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The Electric Mine 2025

Driving the next wave of transformation

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KOMATSU

Schneider Electric

Driving the next wave of transformation

The mining industry stands at a critical inflection point, driven by the twin forces of electrification and digitalisation. The imperative to reduce carbon emissions and meet global sustainability goals is reshaping how natural resources are extracted and processed. At the same time, advances in technology offer unprecedented opportunities to enhance operational efficiency, safety and resilience.

The Electric Mine Report 2025 explores how these transformative trends are converging to redefine mining operations worldwide. This report examines the evolving landscape through three lenses: the role of digital technologies in mining operations, the accelerating adoption of electric mining equipment and the strategic challenges and future outlook facing the sector.

Digitalisation is unlocking new levels of insight and control through tools such as the Internet of Things (IoT), artificial intelligence (AI) and digital twins. These technologies enable real-time monitoring, predictive maintenance and optimised resource management, improving both productivity and environmental stewardship.

Meanwhile, electrification is revolutionising the mining fleet with battery-electric and hybrid machinery increasingly proving their operational and economic viability. Early adopters demonstrate significant gains in reduced emissions, lower maintenance requirements and improved machine availability, signalling a shift from niche trials to scalable solutions.

Despite these advancements, the path to fully electric mines is complex. Infrastructure limitations, capital investment hurdles, skills shortages and regulatory uncertainties pose significant implementation challenges. Addressing these requires coordinated strategies that integrate technological innovation with site-specific operational realities.

Looking ahead, the industry is poised for deeper integration of automation, renewable energy and energy storage, moving toward autonomous electric fleets managed by intelligent, adaptive systems. Cross-sector collaboration and thoughtful deployment strategies will be essential to unlocking the full potential of the electric mine to deliver transformation that is both sustainable and commercially viable.

Foundations of a new mining era

The mining sector is undergoing a profound change, driven by the convergence of two pivotal trends: digitalisation and electrification. These forces are reshaping traditional mining paradigms, ushering in a new era defined by enhanced efficiency, sustainability and operational agility.

Unlocking the power of data

At the core of mining's digital transformation is the rapid growth in data generation and the increasing capacity to use it effectively. For electric mines, this shift is fundamental. Modern minesites equipped with sensors and connected systems generate vast streams of information from electric vehicles, charging stations, power distribution networks and environmental monitors. This real-time data is essential for tracking asset health, energy performance, emissions and interactions with the grid.


Image: Andrey Popov

Advanced analytics and artificial intelligence are playing a growing role in making sense of this complexity. These technologies turn raw data into predictive insights, helping operators spot battery degradation early, identify charging inefficiencies and prevent unplanned maintenance. The result is improved safety, fewer interruptions and better use of equipment across the fleet.

Digital twins, or virtual models of electric mine systems, allow companies to simulate charging patterns, equipment loads and integration with power infrastructure. They make it possible to test strategies before applying them in the field, reducing operational risk and speeding up innovation.

Live data also supports better route planning and coordination of electric vehicles, especially in automated or semi-autonomous operations. Yet barriers remain. Many operators still contend with fragmented systems, outdated infrastructure and limited connectivity, which slows the digital shift needed to support electrification.

Advanced analytics and AI turn raw data into predictive insights, helping operators spot battery degradation early, identify charging inefficiencies and prevent unplanned maintenance

Addressing these issues requires robust digital infrastructure and closer collaboration across disciplines. Building workforce skills to manage both electric and digital systems is equally important. Aligning electrification with data-driven tools and systems is essential if mining is to achieve its goals for safety, sustainability and operational excellence.

The necessary leap towards sustainability

Parallel to digital advancements, the electrification of mining equipment is accelerating, driven primarily by the imperative to reduce carbon emissions and improve operational economics. Consequently, traditional diesel-powered fleets are increasingly being supplemented, or even replaced, by battery-electric and hybrid alternatives.

Electrification offers several distinct advantages, not least electric drivetrains are mechanically simpler than combustion engines, leading to lower maintenance demands and improved reliability. This reduced mechanical complexity translates into fewer failure points, improving equipment availability and uptime; these improvements directly affect the bottom line by lowering maintenance costs and increasing production efficiency.

Environmental benefits are also significant, whereby the electrification of haul trucks, loaders and drills reduces onsite greenhouse gas emissions, thereby improving air quality and worker health. This is particularly impactful in underground mining, where ventilation to remove diesel exhaust represents a major operational cost and safety concern. Shifting to electric fleets can therefore yield both ecological and financial returns.

It is important to note, however, that the transition to electrification is nuanced and site-specific. Not every technology suits every application; factors such as haul distance, site topology, infrastructure readiness and regional energy availability influence the choice between battery-electric, hybrid, or alternative fuel solutions like hydrogen. Flexibility in approach remains crucial to achieving both decarbonisation and operational targets.

The importance of pragmatic, application-driven strategies should not be underestimated. Rather than betting on a single technology, companies would be wise to evaluate multiple options to identify scalable, serviceable, and economically viable solutions tailored to their specific mining context. For example, Komatsu's layered transition – from diesel to hybrid, battery-electric and now trolley-assist – demonstrates a deployable, flexible electrification strategy. By pairing down-slope energy recuperation with stationary charging options, it is ensuring solutions are future-proof and tailored to varying haul routes, terrain and fleet needs.

Integration of digital and electric technologies

Electrification and digitalisation are not parallel trajectories but deeply interconnected elements of the mining transformation. The full potential of electric mining equipment is realised only when integrated with digital systems that manage energy consumption, vehicle scheduling and predictive maintenance.

Charging infrastructure and energy management platforms are critical to electric mine viability. These systems coordinate the timing and power delivery for fleets of battery-electric vehicles, optimising usage to minimise downtime and energy costs. Digital controls also facilitate renewable energy integration, leveraging solar or wind power where available to further reduce carbon footprints.

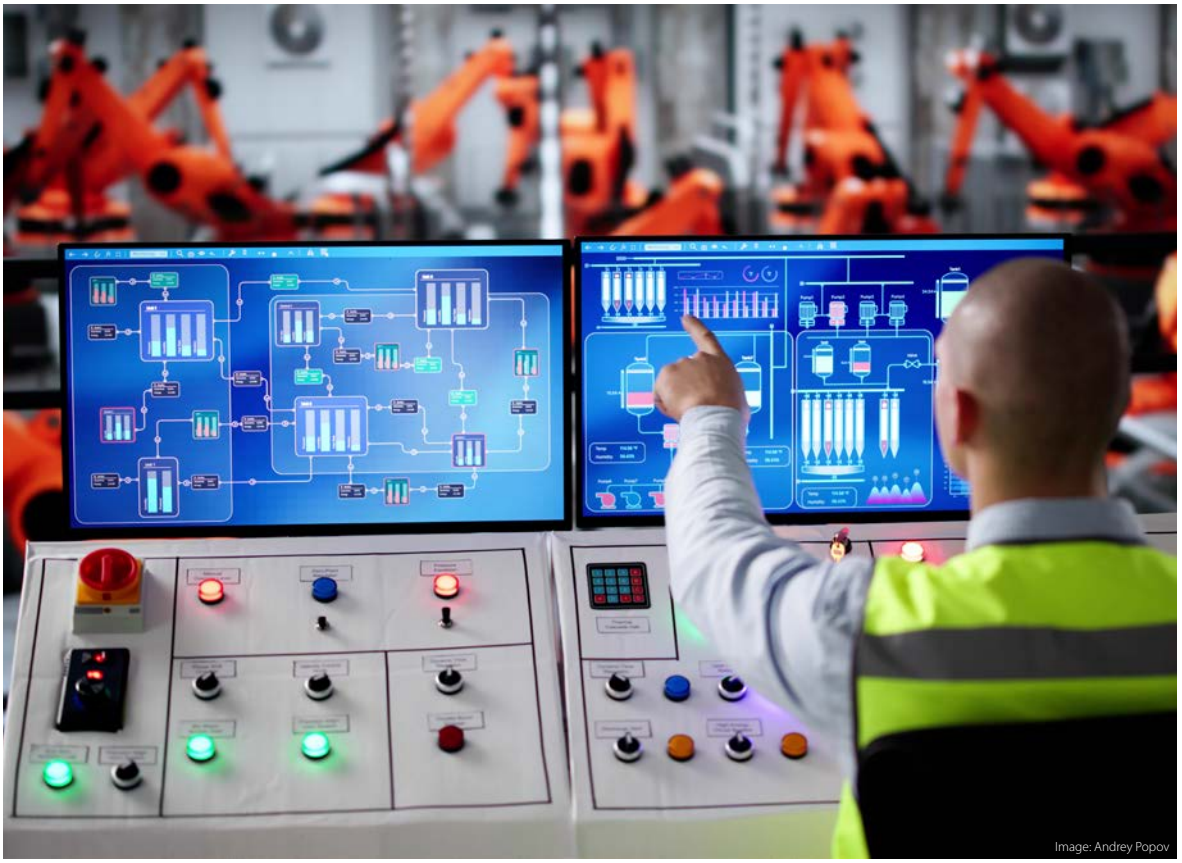
Image: Andrey Popov

The concept of the electric mine extends beyond replacing diesel engines with batteries. It encompasses a holistic rethinking of the mine as a digitally connected ecosystem, where energy flows, equipment status and operational data are synchronised to drive continuous improvement. Moreover, leading equipment manufacturers are reorganising internally to reflect this systems perspective, with cross-functional teams coordinating electrification, automation and digital innovation to avoid siloed development.

Balancing operational realities and innovation

Mining companies face a complex balancing act between embracing innovation and meeting stringent operational and financial targets. While sustainability imperatives push for faster electrification and digital adoption, capital discipline and risk aversion temper the pace of change.

The economic value proposition of new technologies must be clearly demonstrated. This is why operators prioritise total cost of ownership, factoring in maintenance savings, energy costs and productivity gains alongside capital outlays. For example, the simplicity and reliability of electric drivetrains often yield higher machine availability, which can offset upfront investment.

Workforce readiness is another critical factor. The shift to electric and digital mining demands new skills in electrical engineering, data analysis and digital operations, such that training and change management become as important as technology deployment.

Additionally, mines operate under widely varying conditions globally. Smaller regional operations or those in remote areas face unique constraints, such as limited grid infrastructure, which require modular and flexible solutions.

Electrification of mining equipment and environmental sustainability

Beyond concept to practical deployment

The shift toward electrification in mining is no longer a future vision, but an active and accelerating reality. Across the globe, mining operators are incorporating battery-electric and hybrid equipment into their fleets, driven by a complex interplay of environmental imperatives, operational benefits and technological maturity.

Electric haul trucks, once a niche experiment, are increasingly becoming mainstream in surface mining operations. These machines demonstrate how electrification can reduce emissions while maintaining or improving productivity. The industry's progress, however, demands a pragmatic understanding of where and how electric equipment delivers the most value.

Electrification is rarely a one-size-fits-all solution. Factors such as haul route length, grade, loading practices and site power availability significantly influence the effectiveness of electric machinery. For instance, battery-electric trucks are particularly effective in mines with shorter haul cycles or where opportunities for onsite renewable energy integration exist. In contrast, hybrid solutions may provide an optimal bridge in locations with longer haul distances or challenging terrain, by combining electric drive benefits with combustion engine endurance.

Operational and economic benefits: the business case for electrification

As well as mechanical simplicity translating into lower repair costs and increased machine availability, a more consistent torque delivery from electric motors also improves operational efficiency. For example, electric haul trucks exhibit better acceleration and grade performance, delivering equivalent or reduced cycle times and fuel consumption than their diesel counterparts. In addition, the quieter operation of electric vehicles improves onsite working conditions, contributing to workforce well-being and safety.

Financially, while capital expenditure on electric equipment and supporting infrastructure remains higher, the total cost of ownership is increasingly competitive. Reduced fuel costs, maintenance savings and improved uptime contribute to a positive return on investment over the lifecycle of the machinery. Mining companies with long-term fleet plans are leveraging these savings to justify electrification transitions within their capital programmes.

Nevertheless, initial investments in charging stations, power upgrades and energy management systems require careful planning and alignment with site capabilities. Ensuring a reliable, scalable energy supply is critical – for example, by integrating with renewables or grid enhancements to reduce emissions and lower operational energy costs.

> **Advanced digital energy management systems help to smooth demand and enable higher penetration of intermittent renewables such as solar and wind**

Toward net zero mining

The mining industry faces mounting pressure from governments, investors and communities to reduce greenhouse gas emissions. Electrification plays a pivotal role in achieving these net zero ambitions, offering a direct pathway to decarbonise onsite mobile equipment, traditionally responsible for a significant share of emissions.

By eliminating diesel combustion, electric vehicles cut scope one emissions onsite. Coupled with renewable energy adoption or low-carbon grid power, this also reduces scope two emissions related to electricity consumption. Advanced digital energy management systems help to optimise this energy usage, smoothing demand and enabling higher penetration of intermittent renewables such as solar and wind.

Mining companies are increasingly adopting holistic strategies to tackle emissions across scopes one, two and three, which includes upstream emissions in the supply chain and downstream impacts. Electrification intersects with these goals by fostering a cleaner operational footprint and facilitating resource efficiency improvements that reduce the overall carbon intensity of mined materials.

Beyond carbon, electrification improves onsite environmental quality, with reduced diesel particulate matter lowering health risks for workers and surrounding communities. Decreased noise pollution contributes to a safer, less disruptive mining environment, especially near residential or ecologically sensitive areas.

Digital solutions in environmental monitoring and emissions tracking

Digitalisation complements electrification by providing sophisticated tools for environmental stewardship. Real-time monitoring of emissions, energy consumption, and resource usage enables more precise management and reporting, essential for regulatory compliance and stakeholder transparency.

Advanced sensor networks track particulate levels, greenhouse gas emissions and water usage, feeding data into analytics platforms that identify inefficiencies or potential environmental risks. This insight supports proactive interventions, reducing the likelihood of costly environmental incidents and enhancing sustainability performance.

Predictive models integrated with digital twins can simulate environmental outcomes under various operational scenarios. These tools guide decision-making on energy sourcing, equipment scheduling and site layout to optimise both productivity and environmental impact.

Addressing challenges

Despite the clear benefits, several challenges hinder widespread electrification adoption. One of the primary barriers remains the need for substantial upfront investment in both equipment and supporting infrastructure. Establishing charging stations, upgrading site power networks and integrating energy storage solutions require capital and time, which may strain operational budgets and planning cycles.

The complexity of retrofitting existing mines with electric equipment further complicates adoption. Mines often have legacy infrastructure not designed for high-capacity electric power demands. Phased or hybrid deployment strategies that incorporate modular electrification solutions can mitigate these challenges, allowing operators to balance risk and investment.

Skills shortages represent another significant hurdle. Electrification and digital integration require specialised expertise in electrical engineering, power management and data analytics, often necessitating workforce retraining or new talent acquisition. Mining companies and technology providers are collaborating to build capabilities through training programmes and cross-industry partnerships.

Thought leadership in practice

It is illustrative that global leaders in mining equipment and energy management are converging on these approaches. Manufacturers like Komatsu are deploying application-driven, power-agnostic platforms, enabling flexibility across diesel, hybrid and battery-electric haul trucks. This pragmatic strategy prioritises trolley-assist systems and stationary charging solutions, offering operational adaptability while accelerating the journey to carbon neutrality.


Image: Poco_bw

Komatsu's integrated perspective highlights the importance of aligning electrification with real-world operational demands, emphasising modularity and system-wide integration over one-size-fits-all solutions.

Concurrently, Schneider Electric emphasises interoperable modular infrastructure and the seamless integration of automation and power systems through its EcoStruxure platform. Its whole-of-lifecycle approach – from design to operation – enables phased and hybrid electrification, even in grid-constrained sites. Through advanced microgrids, energy storage and intelligent load management, Schneider Electric ensures resilient, low carbon operations aligned with scope one, two and three emission targets.

Schneider Electric's work highlights the importance of an open, interoperable architecture that supports endpoint-to-cloud visibility, avoids vendor lock in and ensures future scalability in dynamic mining environments.

Together, these perspectives reinforce the central theme: electrification in mining is a complex, multi-dimensional challenge requiring systems thinking, collaboration across disciplines and measured, data-driven execution.

The future of electric mining equipment

Advances in battery technology continue to lower costs, improve energy density and reduce charging times. Complementing this, fuel cell technologies, including hydrogen, are gaining momentum as potential solutions where battery electric systems face practical limitations.

The integration of autonomous operation with electrification promises further efficiency and safety gains. Komatsu's world-first autonomous trolley truck marks a breakthrough that combines autonomy with electrification, demonstrating the company's commitment to scalable, flexible solutions that adapt dynamically to site conditions, improve energy efficiency and advance long-term decarbonisation goals.

Simultaneously, Schneider Electric drives innovation in energy management that enables renewable microgrids and battery storage, reducing reliance on fossil-powered grids. Through its intelligent EV charging infrastructure, predictive energy coordination and ecosystem of partners, Schneider Electric builds sustainable and resilient power platforms essential for scaling electric fleets, especially at remote or constrained mine sites.

Looking forward, regulatory frameworks and carbon pricing mechanisms are expected to accelerate investments in electric and digital technologies. Mining operations that proactively adopt these innovations are better positioned to meet tightening emissions standards while unlocking operational efficiencies and enhancing long-term resilience.

Challenges, implementation and outlook

From innovation to adoption

The journey toward fully electrified mining operations is marked by significant hurdles that extend beyond technology alone. While innovations in battery-electric vehicles, hybrid systems and digital tools have matured rapidly, the practical deployment of these advances faces multi-faceted challenges rooted in infrastructure, economics, workforce and risk management.

A key constraint remains the scale and readiness of power infrastructure at many minesites. Mines are often located in remote regions with limited grid capacity or reliability. Upgrading or extending power supply to support energy-intensive electric fleets is capital-intensive and logistically complex. These infrastructure demands can delay or complicate electrification projects, particularly for smaller or regional operators without the financial flexibility of larger miners.

This infrastructural challenge underscores the importance of phased, flexible approaches to electrification. Deploying hybrid fleets or modular battery systems can ease transitions while accommodating site-specific power limitations. Meanwhile, energy management systems that optimise demand and integrate onsite renewable energy sources further mitigate grid dependency and support sustainability goals.

Investment and financial considerations

The high upfront capital expenditure required for electric equipment and supporting infrastructure remains a significant barrier. Unlike conventional diesel fleets, electric mining vehicles and charging installations demand substantial initial outlays. Even with promising total cost of ownership benefits over the lifecycle, the timing and scale of these investments can strain mining companies' capital allocation strategies.

Financial decision-makers must balance near-term budget constraints with long-term operational savings and environmental compliance requirements. In this context, clear, data-driven business cases supported by real-world pilot projects are essential to demonstrate not only the emissions reductions, but also the tangible economic advantages of electrification.

Leasing models, financing innovations and partnerships between miners, OEMs and energy providers will assist in alleviating these upfront costs, with such structures spreading the financial risk and aligning incentives for ongoing performance improvements.

Image: Alfio Manciagli


Image: Scharfsinn86

Skills and workforce transition

Electrification's shift from mechanical to electrical and software-intensive systems necessitates new workforce capabilities. Traditional maintenance crews and operators require retraining to handle high-voltage systems, battery management and digital control interfaces. However, the shortage of these specialised skills is a bottleneck that mining companies must address proactively.

Mining and technology partners must better collaborate on training programmes, apprenticeships and knowledge transfer initiatives, since cultivating such a workforce adept at both mining operations and advanced electrification technologies will be crucial to sustaining and scaling the transition.

Bridging innovation and real-world performance

The electric mine of the future will not be built on innovation alone. Rather, success depends on how rigorously new technologies are tested in live operational settings and refined to withstand mining's demanding conditions. Leading OEMs like Komatsu employ a layered, field first approach that tests diesel, hybrid, battery and trolley options for real-world operability and ROI. This methodical deployment ensures solutions are technically viable, commercially scalable and aligned with emission goals, always prioritising value creation over hype.

The complexity of mining electrification requires a systems perspective that integrates equipment with site layout, energy sources and digital infrastructure. Companies like Schneider Electric advocate for holistic solutions that tie together power systems and automation to future-proof operations, particularly at sites with constrained grids or phased transitions.

At the regulatory level, emissions standards and carbon pricing frameworks are reshaping project economics, with investors and communities increasingly favouring miners with credible, transparent and well-executed decarbonisation strategies. This makes the ability to demonstrate measurable emissions reductions, operational cost efficiencies and ESG alignment not just preferable, but an imperative for long-term viability.

The electric mine is not a distant goal, but an evolving operational model. Companies that fuse innovation with practical execution, data-driven planning, cross-functional integration and long-term resilience will define mining's next era. By embracing a disciplined, whole-of-system transformation that adapts to real-world complexity, both environmental sustainability and productivity gains can and will be achieved.

Forging the future: how Komatsu is navigating surface mining's path to decarbonisation

In surface mining, decarbonisation is no longer theoretical. It is a real operational challenge, especially in haulage systems. For Komatsu, one of the industry's heavyweights, the question is not if, but how, and just as importantly, where and when emissions reductions can be achieved without compromising productivity or cost-efficiency.

Anthony Cook, vice president of sales and marketing for Komatsu's Surface Haulage Business Unit, said: "At the end of the day, we have to provide a solution that's valuable to the customer. That value has to be economically viable, not just socially responsible."

That reflects a sector in transition. Operators face pressure from regulators, investors and communities to reduce emissions, but are still bound by capital discipline and performance targets. For Komatsu, the path forward is about precision.

Powering the change: a pragmatic approach

Komatsu's approach is built on customer-driven innovation across battery electric, hybrid, hydrogen and alternative fuels. The focus is on scalable, serviceable and regionally viable solutions.

Hybrid systems, such as regenerative energy storage, show promise in specific use cases like downhill haulage. Cook said: "There might be applications where it looks like a stronger value case, and we're evaluating this. But we want to make sure of the value to our customers before we put it out there."

Battery electric development is also progressing, focused on the 930-class haul truck, a fleet mainstay. "We picked the 930-class because of its applicability and broad market acceptance. It gives us the best chance to understand how to deliver value at scale because of how successful this truck has been, and how well we know and can support this truck platform," Cook said.

Komatsu's strategy is application-first. "It will be very application and customer-driven, first and foremost. We have such a variety of customers globally and we need to understand what their objective is. Is it carbon reduction? Cost per tonne? Total cost of ownership? We aim to provide a haulage solution that serves the comprehensive needs of our customers," he added.

This demands flexibility in design. Komatsu is introducing a power agnostic truck platform that lets customers select the most suitable power source as technology and infrastructure mature.

Cook explained: "Combustion engines will still be a solution for many decades to come. We have to be honest with the constraints of electrification, and when alternate fuels are available to show the value case. It is not practical if you cannot supply the fuel or power."

Integration, not isolation

Komatsu sees decarbonising haulage not as a simple diesel to battery switch, but a complex systems challenge. Infrastructure, energy sourcing, digital tools and autonomy all influence what is possible.

This complexity is reshaping Komatsu internally. The company has restructured to support cross-functional innovation. "We have a strategic group in the mining technology division that works across business units, and centres of excellence focused on electrification and other emerging technologies to ensure the best solutions are being deployed group wide," Cook said.

The business of better

Komatsu's strategy links emissions reduction with business performance. Electrification, when correctly matched to the application, can reduce costs, cut maintenance and increase machine availability.

Cook pointed to the simplicity of electric drivetrains: "If you look at a combustion engine side by side with a battery, and the complexity involved in generating power, certainly the battery technology is appealing."

Fewer components mean fewer failure points. "There are quite a few percentage points in machine availability that you can gain if you can deliver reliable battery power," he added.

However, no solution will be released without rigorous field testing. "We want to make sure our solution is either the same or better than existing diesel-powered options. You could argue it has to be better than what we have today. Otherwise, why take the risk?" Cook said.

More than technology: a broader opportunity

For Cook, decarbonisation is also a route to wider innovation. Electrification and autonomy are not separate goals, but converging ones. The vision is a responsive system that adapts in real time to variability across a site.

"The Holy Grail is having an electrified autonomous fleet that optimises power consumption, regeneration

The 930E PADT by Komatsu is power agnostic

Komatsu's 930E PADT can be deployed with trolley assist

and charging to achieve an endless haul cycle that responds in real time to changes in operational conditions, such as weather, production and maintenance requirements. We have some of these elements today such as autonomous and fleet management, but it all needs to come together with the next generation of technology and platforms."

This systems approach could unlock improvements in efficiency, safety and agility far beyond emissions.

Decarbonisation as discipline

Komatsu's haulage decarbonisation strategy avoids showmanship. It is driven by engineering discipline, real-world testing and commercial logic.

While some may expect bold declarations, Komatsu sees decarbonisation not as a sprint but as a long-term shift in how mining works.

Technologies such as hybrid trucks or battery electric drivetrains are being developed not for novelty but because, in the right context, they deliver.

Cook summed it up: "We have to deliver value. It is not enough to say something is lower carbon. If it does not reduce cost per tonne with high availability, or cannot be serviced reliably, it is not a solution."

That value filter guides every decision, from product platforms to how Komatsu shares knowledge across its teams. Insights from underground battery programmes support surface haulage development. Centres of excellence coordinate innovation beyond traditional silos.

This is not disruption for its own sake. It is strategic constraint, with decarbonisation treated as a design input rather than a slogan. It prompts important questions: what does readiness mean? How is risk shared? Can new technology scale across decades-long fleets?

Prototypes alone cannot answer these. Komatsu's focus on system-wide impact and proven performance suggests that real success will come not from speed, but from purposeful progress.

"Change is inevitable," Anthony Cook said. "What matters is that we're not guessing. We're learning, testing, and proving. "The industry won't be transformed by grand declarations, but by deliberate, data-driven decisions."

The Power Agnostic 930E redefines mining equipment standards by seamlessly supporting a wide range of current and future power sources.

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Our changing planet demands innovative solutions to fuel a sustainable and responsible industry. Together we can rise to the challenge.

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Power, process, progress: Schneider Electric's vision for the electric mine

As the mining sector intensifies its efforts to reduce emissions and improve operational efficiency, Schneider Electric is at the forefront, enabling the shift to the electric mine. The company combines advanced electrification, renewable energy integration and digital energy management to help mines operate more sustainably and efficiently.

Four pillars of electrification

Schneider Electric global principal mining consultant Ella Kashi identifies four core efficiencies that underpin the company's electrification strategy: energy efficiency, process efficiency, carbon efficiency and resource innovation. These together form a comprehensive approach to transforming mining operations.

Energy efficiency involves optimising the way energy is used across a minesite. Schneider Electric's technologies allow mines to closely match energy consumption to operational needs, reducing waste and lowering overall energy use. This digital optimisation plays a vital role in cutting costs and emissions.

Process efficiency focuses on improving productivity by automating and integrating mining processes. By using smart automation and control systems, Schneider Electric helps remove bottlenecks and increase throughput, enabling mines to operate more smoothly and effectively.

Carbon efficiency is achieved by replacing diesel-powered equipment with electric alternatives, significantly reducing onsite greenhouse gas emissions. This transition is critical as mining seeks to lower its direct carbon footprint.

Resource innovation introduces new sustainable technologies such as renewable energy microgrids, battery storage and electric vehicles. These innovations accelerate the adoption of fully electric mining operations and support long-term sustainability goals.

Digital integration and open infrastructure

At the heart of this strategy is the integration of energy and automation systems. Kashi explained that integrating these domains "allows mines to synchronise their energy consumption directly with operational demands". This synchronisation optimises energy use, enhances productivity and supports sustainable mining practices.

Flexibility is another key component. Schneider Electric advocates for open, interoperable infrastructure that enables mines to adopt electrification incrementally. This modular approach avoids vendor lock-in and allows operators to scale their electric capabilities progressively, adapting to their unique circumstances and financial constraints.

From vision to execution

Schneider Electric's expertise is demonstrated in projects such as the implementation of a renewable microgrid at a remote lithium mine, undertaken in collaboration with Wärtsilä. This project highlights the importance of holistic lifecycle planning, robust operational performance metrics and strong partnerships to successfully electrify mining operations in challenging environments.

Reliable energy supply remains a major challenge, particularly for remote or grid-constrained mines. Schneider Electric addresses this by deploying advanced microgrid technology, energy storage solutions and intelligent load management to ensure a stable and resilient power supply. This approach reduces reliance on fossil fuel-based grid power and enhances operational continuity.

Renewable energy integration is a key pillar of Schneider Electric's vision. The company supports mining clients in incorporating solar, wind and other renewables alongside energy storage and sophisticated management systems. This reduces the carbon intensity of mining and helps clients meet stringent sustainability targets.

Electrification also benefits water management by reducing cooling needs and dust generation while enabling advanced digital water recycling technologies. This improves water efficiency, a critical advantage in regions facing water scarcity.

Finance, fleets and future outlook

Financially, Schneider Electric helps mining operators manage the balance between upfront capital expenditure and ongoing operational costs. By

providing detailed total cost of ownership analyses, phased implementation plans and innovative financing models such as Energy as a Service, the company ensures investments in electrification deliver strong, sustained returns.

As electric vehicle fleets become more widespread, Schneider Electric offers scalable charging infrastructure and intelligent energy management. Integrated with renewable microgrids and predictive maintenance systems, these solutions enable reliable, efficient electrification of mining equipment.

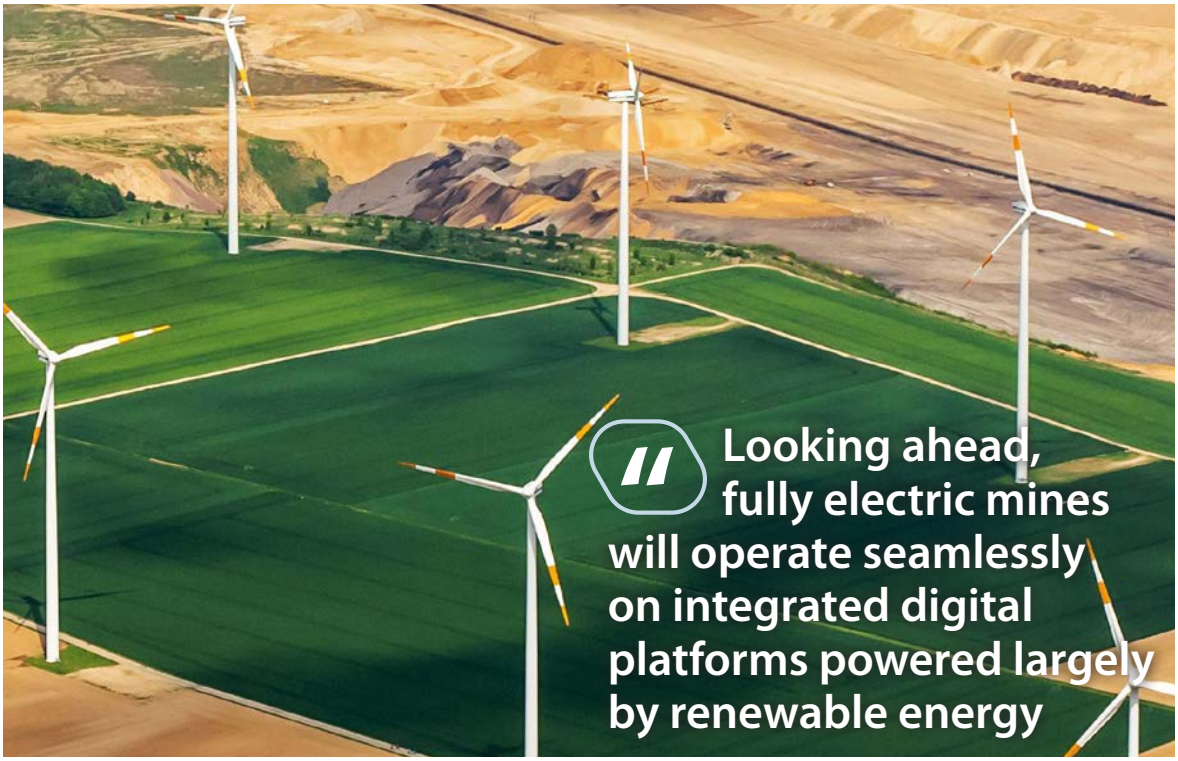
Supporting clients throughout the electrification journey is crucial. Schneider Electric's whole-of-lifecycle approach covers everything from initial design through implementation to ongoing operation and optimisation. Digital tools for predictive maintenance and continuous monitoring help maintain resilience and minimise downtime during the transition to electric systems.

Electrification solutions are not just for large miners. Schneider Electric provides modular, scalable technologies and flexible financial options that allow smaller and regional mining companies to adopt electric systems in a way that suits their scale and budgets.

Beyond onsite operations, Schneider Electric promotes sustainability in supply chains through initiatives like the Materialize programme. This programme works with critical mineral suppliers to reduce emissions and encourage decarbonisation strategies, supporting circular economy principles and responsible sourcing.

Looking ahead five to 10 years, Kashi foresees fully electric mines operating seamlessly on integrated digital platforms powered largely by renewable energy. Schneider Electric will be central to this future, providing the digital architecture, renewable energy infrastructure, lifecycle services and intelligent energy management systems required for sustainable and efficient mining.

By combining technology innovation, open architecture and strategic partnerships, Schneider Electric empowers mining clients worldwide to embrace electrification. Its comprehensive focus on energy, process, carbon and resource efficiencies paves the way for a new era of sustainable mining that balances economic performance with environmental responsibility.



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