step" mining bolt.

One-step is a self-drilling mining bolt which combines the drill head, drill steel, bolt, and adhesive resin in a single unit. It offers a unique value proposition since drilling the hole, retracting the drill steel, resin capsule insertion, bolt insertion and setting of the bolt can be done in one single step. The main advantages are faster installation time, better installation quality and improved safety.

The One-step Bolt was introduced to the German Mining industry in 2004 by Hilti to achieve quicker and consistent

bolt cycle times for roadway development in deep level coal mining. After successfully implementing the One-step in Germany, Hilti successfully introduced this technology in other markets including Australia, Czech Republic, Poland, and the US. Today, the One-step is used in Australian coal mines. Last year the product etc was acquired by DSI.

The George Fisher Zinc Mine in the Mount Isa region, provided an altogether different acidic mining scenario: the owner, Xstrata Zinc, wanted to ensure good corrosion protection of its bolting method through full encapsulation of the anchors in the drill hole during driving works.

DSI Australia supplied chemical TB2220T1P10R Posimix Bolts for the anchorage. The bolts are 2.2m-long and have a diameter of 20mm. DSI Australia conducted a comprehensive range of on-site tests in order to find the best possible amount of encapsulation for the anchors by varying the sizes of boreholes and resin cartridges.

Consequently, two alternative trials were conducted: (i) using resin cartridges and reduce the borehole diameter to the minimum diameter of 33mm achieved an encapsulation of 80%; and (ii) keeping the borehole diameter of 35mm and using a larger resin cartridge with a diameter of 30mm resulted in an encapsulation of 87%.

# Indonesia lifts export ban on 139 companies

Indonesia's government has reported critically low coal eased a coal export ban for 139 companies as of Thursday, a senior energy ministry official said, after the firms met local market sales requirements aimed at averting a supply crunch and power outrages.

The world's biggest thermal coal exporter on Jan.1st imposed a monthlong export ban without warning, causing jitters in markets and among major importers such as Japan, the Philippines and South Korea.

Authorities have started a calibrated easing for firms that meet a Domestic Market Obligation (DMO) that has been central to the high-profile suspension, which was introduced to ward off widespread power outages after local plants

inventories. Authorities have blamed

the coal supply saga on poor compliance of the DMO policy, under which coal miners must sell a guarter of their output to local buyers, with a \$70 per tonne price cap for power generators.

"This export ban is temporary, it's

emergency situation management to ensure domestic coal supply," Ridwan Djamaluddin, director general of minerals and coal at the energy ministry, told a



# STRATA CONTROL I

Of course, "resin assisted bolting" has not just been employed with conventional bolts, but has become an equally accepted support method, especially is weak ground which was a case in point when Newcrest began to expand its Cadia Valley gold-and-copper operation by developing a decline to access the Cadia East orebody. At the beginning, cross cuts were stabilised using common grouted cable bolts. However, for added safety, during the grout curing time, heading development could not continue until the cable bolts had reached their defined loadbearing capacity and a search was conducted to investigate possible alternatives to the traditional cable bolting methods.

It was proposed to adapt the Hi-Ten Strand Bolt which it had recently developed especially for underground coal mines. The bolt is anchored "from the bottom up." At first, anchorage is achieved to a length of 2m by using resin. The Hi-Ten Strand Bolt is then tensioned to 250kN, thus providing immediate stabilisation of the development area. Grout injection can be conducted immediately or at a later stage. Consequently, decline development can proceed at once, independent of the grouting process and curing time. Post-groutable Hi-Ten Strand Bolts are especially suited for areas in which full resin encapsulation is impossible due to technical limitations or unstable rock layers.

# **NEWS, PLANT AND EQUIPMENT**

media briefing

He said 75 ships had been allowed to load coal from firms that had met all their DMO requirements, while 12 more had been allowed to proceed having provided a written assurance of compliance and acceptance of penalties.

Another ministry official

on Tuesdav said coal stocks at local plants had improved and authorities had stepped up monitoring of deliveries to generators.

The ministry has set a target of enabling local power plants to have enough inventory by the end of January for more than 20 days of operations.



# China mined a record amount in 2021

China produced more coal than ever last year as its power stations struggled to meet demand for electricity, undermining plans to curb carbon emissions.

While the surge in output helped bring the power crisis under control, coal prices are creeping up yet again this year amid expectations that China is going to need even more of the fossil fuel to power its economic recovery.

Coal output hit a record 4.07 billion metric tons last year, up 4.7% from 2020, according to data released by China's National Bureau of Statistics recently. Imports of coal also rose last year, to their highest level since 2013.

China is already the world's largest coal producer and consumer, but its record production is notable given that just a year ago the country was touting aggressive measures meant to seriously curb its emissions.

In September 2020, Chinese President Xi Jinping declared that the country would become carbon neutral by 2060, and his government took drastic steps in the first half of 2021 toward making that a reality - including shutting down hundreds of coal mines.

Those ambitions which analysts already suspected would be tough to achieve, especially as China's economy recovered - were challenged by a power crunch last year, as coal supply fell sharply. The country recorded widespread power shortages, including household blackouts.

Factories were also forced to cut production, causing disruption to supply chains.

#### China's economy expanded 8.1% in 2021, but growth is slowing

To ease the crisis. China ordered mines to boost coal production last fall. By December, production had jumped more than 7% from a year earlier to an alltime monthly high of 385 million metric tons, recent statistics show. That was also the third straight month of increases.

Even Xi has softened his tone a bit on carbon emissions, suggesting that Chinese leaders understand the challenges of their targets.

"Carbon peak and carbon neutrality cannot be realized overnight," Xi said in an online speech at the World Economic Forum. "Through solid and steady steps, China will pursue an orderly phase-down of traditional energy in the course of finding reliable substitution in new energy.'

Meanwhile, prices in China for thermal coal which is mainly used to generate electricity and provide heating - have shot higher in recent days. Thermal coal futures surged nearly 7% to about 775 yuan (\$122) per metric ton, according to the Zhengzhou Commodity Exchange. The contract has soared 13% so far this year.

China expects its power consumption "to continue its rapid growth in 2022," said Li Yunging, an official with the National



China vs US: Who can lead the change in combating climate crisis?

Development and Reform Commission, at a press conference in Beijing. Consumption in 2021 was already strong, increasing 10.3% from 2020, according to government statistics.

#### The world's insatiable appetite for electricity is setting up a climate disaster

Analysts from Guotai Junan Securities, a major Chinese investment bank, attributed January's rebound in coal prices in part to a recent export ban on coal from Indonesia. China had been importing more coal from the Southeast Asian nation to keep up with its domestic demand, especially after reportedly restricting imports from Australia in late 2020.

The Guotai Junan analysts expect the demand for coal to remain strong this year, as China

needs to stabilize economic growth, and coal power is critical to that plan, according to a research report.

Chinese policymakers have made it clear that ensuring stability is a top priority in 2022 and pledged to take proactive measures to support growth. Recently, China reported its GDP grew 8.1% in 2021, outstripping the government's own targets. But growth slowed to half that pace in the last quarter, and may not accelerate much this year, according to some economists.

Leaders of China's ruling Communist Party said last month that they would prioritize investment in infrastructure in 2022 to bolster economic growth, as such projects can create more jobs. But such work is heavily reliant on fossil fuels.





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# Study on safety and efficient production in china coal mines



his paper reviewed the achievement of safety and efficient production in China coal mines. In 2019, the mortality per million tons was 0.083, the mechanization degree of coal mining in large coal mine enterprises reached 96.8%, and the productivity in

the whole of China reached 1000 tons per year per capita. It summarized the main practices on safety and efficiency production in coal mines systematically, especially in scientific and technological progress, intensification layout, policy & regulation, and monitoring & early warning. The paper deeply analyzed main problems on safety and efficient production, such as: management concepts, complex multi-field coupling disasters, unbalanced development, professional talent shortage, and occupational health hazards. At last, the developmental counter measures were proposed to raise the level of safety and efficiency production in detail.

Coal yield was 3.75 billion tons in 2019. It basically reached the balance between supply and consumption. It is expected that coal yield will remain at around 3.6 billion tons in the next decade. In terms of safety, the situation was improved continuously by increasing investment and upgrading technology<sup>1</sup>. The numbers of coal mine accidents and casualties have decreased year by year. In 1978, there were more than 3,000 accidents, more than 4,500 deaths, and the mortality per million tons was 9.436. In contrast, in 2019, there were 170 accidents, 316 deaths, and the mortality per million tons had dropped to 0.083. The coal mine safety level in China has been greatly improved and the results are remarkable. In terms of efficiency, the number of safety and efficient coal mines has increased year by year, from 12 in 1993 to 1904 in 2018, shown in Figure 1. There was an obvious rise. The construction of safety and efficient mines raised the overall level, such as: mine design, mine construction, mining equipment, mining technology and management. From 1978 to 2019 in China, the mining mechanization degree in large coal mine enterprises was increased from 32.34% to 96.8% and the per capita productivity in all China coal mines from 137t per year to 1000t per year<sup>2</sup>.

#### PRACTICES ON SAFETY AND EFFICIENT PRODUCTION IN COAL MINES

#### Technological progress for safety and efficiency development

Unmanned mining technology: A number of major technical problems which restricting safety production have been solved by the support of national research plans, several developments in key equipment pieces related to coal mine safety, such as:

3D seismic exploration technology with high-resolution, which can detect a fault with a drop of more than 5m within 1000 m depth, 8.8m-heigh-seam mining technology at one time in fully mechanized mining faces, 20m-heightseam (cutting plus caving) mining technology at one time in fully mechanized caving face, and so on<sup>3</sup>. In particular, the coal mine intelligence level is greatly enhanced with the application of advanced network technologies.

Taking automatic control systems as the hub and the visual remote monitoring as the means, safety and efficient



Figure 1: Number of safety and efficient mines in China.

intelligent mining can be realized in fully mechanized mining faces with "unmanned operations and human inspections" during the entire process of coal mining.

Practice on unmanned mining in Huangling mining group: Coal seam thickness of test mining face is 1.8 to 2.8m, with an average of 2.5m. The pseudo-top is mostly mudstone with a thickness of 0.1 to 0.5 m. Hydraulic support is ZY7800/17/32D, shearer is MG620/1660-WD, scraper conveyor is SGZ1000/2×855, transfer machine is SZZ1000/525, and crusher is PLM3000.

The automatic controlling and monitoring system includes the electro-hydraulic control, industrial Ethernet, working face video monitor, shearer control and so on. Shearer, hydraulic supports, transportation equipment, power supply, and liquid supply are all controlled remotely. One click starts and one click stops. Operational workers have been reduced from 9 persons to 1 person, consequently realizing the requirement for human intervention was reduced for both operational workers and inspection. The highest record of eight and a half cuts at one shift was created. The production capacity can achieve more than 2.0 million tons one year.

Intensification layout for safety and efficiency development Intensification mining technology: To Policies and regulations for safety and efficiency promote intensification layout, many large and mediumdevelopment sized coal mines have been constructed. A group of world-Policy to resolve excess capacity in coal industry: The class coal mines with more than 10 million tons have been State Council issued documents (No.7) in 2016, which claimed to guit and close 500 million tons of coal capacity constructed according to a standard perceived for modern coal mines. At the same time, small coal mines are strictly and to reduce and integrate 500 million tons coal capacity integrated and closed to cut the backward production within 3 to 5 years from 2016<sup>6</sup>. The policy to reduce excess capacity laid the foundation for the continued improvement capacity. The structure of coal production is adjusted, mining layout has been optimized, and underground of the health and safety within the production of coal. Firstly, production has been reasonably centralized to improve production is concentrated in the areas with valuable coal mining mechanization<sup>4</sup>. The problems associated with resource conditions, and the proportion of coal production

# SAFETY AND EFFICIENCY

working faces and low efficiencies are solved by reforming mining layout, simplifying production links, optimizing roadway design, increasing the length of working faces, enhancing mechanized production and automation control, and improving equipment stability<sup>5</sup>, all contribute to creating good conditions for production and management

An example of intensification on production and safety: CHN Energy Group has built a number of safety and efficient coal mines by using a series of advanced technologies and equipment. In 2017, it had 64 coal mines with 508.87 million tons yield, the average yield was 8 million tons, and the mortality per million tons was 0.005. In the same year,

The whole of China has 6794 coal mines with 3.52 billion tons yield, the average yield was 0.52 million tons, and the mortality per million tons was 0.106. Obviously, CHN Energy Group has higher intensification, higher average yield, and higher levels of safety than the whole of China and has become one of the world leaders in this area without considering other factors, the higher the intensification results in an increase in safety and creates a positive correlation between the two sides.

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capacity in the areas, including Shanxi, Shaanxi, Inner Mongolia and Ningxia, is further increased. Secondly, the productivity level was improved.

There are 47 intelligent coal mines and 59 large-scale coal mines with an annual yield of more than 10 million tons, their production capacity is nearly 800 million tons yearly. Thirdly, the small coal mines were quitted and closed at when the intensity was at its peak, now their production capacity only accounts for 6.2% of the total production capacity and fourthly, illegal production was controlled effectively.

**Coal mine safety regulations:** Coal Mine Safety Regulations have been revised and implemented since 1 October 2016. The new regulations strongly encourage coal mines to adopt modern technology and improve the level of production and safety. The overall effect was good since the implementation of the new regulation. The mortality per million tons had dropped nearly 50% in 2018, compared with that in 2016.

**Special action to reduce underground workers:** Special action/investigations of 'thousand- people-scale mines was organized by the China government in 2016. Seven expert groups were organized to investigate into 48 coal mines to compile the technical countermeasures for each mine to reduce the workforce. Through this action, at the end of 2018, the maximum number decreased below a thousand people in a single shift underground in 48 coal mines, this action promoted the progress of safe and efficient working in those coal mines. Taking Shanxi Province as an example, the number of deaths in coal mines in 2018 decreased 53.13%, the mortality per million tons is 0.033 which is also approaching the 0.01 in developed countries resulting in far fewer major accidents, thus the safety levels were greatly improved.

# Monitoring, early-warning and emergency rescue for safety production

**Disaster monitoring and early-warning technology:** National Science and Technology Development Plan (2006-2020) add the early-warning and emergency rescue of major production accidents into the public safety field. It is good for breaking through key technologies, developing new emergency rescue equipment, strengthening technology integration application and industrialization demonstration, such as detection and identification technology of disaster



hazard source, intelligent monitoring technology and equipment for dynamic evolution of disasters, self-analysis and early-warning evaluation model for major disasters based on big data.

**Emergency rescue system:** The State Council issued document No.99 in 2013, which claimed to raise the scientific level of emergency rescue and strengthen the construction of coal mine emergency rescue equipment. Based on the large coal industry groups 7 national emergency rescue teams (bases), 17 regional teams and 45 central enterprise rescue teams have been constructed.

Based on mining production companies, part-time emergency rescue teams have been developed highlighting the technology and equipment to be used, such as detection and positioning of workers in disaster areas, rapid drilling of emergency life channel. The emergency rescue management plan and systems have been formed resulting in an increased emergency and rescue team.

# PROBLEMS ON SAFETY AND EFFICIENT PRODUCTION IN COAL MINES

#### Problems of management concepts

Although good results were apparent in China's coal mines in 2018, including total accidents, large accidents, heavy accidents, and the mortality per million tons, there is still a big gap when compared with international advanced level of mortality per million tons of 0.01. There still exists many management problems in today's coal mines, such as: shortage of management, awareness in disasters prevention methods, insufficient understanding in regional prevention for compound disasters, a lack of concern for occupational health hazards and control of casualties. As a result of this it is necessary to change the management concepts to meet the needs of the safe and efficient production in China coal mines.

#### Problems of complex dynamic disasters

Coal mine disasters have become increasingly serious in the deep mining fields in the east of China [7,8]. The mining depth has been increased to 10-20m per year in coal mines. There are 50 coal mines with mining depth of more than 1000m in China, in which the maximum mining depth is 1500m and the maximum ground stress more than 40MPa. There are 62 coal mines with elevated temperatures being recorded, in which there are 38 coal mines with temperatures exceedingly more than 30°C in working coal faces. Because of deep mining, gas problems are more severe. In mining areas of western China, dynamic disasters are more frequent with the increasing mining intensity in extra-thickness coal seams. Disaster probability of high ground pressure, high geothermal temperature, high gas, rock burst, and their compound is increasing. Geological disasters have been transformed from single-type to coupled-type, which are more difficult to prevent. Due to the characteristics of complex coupled dynamic disasters it is difficult to solve the disasters only by local partial measures.

#### Problems of unbalanced development

From a regional view, the construction of safety and efficient coal mines has been highly valued in Shanxi, Henan,

Shandong and Hebei provinces. The relevant planning and policies were formulated by the local governments and so have achieved good results. However, in Southwest and South China, due to poor geological conditions and difficult mining conditions, the degree of mining mechanization is generally low, and the data shows quite a low standard of safety and efficient mine operation<sup>9,10</sup>.

There are still 2000 small coal mines in China, accounting for about 28% of the total coal production. The equipment and technologies used are far from the standards that have been achieved in other areas and as a result these mines lag behind in equipment, mechanization and technologies consequently there is evidence of an upward trend in rock burst accidents.

#### Problems of professional talent shortage

Recent data showed that 96% of coal mines are severely lacking in mechanical and electrical professionals and 88% of coal mines are short of mining professional being used in China. Very few graduates pay any attention to the mining industry, and it is extremely difficult to recruit professionals to the industry.

Coal mines and mining in general are not attractive to graduates because of the perceived demanding work, living environment, and relatively low welfare benefits. The tendency to steer away from coal and mining in educational institutions is becoming more obvious. Data taken from employment records show that graduate employment rates in geology and mining in general is about 90%. Data shows that the admission and employment in coal mines in China's Universities of Mining and Technology (CUMT) and Heilongjiang University of Science and Technology (HUST) are shown at table1. Taking HUST as an example, 44.67% of graduates were engaged in coal mines in some (major) related capacity up to 2013. From 2014, the employment rate has been declining quickly. Only 6.34% of the graduates were engaged in those mining related majors. As a result, few graduates go to work in coal mines thus a resultant effect is that the professional talents that existed are retired with age, we can conclude that professional talent shortages have limited the promotion and application of advanced technical equipment in coal mines.

#### Problems of occupational health hazards

According to statistics from 26 coal enterprises, the new added pneumoconiosis patients is 8300 and deaths are nearly 1500 people in 2013. Compared with data in 2005, they increased 85.39% and 118.97%, respectively. According to the statistical bulletin in 2017, the occupational pneumoconiosis patients total 22,701, in which there are about 11,000 in coal mines. Occupational health hazards are becoming increasingly prominent in coal mines.

#### **COUNTERMEASURES TO IMPROVE SAFETY AND EFFICIENT**

#### Production in Coal Mines

Changing outdated concepts on safety and efficient production to improve the safety and production level in coal mines, it is necessary to implement four changes from the outdated concepts of safety production.

# SAFETY AND EFFICIENCY I



- The first is the change from control of disaster accidents to prevention of disaster source.
- The second is the change from the single disaster prevention to the multi-disaster prevention.
- The third is the change from partial governance to regional governance.
- And the fourth is the change from control of the death to guarantee of the health.

As a result, we reach disaster prevention and control in the whole processes involved in coal mining (pre-mining, during mining and post-mining); precise intelligent mining, disaster prevention and treatment, these interventions should enhance and promote the coal industry to develop its high-tech status and improved Health and Safety.

# Strengthening scientific & technological research and demonstration

The government gives its full attention to the enthusiasm of multi-parties (industry-college-institute) to boost the science & technology innovation. Multiple parties should be focused on the research of key technology and theories to reduce mine disasters:

- develop the prevention and control technology of dynamic multi-field coupling disasters
- develop the remote controllable unmanned precision mining technology and equipment and compile the design specifications
- the construction standards and the mining regulations that meet the requirements for safety and efficiency.

Safe and efficient mining as two main lines, the transformation of advanced scientific and technological achievements should be accelerated. The new mode of integrated mining and disaster prevention should be created. Demonstration projects with information, digitization and intelligence which cover integrated production, disaster monitoring, and prevention & control management.

# Improving the overall level of safety and efficient production

For a new coal mine it should be built to the highest standard possible and used as the starting point for monitoring and recording data in relation to production, efficiencies and

#### SAFETY AND EFFICIENCY



Health and Safety. For old large and medium-sized coal mines, it should improve the degree of mechanization through technological transformation. For coal enterprises, it should increase the industrial concentration by merging coal enterprises and integrating coal resource to end a reverse in production capacity gradually.

For the whole of China, we should exchange and share the experience in technology, engineering, and management on the construction of safe and efficient mines in a timely manner. The aims are to solve the problems of imbalance and inadequacy and to promote the overall level in safety and efficient development of our future mines.

#### Strongly training professional talents

It is necessary to strengthen the main channel function of personnel training in universities to supply sufficient graduate source for coal enterprises; to train young and middle-aged professionals in coal mines by updating their knowledge and exchanging technological achievements regularly. The gualification of workers in coal mines should be supported to a certificated level, according to the national occupational skills standards. At the same time, the qualification allowance should coincide with the wage structure thus as a result living conditions would be much improved. A long-term plan should be set up to attract professional people to work in coal mines. As a result, a group of compound professional talents who master safety technology, understand safety management and be able to run on-site should be trained to meet the needs of mechanization, automation and information intelligence in mines. A result of these measures put in place would go some way to solving the shortage of professionals within the industry.

#### Building a better occupational health system

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#### REFERENCES

- 1. Liang Y (2017) Strategic studies of high-efficient and energyeffective coal extractions in China. Science Press, Beijing, China
- 2. Hu BN, Zhang P (2016) Research on development environment of safety and efficient mine construction of China during 13th five-year period. Coal Economic Research 36(11): 11-16.
- 3 Wang GF, Fan JD, Xu YJ (2018) Innovation progress and prospect on key technologies of intelligent coal mining. Industry and Mine Automation 44(2): 5-12.
- Zhang JG, Wang H (2018) Practice of safety and efficient 4 production with less personnel boosted by four optimizations and one promotion for coal enterprise and its inspiration. China Energy and Environmental Protection 40(7): 1-4.
- 5. Ning Y (2011) Innovating safety and high-efficiency coal mining technology and supporting extra-large mine construction. Coal Mining Technology 16(3): 1-3.
- 6. Qin RJ (2019) Research on current status and policy of coal mining in China. Coal Economic Research 39(1): 57-61.
- Lan H, Chen DK, Mao DB (2016) Current status of deep mining and disaster prevention in China. Coal Science and Technology 44(1): 39-46.
- 8. Li Wanming (2013) Review of the current situation of safety and efficient mining in mines in China. Science and Technology Innovation Heraid 20: 112.
- 9. Shen BH, Guo YH (2012) Development status and tendency of technology and equipment for fully mechanized coal mining in China. Coal Science and Technology 40(2): 1-3.
- 10. Wu J (2016) Innovative management and control mode to promote safety and efficient mine construction. China Coal Industry 6: 49-51

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# Coal exploration and drilling





he purpose of coal exploration is to determine the nature, location, and extent of the resources available in a particular situation and delineate the features that may affect their economic extraction. A program of geological exploration for coal usually has one of two possible

objectives: (a) to find an area from which a given amount of coal of a specific quality may be successfully recovered, or (b) to determine the amount and quality of coal that can be economically extracted from a given area. Like other exploration activities, the evaluation of coal deposits involves the following operations:



- · obtain legal title to explore the area
- evaluate the geologic information already available
- carry out surface exploration
- · carry out subsurface exploration
- collect and analyse samples
- estimate the coal resources and the significance of geological factors in their extraction

Mining operations employ a variety of drilling methods based on the requirements of the project. In the majority of cases, a drilling program will begin with the exploration phase. The aim is to confirm survey data about the location and extent of the coal deposits or seams. Additionally, exploration drilling is used to identify or confirm the location of faults, folds, dikes, sills, and other geologic features that may influence how the coal is ultimately mined.

#### **INITIAL EXPLORATION DRILLING**

The initial phase of many exploration drilling programs involves a method known as chipping. True to its name, chipping involves a drill that cuts into the subsurface rock and produces small chips of the material it encounters. These chips range from very small sand particles (<4mm) to larger pebbles (2-3cm). From a geological perspective, chipping is useful for understanding the boundaries of a deposit or seam but is not so helpful for providing information about the quality or grade of the target coal. Chipping paints a broad picture for mine geologists and



Australian coring drill rig with a rod visible on the stands to the right.

provides crucial information for refining the geologic model of a mine site.

Geologists will sometimes collect samples for geochemical analysis during drilling, but typically, the most important part of chip drilling for a geologist is logging the chips. As the drill advances meter by meter, the chips produced are blasted up the sides of the borehole. When they emerge at the surface, they are caught in a bucket and set out in rows.

One pile of chips is roughly equivalent to one meter of drilling, and this way the geologist is able to log the entire depth of the borehole. Some of the data recorded includes rock type, minerals present, colour, grain size, and any unusual traits. Since chips are coarsely pulverized rock fragments at best, when true detail about a deposit or seam is needed mines turn to a different method of data collection.

#### DETAILED MINE RESOURCE DRILLING

As mining progresses from the initial exploration phase to the latter stages of exploration and into production, a higher level of detail about the site's subsurface is required. Coring (diamond drilling) is another way of collecting information about a potential coal resource. The drill rig is equipped with a hollow tube, and as the drill pushes the rods into the ground, a cylindrical piece of the rock is pushed into the hollow tube. These samples are usually the length of a drill rod, which is 6 meters. Shorter and longer samples are

# SURFACE DRILLING



Piles of chips after logging.

also possible. The "core sample" is then pulled back to the surface, where the geologist has a few minutes to log the core in detail before the drill rig produces another sample. Time is important during this process, as drill crews are often paid by the number of meters drilled in a day. It is in everyone's interests to produce good core samples quickly and accurately.

Logging diamond core is slower and more labour-intensive than logging chips, but it produces much more detailed information than chip logging. The information a geologist records may be used to make a rough determination of the quality or grade of a resource at a specific location within the mining lease. Core samples can be used to identify potentially combustible minerals, faults, and other weaknesses in the rock surrounding a deposit. Geotechnical samples of the "roof" and "floor" material bordering a deposit are taken from core samples, and this information is critical to understanding the potential integrity of a mine's construction.

Unexpected deposits of intrusive volcanic rocks or extremely lithified (hardened) sedimentary rocks can often be seen in core samples, and identifying these is essential when creating a cost-effective mine design. Encountering an unexpected section of very hard rock can derail mine production by hours or even days, which is a delay that mines cannot afford. Core sampling has the ability to pick up finer variations in the country rock than seismic surveys can, and this is why such a labourintensive process is still used at even the most costconscious mining operations.



Geotechnical core sample after logging.

**Jess Pelaez** is a geoscientist, researcher, and mining industry expert with work experience in North America, South America, Australia, Asia, Europe and Africa.

# South Africa's RBCT exports lowest coal tonnage since 1996

The Richards Bay Coal Terminal (RBCT) last year exported its lowest volume of coal since 1996.

In exporting 58.72-million tons of coal. RBCT was 11-million tons down on what it achieved in 2020 and 18-million tons down on its 77-million-ton budget for the 2021 year.

The target for the upcoming 2022 is 70-million tons.

Of the 11-million tons that RBCT was down on last year, 1.8-million tons can be ascribed to two overall value-chain shuts totalling 19 days compared with the normal year's ten days.

In other words, RBCT was 9-million tons down on operational matters impacting the value chain.

"It's not one of those easy announcements to make for RBCT and Transnet in this year. Just to put it on the table - 2021 has been a very difficult year," said **RBCT** chairperson Nosipho Damasane.

The biggest challenge experienced as a value chain was receiving coal from the coal mines.

"Cable theft has been a significant matter in terms of what the coal line

has been dealt with, and we've seen that on a daily, weekly basis throughout the course of last year. Loco availability has been a challenge," said RBCT CEO Alan Waller.

"We have been working on a continuous basis from a terminal point of view as well as from an industry point of view, in partnership with Transnet Freight Rail (TFR), to understand how we can work together to understand what these challenges are and how we can contribute where required to assist in trying to improve the overall efficiencies. We have worked together on security issues and that process kicked off in October last year," said Waller.

"We have definitely seen some gains and the true gains we've only started seeing now in January. The result where we find ourselves at this stage is that it's really what the industry has brought to the party as additional resources.

"We have partnered with existing service providers that TFR use and at this stage industry and existing service providers, and

the increased capacity that has been put on the line, are looking at the night shift on the security of the 750 km of the coal line. This doesn't go all the way through to the Waterberg. It just goes to the Mpumalanga area, and we're covering that in terms of the six-to-six shift at night, and then Transnet have doubled up on their security service providers on the day shift.

"We definitely, in January, are seeing some significant improvements in this regard, but it is a continuous battle and there are initiatives that are ongoing, still within the security area, to look at how we improve the issue. But it is a battle that we are winning at this stage," said Waller.

Damasane emphasised the importance of the partnership that RBCT has had with TFR and Transnet National Ports Authority since 2012, with joint initiatives resulting in claw back and corridor recovery. Located in KwaZulu-

Natal, RBCT, which loaded only 645 vessels in 2021 compared with 907 in 2017, is owned by a consortium of shareholding coal



companies. The terminal received coal from 65 collieries, with ten active junior miners contributing 3.5-million tons. Fourmillion tons of RBCT's 91-million ton capacity is allocated to junior miners in terms of a programme guided by the Department of Mineral Resources and Energy. Vessel turnaround time

moved out from 34 hours to 39 hours, partially influenced by vessel sizes. The increased number of Cape-sized vessels in 2021 assists with the efficiency of the terminal and is favoured, but they take slightly longer to load. Cape-sized vessels have risen to half from 39%.

**RBCT** has 98 stockpiles of coal at the terminal and with the low stock levels it was having to clear up to 25 stockpiles a month, whereas the 77-millionton rate normally involves clearing about 15 stockpiles a month. "Although the terminal

perse is not affected by all that's happening, it obviously does have an impact in terms of the operational efficiency that the terminal has, and as a terminal, we need to adapt accordingly to meet those efficiency requirements," Waller said.

More than 86% of the coal exported in 2021, or 50.7-million tons, went to the Asian countries of India, Pakistan and China; under the African heading, 5.3%, or 3.1-million tons, was exported to Mauritius and Morocco; under the Middle East heading, 4.3%, or 2.5-million tons, went to United Arab Emirates and Israel; and under the European heading 4%, or 2.3-million tons, went to the Netherlands and Italy.





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