



ELECTRIFICATION OF MINING SERIES

CARBON-FREE BY 2050 & THE ELECTRIC MINE CONSORTIUM

Race to decarbonize

The electrified mine

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CARBON FREE BY 2050 & THE ELECTRIC MINE CONSORTIUM

The global mining sector plans to operate carbon-free by 2050, a herculean task. There are compelling reasons to do so.

Global warming looms as an existential threat. The 2015 Paris Agreement on climate change clarifies that avoiding catastrophe – holding warming to under 2 degrees C above preindustrial levels, and ideally to 1.5 degrees – requires immediate, substantial decarbonization down entire supply chains, with mining occupying the base of those chains.



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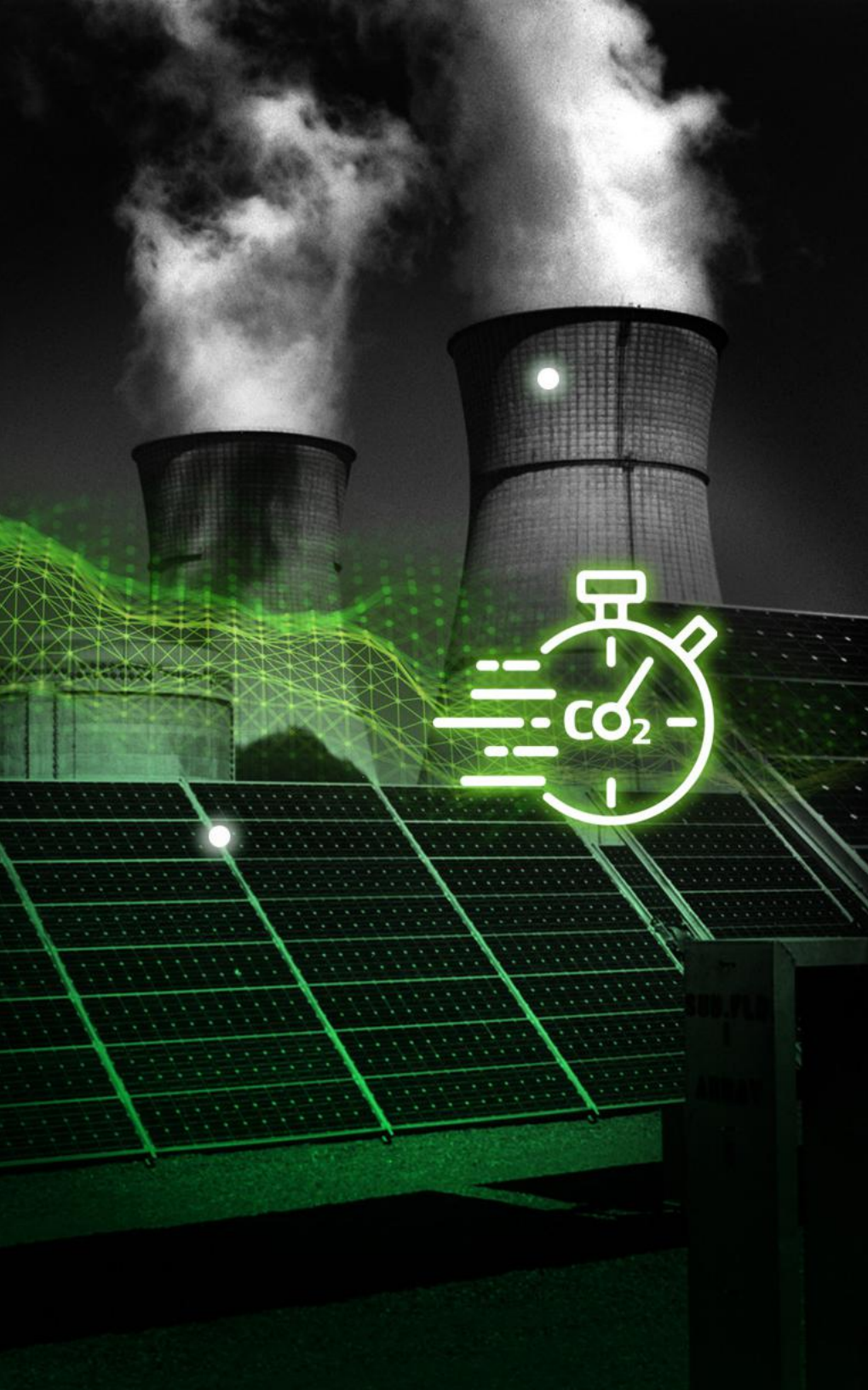
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RACE TO DECARBONIZE

There are good business reasons to decarbonize. One is health related. Nearly eight out of 10 industry executives expect health-related industry class action lawsuits in the next 15 years, according to a sweeping 2020 report titled [State of Play: Electrification](#). State of Play is an Australian-based mining research organization that fostered the Electric Mine Consortium (EMC) in 2021. Many mining companies expect declining profits by 2025 because of carbon regulation costs and higher water costs due to climate change. Unless something changes, companies have few options.

Industry analysts agree mining must innovate quickly. That's important because the entire global zero-carbon energy transformation depends on this industry. Rare earth minerals are needed for wind turbine magnets. Lithium, nickel, cobalt, lead, manganese, aluminium, graphite, and vanadium must be supplied for batteries and other emerging energy storage systems. Copper is needed throughout electricity transmission, silver and silicon feed solar technologies, and iron ore fuels a growing portfolio of new structural materials.

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“They really stepped forward, but I think largely for a lot of competitive reasons which are good reasons, to really get scale in the efforts both through trials and also through peer collaboration,” *Graeme Stanway, founder of State of Play.*

THE ELECTRIFIED MINE

EMC believes electrification is the key. Working groups are developing mine scale energy storage technologies and charging system infrastructures, simulating various mining methods to establish electrification benchmarks for future mine designs, and introducing heavy and light battery electric vehicles (BEVs) in greenfield and brownfield mine sites.

“They really stepped forward, but I think largely for a lot of competitive reasons which are good reasons, to really get scale in the efforts both through trials and also through peer collaboration,” Graeme Stanway, founder of State of Play.

According to State of Play research, electrification projects using onsite renewable energy sources have been gaining rapidly since 2019, particularly in Australia and Sub-Saharan Africa.

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ELECTRIFICATION & THE INDUSTRY TRIFECTA: ENVIRONMENT, HEALTH, ECONOMICS

There is an ecosystem of innovation and scaling of electrification technologies emerging in the mining industry that is providing economic, health and environmental value: an Industry Trifecta. This is good news because the climate clock is ticking, the value is clear, and there is much work to be done.

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ECONOMICS OF ELECTRIFICATION

Electrification creates enormous opportunities for operational cost savings, innovative mine designs and resilience against uncertainty. It will reduce human exposure to carcinogenic diesel particulates and reduce scope 1 and 2 carbon emissions by almost 100. Electric engines are three times more efficient than their diesel equivalents and reduce megawatt hours (MWh) by 33,000 per year because of reduced ventilation requirements.

The value increases productivity and profitability in existing assets, while improving a company's ability to unlock deeper and more remote ore bodies. Clean energy electrification facilitates precision automation and the digitization of mine operations, while improving environmental and health outcomes. Moreover, electrification opens exciting opportunities for novel equipment design that lowers capital costs of entry, smaller modular solar fields that can be deployed quickly, and most important, automation. Businesses that drive this shift will see economic, health and environmental opportunities; those that don't face a bleak future.

Mine scale energy storage technologies and charging system infrastructures are in early development. Engineers are simulating various mining methods to establish electrification benchmarks for future mine designs. Heavy and light battery electric vehicles (BEVs) are already being introduced in greenfield and brownfield mine sites.



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“ Eighty percent of the industry believe there will be a major health-related industry class-action over the next 15 years.

ELECTRIFICATION IMPROVES HEALTH AND SAFETY

The health and safety of men and women who work in mines will improve with electrification. Diesel particulate matter emitted from vehicles and generators, especially in underground mines, pose both short- and long-term risks to health, from headaches and nausea to serious illnesses such as cancer. In Australia alone, 1.2 million industry workers are exposed to dangerous levels of diesel particulate matter. More than 40 additional substances released from a diesel exhaust are considered hazardous air pollutants. The long-term health effects from these pollutants could be tied directly to mining exposure. Eighty percent of the industry believe there will be a major health-related industry class-action over the next 15 years, with diesel particulates being the second highest health risk.

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MERGING TECHNOLOGIES CREATE NEW POSSIBILITIES

Electricity breeds invention. The light bulb. Alternating Current (AC). Electric motors. Transistors. GPS. The Internet. Because of its unique power to spur innovation, electrification is enabling the two biggest shifts transforming the mining industry today - clean energy and digitization.

Electrification leads to new equipment design and design methods. Electricity conveys information and data for reporting, control, simulation, and automation, a capability that gets miners out of reacting and into anticipating next moves. With the power to predict, novel business models evolve.

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BETTER DATA, QUANTIFIED VALUE

As companies electrify more operations with renewable technologies, the capital costs of entry falls. Renewable energy kilowatt-per-hour costs have plunged over the past 15 years from about \$75 to around \$0.05, said Michelle Ash, CEO of Dassault Systèmes GEOVIA.

“This dramatic drop in renewable technology costs is now putting some of these technologies right in the reach of cost-effectiveness,” Ash said. “That also has prompted companies to reconsider the risks of ‘standard’ technologies going forward”.

Large-scale pilot studies in energy storage are under way. Advances in digital integration and supporting infrastructure allow mining energy systems to be designed as a single platform. With full value-chain visibility and advanced energy control, mines can optimize, capture and re-use energy, structurally reducing overall operating costs.

Automation has been developing in the mining industry for many years, but its advancement has been hampered by disparate energy systems and the imprecision of non-electric drive vehicles. A unified electric energy system, on the other hand, enables automation by integrating sensors and control compatibility required for precise control.

Better data from an electrified system reveal value that can be more effectively quantified. A manager can definitively track wear and tear on equipment, or energy wasted in a process. In this system, service companies can improve equipment life or reduce energy inputs without reducing output. In this business model, a company demonstrates the value of its services in quantifiable data. Instead of selling equipment, these new service model businesses charge for use per unit of performance, an effective way of implementing new energy technology. Companies grow by improving the value of their service instead of merely reducing costs.

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EARLY STAGES OF DEVELOPMENT

Challenges lie ahead. Implementation of electrification technologies will require significant mine-level investment.

Working groups with the Electric Mine Consortium have identified some of the most important current barriers to adoption. For example, mine scale energy storage technologies are not yet operational or economically proven in mining. Mine design is in early stages of R&D because traditional asset design does not capture the full benefits of electrification. Heavy BEVs (Battery Electric Vehicles) are not yet commercially available at the larger end of the scale, nor technically viable underground. Light BEVs are beginning to be deployed, but there are many economic and operational assumptions around this technology that remain unclear. More broadly, there remains a clear lack of understanding of supporting infrastructure requirements needed for a robust charging ecosystem. These are big challenges, but mining is moving toward electrification.



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As technologically challenging electrification is for mining's future, the industry's social contracts with labor and local communities represent perhaps the greatest test. Electrification, automation, virtual twins, robotics, and data analyses are pointless without people. Recruiting employees skilled in digital technologies is important, but mining needs men and women who are committed to a company's broader mission and proud of the work they do. Mining needs good relationships with communities and governments where companies operate around the world.

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“Mining is the business of extracting and exploiting mineral resources. That mindset doesn't work when it comes to human resources.”

RECRUITING THE RIGHT TALENT

Much of the technology for full electrification of mine sites is available today; however, a significant knowledge gap exists about how, exactly, to implement this capability. Recruiting talent can address that problem.

“I think we've got two challenges,” Mining Education Australia director Steve Hall said in a 2018 [Mining Technology](#) report about training mine workers for a digital future. “We need to compete with the Ubers and the Googles of the world and attract the IT, the mechatronics, the robotics people and get them to look at mining and get involved in it. But we've also got to get the mining people to understand what's really going on in those same disciplines; it's got to come at it both ways.”

According to GlobalData's Job Analytics index published by [Mining Technology](#) in July 2021, nearly 98 percent of IT-related mining job recruitment activity went to software and web developers, programmers and testers, database and network administrators and architects, information analysts and computer support specialists.

Digital transformation affects other mining jobs as well, including project and maintenance managers, mechanical and mining engineers, dozer and excavator operators, geologists and underground mining operators, CDL drivers and leading hands.

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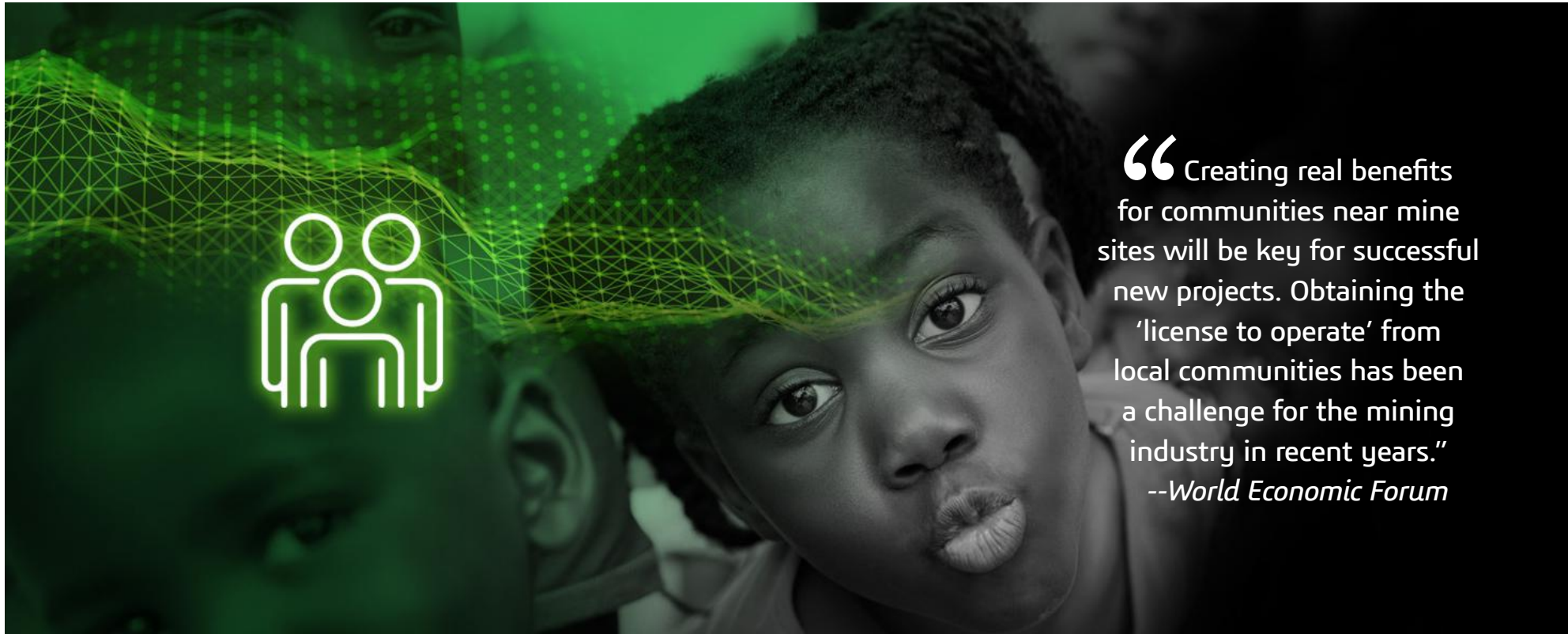
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“Creating real benefits for communities near mine sites will be key for successful new projects. Obtaining the ‘license to operate’ from local communities has been a challenge for the mining industry in recent years.”
--World Economic Forum

COMMUNITY RELATIONS

Mining companies know they must recruit and train digitally savvy employees because mineral extraction is getting more difficult, and today’s workforce is retiring at an accelerating pace. But mining’s challenge with human resources reaches beyond technical skills.

In a 2019 [World Economic Forum](#) report on the top trends shaping the global mining and metals industry, issues of equitable social contracts with local communities, transparency in data acquisition

and value chain structure, and the geopolitics of globalization and protectionism rank equally with new financing models, access to mineral resources and transition to carbon-neutral operations.

“Creating real benefits for communities near mine sites will be key for successful new projects. Obtaining the ‘license to operate’ from local communities has been a challenge for the mining industry in recent years,” the report said.

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Transitioning the mining industry to a new energy platform requires several things no single company can deliver, the authors of *State of Play: Electrification* say in the 2021 industry report. Renewable energy electrification represents “a collective responsibility for the whole industry.” Widespread collaboration is just getting started and has a long way to go.



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COLLABORATION ACROSS THE VALUE CHAIN

Collaborative testing and piloting of developing technologies will help accelerate mass adoption. However, system integration requires different approaches for greenfield and brownfield sites, with retrofitting legacy systems and transitioning existing infrastructure and equipment the biggest challenge. Sequencing transition appropriately involves complex, strategic choices.

The supply chain for mine electrification is relatively immature; procurement and sourcing of electrification equipment is in its infancy. In consumer-facing and digital industries, suppliers predominantly drive new product innovation and adoption. In mining, however, electrification will be demand-led because the capital required to develop physical technology is considerably larger and arguably riskier.



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ENABLERS FOR INTEGRATION

In a report published in July 2020 by the [Joint Institute for Strategic Energy Analysis](#), researchers examined technical issues, key barriers of industry design and investment structures, and other challenges slowing renewable energy integration into mining operations. The report also identified opportunities and “enabling approaches” to scale up integration. All entail broad collaboration throughout mining’s value chain.

For example, the structure of mining investments makes it harder to phase out old technology and incorporate new technologies such as renewable energy or electrified equipment before end-of-mine-life, the report said. Going forward, clean energy sources need to be an integral part of mine planning and design during the planning phase, as well as during operation expansions.

Surveys show that interest in renewable energy and electrification is high and growing within the mining sector, but there remains a pervasive lack of awareness among decision makers at both company and government levels who rarely consider renewable solutions during mining project planning, negotiations, and design.

Improved tools and education programs can help close the renewable energy knowledge gap. New business models can be developed that capture true return-on-investment data for renewable energy. Supply chain certifications can help create product differentiation, which may help downstream companies under pressure from shareholders to source inputs from sustainable sources. “It is not simple,” said Dassault Systèmes GEOVIA CEO Michelle Ash. “Collaboration is hard work.”



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Innovation is about invention and doing things differently, and that's risky. New electrified mining equipment and technologies are being developed. Companies up and down the value chain are creating new business models, value metrics, contracts, and financing schemes to capture the true value of renewable energy electrification and the true cost of carbon. But there are many unknowns. So much is being done for the first time.



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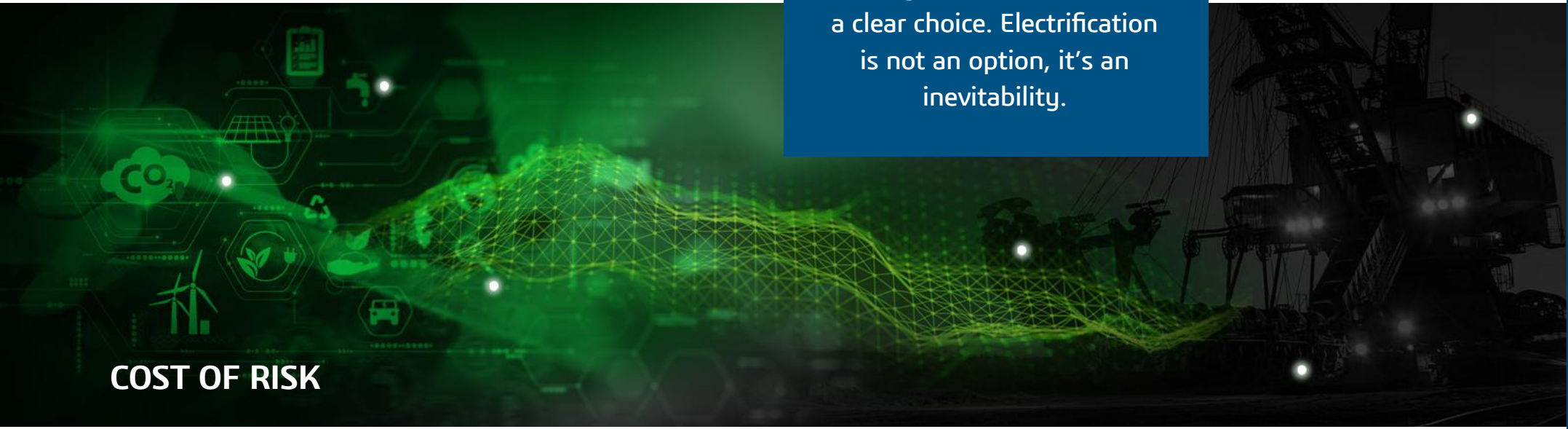
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COST OF RISK

“Mining must change quickly, and executives face a clear choice. Electrification is not an option, it’s an inevitability.”

In our [Virtual Twin Maturity Model article](#) series we discussed how to accelerate innovation with virtual twin simulation by testing new ideas before building them. This data-driven technology also reduces risk by informing decision-makers better and faster.

“One of the ways as an industry we’re going to rapidly innovate is not only through consortiums and through collaboration, is by de-risking,” Dassault Systèmes GEOVIA CEO Michelle Ash said.

“One way we can de-risk is to try things in the virtual world before we have to try them in the real world. So, literally if you can look at what having a battery electric vehicle might do to your mine plan, your mine design, your workshop setup, your resource recovery, etc., or if you can understand how a battery is going to work within

the fleet of trucks you’re going to retrofit or just replace with a different battery, what the benefit of that is going to be, and be able to simulate that in the virtual world, or create a virtual experience, even better, so people can really understand what that’s going to look like, then people are going to feel more comfortable.

“They can truly stand up in front of boards and executive committees and be able to say, I am confident that these outcomes will be driven by these investments ”

Mining must change quickly, and executives face a clear choice. Electrification is not an option, it’s an inevitability. Decarbonization is the way of the future. Simulation removes risks and speeds up innovation.

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Accelerating sustainability in mining has become a major challenge and opportunity at the same time. We need to transform mining over the next 10 to 20 years to meet societal and environmental expectations while attracting young people.

This transformation hinges on developing digital and processing technologies to drive productivity. Environmental and safety improvements.

Discover more articles on how technology and people can contribute to a sustainable future in the Sustainable Mining Network community. Create your free account now! go.3ds.com/geovia



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