

An aerial photograph of a large-scale mining operation. In the center, a complex network of orange and yellow conveyor belts and structural supports extends across a dark, excavated landscape. To the right, a large piece of heavy machinery, possibly a loader or crusher, is visible. Below the main conveyor system, a long line of yellow and black rectangular bins or chutes is arranged horizontally. The background shows deep, dark pits and mounds of earth, with some lighter-colored material visible in the upper right corner. The overall scene conveys a sense of industrial scale and automation.

BDO'S ENERGY 2020 VISION: THE NEAR FUTURE OF MINING

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EXECUTIVE SUMMARY



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“We expect renewables to account for one-quarter of the world’s electricity generation by 2020.”

Driverless technology, deep-sea excavations and mining expeditions on the moon were once just the ideas of sci-fi movies.

Today, they’re realities or just around the corner. And by 2020, we expect (most of) them to be the norm.

As low commodity prices persist, mining companies are under pressure to reimagine their business models. Those that have incorporated technology into their operations have seen their revenue streams live on, while those that haven’t have fallen short.

Mining is in the early stages of the Fourth Industrial Revolution, or Industry 4.0, and further digitisation is on the horizon. The value of harnessing technology is obvious. Driverless technology increases mining output by 15 to 20 percent while cutting fuel and maintenance costs by 10 to 15 percent and 8 percent, respectively. It also improves mining safety exponentially. At the same time though, these Internet-connected technologies open the mining industry up to new cyberattack vectors that they must hedge against through proper

internal controls. If not, they risk seeing their entire operation crippled by a single attack.

Decreased coal consumption in China—the world’s largest coal consumer—meanwhile, is slowing global demand for the commodity. As dependence on coal wanes, we expect renewables to account for one-quarter of the world’s electricity generation by 2020.

Reflecting on this period of transition, BDO’s Global Natural Resources team is looking towards the future to help mining companies anticipate and plan for the challenges and opportunities ahead. We believe that to prepare for success in 2020 and beyond, mining companies must strive to become “Lean, Green, Digital” machines.

The global predictions presented in this report are based on research and collective input from BDO’s Natural Resources and Mining leaders. In addition, the practice leaders from five countries (Australia, Canada, South Africa, the United Kingdom, and the United States) have provided predictions for the industry in their local markets.

SUMMARISING BDO'S ENERGY 2020 VISION FOR MINING:

1. ROBOTS:

By 2020, robots will replace more than 50 percent of miners, and mining accidents will be cut by 75 percent. Half of the miners will themselves be retrained to run the technology controlling the robots.

2. EU CONFLICT MINERALS:

Supply chain transparency will take the compliance spotlight for 2020 as companies gear up for the European Union’s Conflict Minerals Rule, effective in 2021.

3. CYBERSECURITY:

By 2020, activist hackers will launch at least five cyberattacks on mines around the world in Permanent Denial of Service (PDOS) attacks aimed at eliminating the environmental and social threats they pose. They’ll use workers’ connected devices to initiate the attacks.

4. RENEWABLES:

By 2020, renewables will account for one-quarter of the world’s electricity generation as dependence on coal wanes.

5. IoT IN MINING:

Global mining companies leveraging Internet-connected sensors and automated drillers in mines will decrease their per ton digging costs by more than 30 percent.

Agree or disagree with our predictions? We want to know—reach out to us [here](#).

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BDO'S ENERGY 2020 VISION: THE NEAR FUTURE OF MINING GLOBAL PREDICTIONS



WHEN ROBOTS RUN THE MINES

PREDICTION 1

ROBOTS

BY 2020, ROBOTS WILL REPLACE MORE THAN 50 PERCENT OF MINERS, AND MINING ACCIDENTS WILL BE CUT BY 75 PERCENT. HALF OF THE MINERS WILL THEMSELVES BE RETRAINED TO RUN THE TECHNOLOGY CONTROLLING THE ROBOTS.

Robots will be at the forefront of most mineral extraction by 2020, reducing safety risks for miners, maximising output, and streamlining costs. By 2020, we predict robots will replace most miners. Most in the workforce will be retained, but advances in technology and remote mining equipment will transform what that workforce looks like.

The global mining industry is already well-acquainted with autonomous technology. Self-driving trucks and autonomous drillers and muckers are employed onsite at almost every large multinational company's mines. "[Snake robots](#)"—named for their agility—are equipped with Internet-connected sensors and used to navigate narrow mine shafts and collect data. Drones are also beginning to play a role in mapping the topography of a mine and capturing aerial images of inaccessible areas of the mine to identify possible vulnerabilities and areas of tension. Remote vein miners (RVMs) are being developed to eliminate the need to drill and blast to excavate rock—potentially reducing rock stress that can lead to seismic events.

The rise of the robot is not a death knell for the mining workforce but will inevitably lead to a demand for reskilling. Traditional operational positions—drilling, blasting, and driving—will be downsized, but replaced by demand for remote operators and maintenance personnel to create the new version of the miner. Emerging digital mining jobs—engineers, software developers, and data processing and data analytics specialists—are more likely to attract the technologically savvy millennial workforce. By 2020, mining automation and data analytics will be key components of the curriculum for mining engineers.

Digitisation also promises to reduce safety risks for miners. Not only will robots assume the most dangerous tasks, but they'll also be key to minimising damage if disaster strikes. Snake robots and the smart sensors they're equipped with will be further optimised to capture real-time data to predict or quickly identify equipment malfunctions and closely track miners' exact locations and vitals. With the aid of robots and new technology, the number of mining fatalities will be cut in half by 2020.

Mining is in the early stages of the Fourth Industrial Revolution, or Industry 4.0, and further digitisation is just around the corner.



TRANSPARENCY COMBATS CONFLICT

PREDICTION 2

EU CONFLICT MINERALS RULE

SUPPLY CHAIN TRANSPARENCY WILL TAKE THE COMPLIANCE SPOTLIGHT FOR 2020 AS COMPANIES GEAR UP FOR THE EUROPEAN UNION'S (EU) CONFLICT MINERALS RULE, EFFECTIVE IN 2021.

The EU's efforts to stem trade in minerals that finance armed conflicts and terror groups will turn a spotlight on global mining companies' supply chains by 2020.

The EU's Conflict Minerals Regulation, effective in 2021, establishes supply chain due diligence for imports of tin, tantalum, tungsten, and gold (3TG)—used to produce phones, cars, and jewellery. The rule aims to ensure European industries use responsibly-sourced minerals, stemming proceeds that finance armed conflict in high-risk areas.

What the rule means for the mining industry:

- EU-based 3TG importers and their international supply chain partners—smelters and refiners—will need to update their supply chain due diligence
- Additionally, 3TG importers in the EU will need to identify the smelters and refiners in their supply chains, confirm their due diligence practices comply, and report insufficient supply chain due diligence

- The Organisation for Economic Co-Operation and Development (OECD) laid out a five-step framework for the due diligence requirements:

- Create strong company management systems
- Identify and assess supply chain risk
- Implement a program to respond to such risks
- Conduct an independent third-party audit of supply chain due diligence
- Submit annual reports on supply chain due diligence.

All upstream companies are subject to the due diligence requirements when they import—the riskiest area of the supply chain—as are downstream companies that import metal-stage products. This regulation will likely create a lowest common denominator effect across the global mining industry—for EU-based 3TG importers and their international supply chain partners—requiring the entire industry to put supply chain due diligence at the forefront.



HACKTIVISTS TARGET MINES

PREDICTION 3

CYBERSECURITY

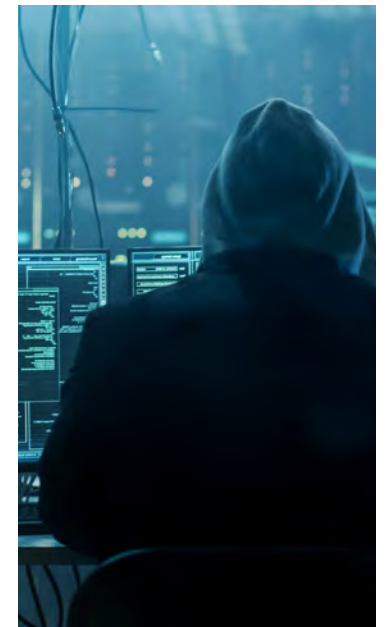
BY 2020, ACTIVIST HACKERS WILL LAUNCH AT LEAST FIVE CYBERATTACKS ON MINES AROUND THE WORLD IN PERMANENT DENIAL OF SERVICE (PDOS) ATTACKS AIMED AT ELIMINATING THE ENVIRONMENTAL AND SOCIAL THREATS THEY POSE. THEY'LL USE WORKERS' CONNECTED DEVICES TO LAUNCH THE ATTACKS.

The mining industry is no stranger to [environmental scrutiny](#). Advances in technology have introduced more sustainable mining methods, including the emerging practice of bioleaching, in which companies extract minerals by using biological assets instead of harmful chemicals. Despite those advancements, environmental concerns persist, including water and soil contamination, carbon emissions, and impact on animal life. Pressure from environmentalists is set to increase by 2020. In fact, an emerging type of environmentalist—activist hackers (hacktivists)—will soon have their targets locked on the mining industry. By 2020, there will be at least five Permanent Denial of Service (PDOS) cyberattacks on mines around the world, motivated by eliminating the environmental and social threats they pose.

PDOS attacks are the next generation of Distributed Denial of Service (DDoS) attacks—which temporarily disable operations—and aim for permanent destruction. In a PDOS attack, hackers' goals include destroying physical equipment and structures, disabling services, and/or wiping out data. For global mining companies in the early stages of harnessing big data, losing seismic and reserves data would be damaging to their ongoing operations.

While the rapid acceleration and adoption of new technology will be instrumental in bolstering mining's future, it will also be the sector's Achilles heel when it comes to cybersecurity. The industrial control system, the central hub controlling a mine's automated operations, could serve as the hacker's point of entry into the mine's remote

operating controllers and connected devices. Damage and disruption to automated equipment could also jeopardise the safety of workers in the mines—as many of the systems in place are designed to monitor and detect dangerous conditions.



COAL STRIPPED OF SOME POWER

PREDICTION 4

RENEWABLES

BY 2020, RENEWABLES WILL ACCOUNT FOR ONE-QUARTER OF THE WORLD'S ELECTRICITY GENERATION AS DEPENDENCE ON COAL WANES.

Decreased coal consumption in China—the world's largest coal consumer—is slowing global demand for the commodity. According to the International Energy Agency, global coal consumption decreased about 2 percent last year. In confluence with the rapid growth of renewables, the world's energy mix is set for a [shakeup](#). By 2020, we predict that renewables will grow to account for one-quarter of the world's electricity generation as dependence on coal wanes.

Mining plays an integral behind-the-scenes role in developing renewable energy. Electric vehicles, wind turbines, and solar panels rely on minerals like aluminium, copper, lithium, and various emerging, rare metals. Powered by new technology, deep-sea mining is allowing mining companies to tap into previously inaccessible reserves of copper, nickel, and cobalt, among others, beneath the ocean floor to fuel increased demand for these minerals.

In 2019, Nautilus Minerals, a Canadian mining firm, is set to launch one of the first large deep-sea mining ventures in the Bismarck Sea with the aid of remote-controlled robots. The excursion is forecast to produce more than [72,500 metric tons of copper](#) and more than 4.5 metric tons of gold. The International Seabed Authority, a United Nations regulatory body, has granted 25 contracts to nations including China, India, Japan, and Brazil to embark on similar deep-sea mining projects.

By 2020, further advancements will be made to overcome one of renewables' largest hurdles: energy storage. The world's largest lithium ion battery—built by Elon Musk in November 2017—is a 100-milliwatt (MW) battery storage farm located in Australia. Come 2020, the capacity of energy storage is likely to evolve well beyond 100MW, solidifying renewables' role in the world's energy mix.



AN ARSENAL OF AUTOMATION BOOSTS PROFITABILITY

PREDICTION 5

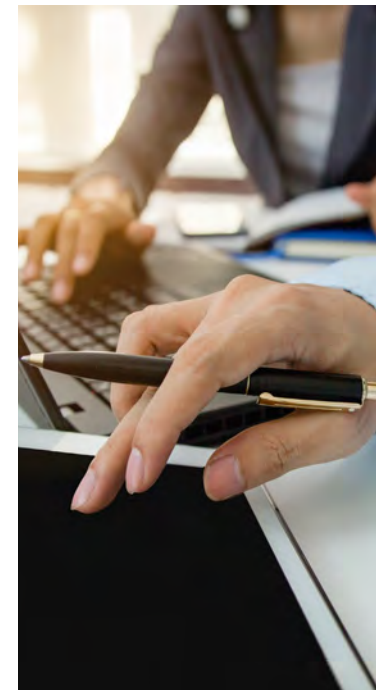
IOT IN MINING

GLOBAL MINING COMPANIES LEVERAGING INTERNET-CONNECTED SENSORS AND AUTOMATED DRILLERS IN MINES WILL DECREASE THEIR PER TON DIGGING COSTS BY MORE THAN 30 PERCENT.

In an environment of subdued commodity prices, the value of harnessing technology is clear. Mining companies' end consumers closely monitor the price of commodities and are sensitive to the slightest uptick. For automakers, for example, steel is a significant expense on their books. When multiplied by a few thousand metric tons, a variance of a few cents on steel price could incentivise automakers to find a new supplier. Global demand is not expected to wane. In fact, steel and mining company ArcelorMittal [forecasts](#) a 36 percent increase to automakers' global demand for steel by 2020. However, which global mining companies win that business is up for debate.

Tapping into [new technology](#) is key to streamlining operations, reducing expenditure, and enabling companies to keep their prices competitive. The [International Institute for Sustainable Development](#) estimates driverless technology, for instance, increases mining output by 15 to 20 percent, while decreasing fuel and maintenance costs by 10 to 15 percent and 8 percent, respectively. Self-driving trucks are just the tip of the iceberg. Global mining companies that digitise nearly all their drilling—relying on a combination of automated drillers and Internet-connected sensors—will recognise far more significant savings. By 2020, we predict global mining companies' per ton digging costs will decrease by more than 30 percent because of automation.

These savings factor in reduced labour costs, increased output, a decrease in the number of safety incidents, and companies' ability to enhance decision-making capabilities leveraging the vast amount of data collected by smart mines.



BDO'S ENERGY 2020 VISION: THE NEAR FUTURE OF MINING IN CANADA



DIGITAL: NO LONGER A BUZZ TERM

PREDICTION 1

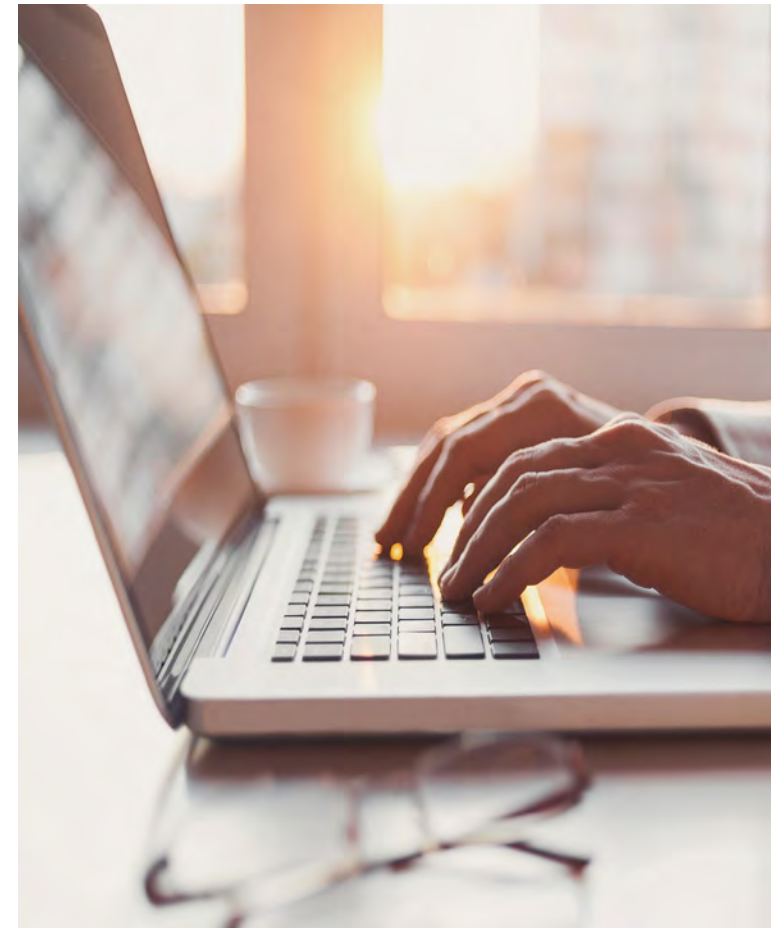
MINING DIGITIZATION

BY 2020, "DIGITAL" WILL NO LONGER BE A BUZZ TERM, AND BLOCKCHAIN WILL BECOME A NECESSITY.

Digitization may not necessarily be new to mining, but the industry is just now figuring out how to get the most out of it.

Companies like Goldcorp, CISCO, AWS, Microsoft, and Barrick Gold have sponsored numerous developer hackathons in recent years. The sector has seen multiple waves of digital transformation since the 1950s—from computer simulations to modern GPS-controlled heavy haulers. But how much has the industry benefited from previous digital waves, and how much will it benefit from the latest wave?

We see [blockchain](#) as the next wave—becoming a necessity to Canadian mining companies by 2020. Think of blockchain as a version of the Internet that can carry out various transactions but is virtually impossible to hack. It has the potential to revolutionize financial services by making transactions cheaper, quicker, and more transparent and trustworthy. [Blockchain in 2020](#) will change the mining and metals industry in Canada by lowering costs in mid and back offices.



DIVERSIFYING THE WORKFORCE

PREDICTION 2

EXPANDED LABOR FORCE

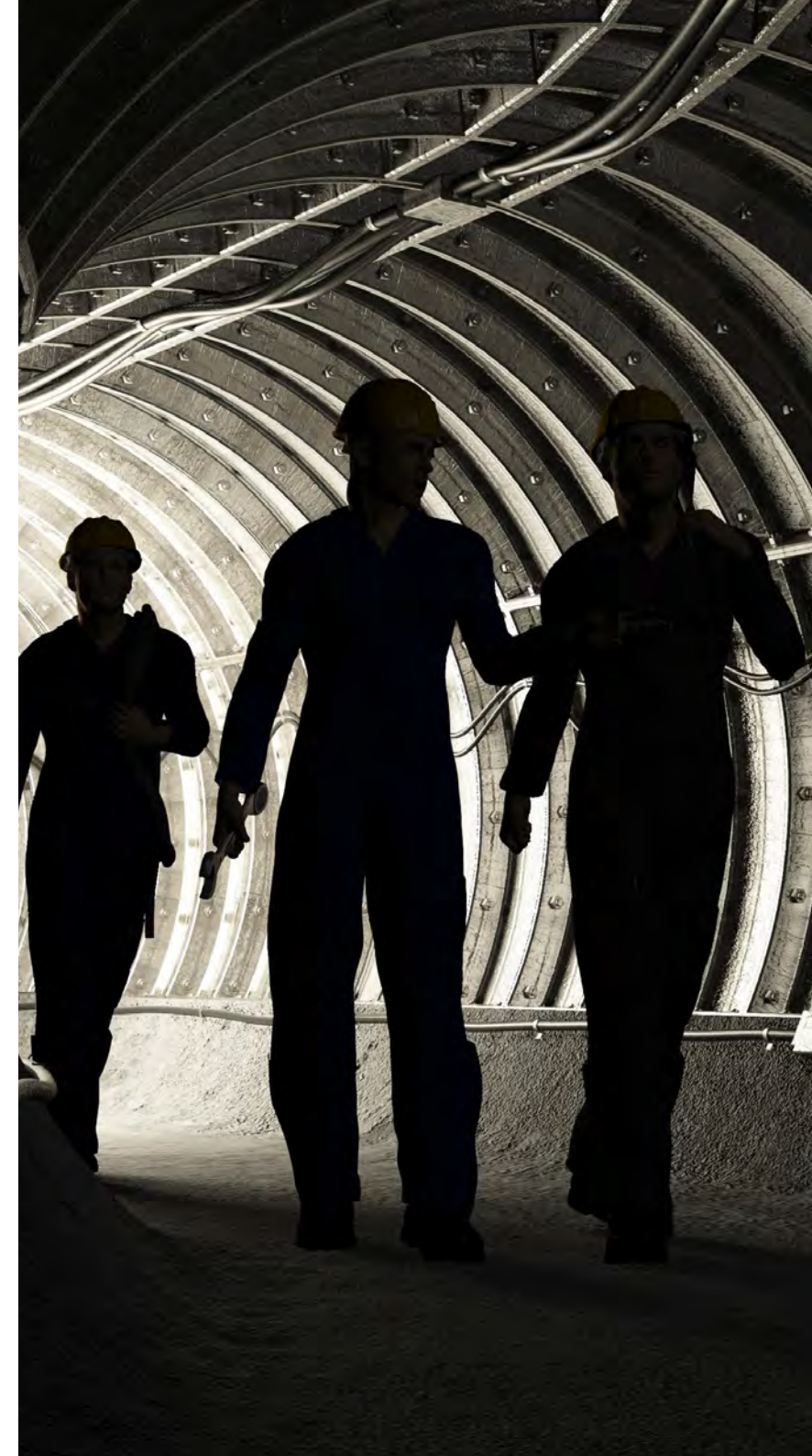
BY 2020, NEW AND RECENT IMMIGRANTS, ABORIGINALS, AND WOMEN WILL CONTINUE TO MAKE UP THE PERSONNEL SHORTFALL IN CANADA'S GROWING MINING SECTOR.

The mining industry, both in Canada and abroad, faces many human resources challenges. We see diversification as the answer.

Competition for skilled workers is fierce both within Canada and globally. In fact, companies in other countries are actively recruiting Canadian graduates and workers, making retention challenging and recruitment highly competitive. According to [Natural Resources Canada](#), the Canadian mining industry will need to hire 106,000 new workers by 2025.

At the end of 2017, in an effort to combat this problem, the [Canadian government](#) announced a 7 percent increase in its target for permanent resident admissions. Other proposed actions to address the mining workforce shortage in Canada include:

- Promoting the industry to youth, aboriginal peoples, and non-traditional worker groups
- Developing programs that bring back retired workers, retain older workers, and increase mentoring
- Improving educational programs and employer-provided training
- Introducing standards for key occupations to facilitate domestic worker mobility and skills recognition.



BITCOIN OR GOLD: THAT IS THE QUESTION

PREDICTION 3

FINANCIAL REGULATION

BY 2020, THE DEBATE OVER BITCOIN VERSUS GOLD WILL ONLY INTENSIFY AS FINANCIAL REGULATORS LOOK TO CONTROL THIS NEW MEDIUM OF EXCHANGE AND AVOID ANOTHER DOTCOM BUST.

Bitcoin or gold—that is the question for the mining industry in Canada. But the answer may be harder to come by as financial regulators seek greater control over the former.

We see several factors—including regulation, meteoric rises and falls in Bitcoin value, currency wars, crypto currency hacking, and another major recession—putting gold back in the top seat.

[Bank of Canada](#) Governor Stephen Poloz is sounding the alarm on [Bitcoin](#), calling the purchase of the cryptocurrency “closer to gambling than investing.” In a December 2017 speech Poloz said Bitcoin is an unreliable store of value and does not constitute “money.” He added that buying the cryptocurrency “means buying risk” and urged those flocking to it to “read the fine print.”



INTEGRATING SUSTAINABLE STRATEGIES ACROSS SUPPLY CHAIN

PREDICTION 4

CLEANTECH

BY 2020, 30 PERCENT OF MINING INDUSTRY LEADERS WILL HAVE DEFINED AND IMPLEMENTED PLATFORM CLEANTECH STRATEGIES.

In such critical times for the mining industry, creating integrated environments across equipment, maintenance, planning and scheduling, and execution is key to addressing concerns around [climate change](#).



Driven by emerging economies, demand for mineral resources continues to rise, but mining companies are under ever-increasing pressure from governments, customers, and other stakeholders to operate in a sustainable manner. Many key [industry players in the mining sector](#) have developed energy saving strategies and are investing directly into renewable energy infrastructure. IAMGOLD, a Canadian firm, signed a \$20 million, 15-year power agreement for a solar installation at its off-grid Essakane mine in Burkina Faso. India is having a clean energy renaissance, with key mining companies joining in. Chile, meanwhile, is seeing a huge clean energy boost from its red metal mines.

In 2020, [climate change concerns](#), greenhouse gases, and regulation will continue to be top of mind and a major issue for the mining and metals sector—a major consumer of energy and primary user of land. New initiatives to combat climate change will be introduced, and there will be an escalating need for companies to respond to increased regulation of emissions.





SHORING UP SPENDING ON DEFENSE

PREDICTION 5

CYBERSECURITY

CYBERSECURITY SPENDING ACROSS IT AND OPERATIONS IN THE MINING INDUSTRY WILL INCREASE 20 PERCENT YEAR-OVER-YEAR BY 2020.

The key to mitigating the cyber threat will be information sharing.

Companies like [Goldcorp](#) and a group of Canadian miners have moved to create a joint task force to increase knowledge sharing specific to the real and present cyber warfare dangers to mining assets.

[Luis Canepari, vice president of IT at Goldcorp](#), sounded the alarm bell in 2017 at a Toronto security conference after hackers penetrated the company's computer network and stole troves of data including bank accounts, wire transfers, and payroll records.

"This was a real eyeopener for us and we were quite frank about what had happened and what we needed to do better," he said. "You can't wrap yourself in a cocoon. Secrecy doesn't help anyone."

Today, virtually all parts of the mining supply chain are connected to the Internet. Ventilation and conveyor systems are managed by supervisory control and data acquisition (SCADA) systems. Even new hauling trucks come with 100 wireless sensors to be used.

Cybersecurity risk mitigation plans for mining organizations should focus on:

- **Operational technology:** This function should work with information technology to make sure the architecture around remote access is well-secured.
- **Emerging technologies:** Mobile technologies, machine automation, and cloud integration are often adopted quickly, and before they can be tied into cybersecurity systems. Beware: Their ease of use can provide a window of opportunity for hackers.
- **M&A:** These generate a huge amount of confidential information. Security needs to be looped in early in the process to make sure that information is safe and both companies involved are protected.
- **Third-party management:** Different parts of the supply chain can have fewer security controls and can put the whole ecosystem at risk. Any data generated between two companies needs to be protected, shared, and stored securely.

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