An untapped goldmine: opportunities for South African mining

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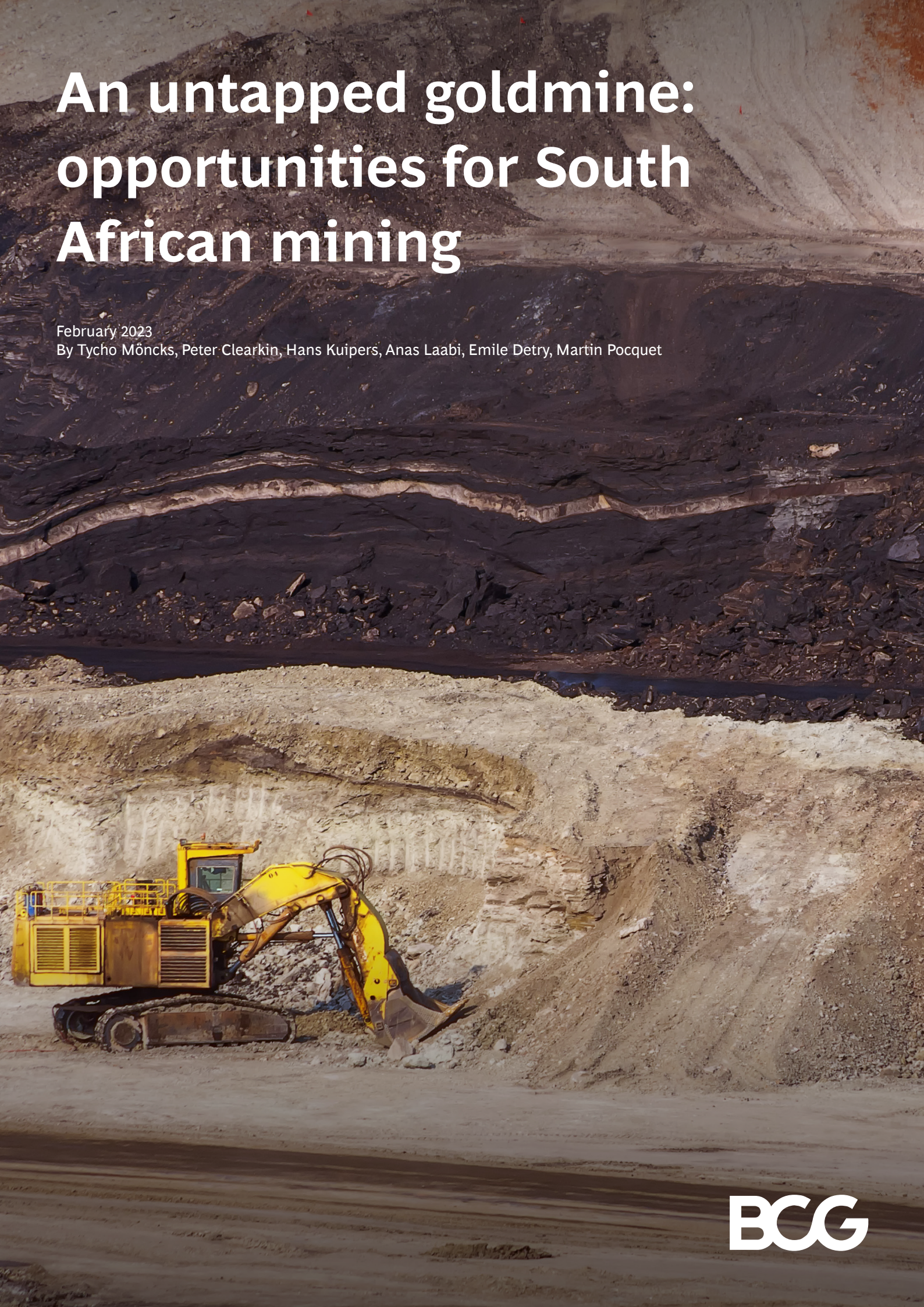

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The potential of South African mining

Historically, the mining sector has contributed significantly to South Africa's economic growth and employment, supported by a rich natural endowment of mineral resources, including Platinum Group Metals (PGMs), gold, iron ore, and manganese. Currently, the mining sector remains an important engine of South Africa's economy, contributing ~8% of GDP and providing direct employment to roughly half a million people.

The South African mining sector also has the capacity to contribute to future growth: as developed economies seek to diversify their supply of critical minerals away from Russia and China, and with its variety of mineral deposits, South Africa has the clear potential to strengthen its position as a supplier of critical minerals, such as PGMs, vanadium, manganese, copper, and nickel. Additionally, early exploration has indicated that there might be potential endowments of future-relevant resources, such as cobalt and magnesium.

Despite the opportunities presented by the mining sector, the industry faces enormous challenges as it seeks to sustain and grow its position. Large-scale investments and strategic partnerships will be required to unlock the value at stake in the mining sector, and certain prevailing roadblocks must be mitigated. We have identified nine overarching challenges that constrain the development of South Africa's mining sector to its full potential, as shown in Exhibit 1. While all nine challenges will need attention and action from public and private stakeholders, three areas stand out where mining companies can take decisive action in the short term: improve exploration to uncover new resources and reserves, address the currently unreliable and unsustainable energy situation, and enhance the cost position of day-to-day mining activities. This paper investigates these three areas in greater detail, with recommendations and tangible examples of how mining companies can act decisively to strengthen their competitive position.

Exhibit 1 - **Roadblocks** | Call for decisive action especially on three focus areas

Focus Area

Limited exploration

1 Poor quality and outdated geo-maps inhibit exploration for high-demand resources

Unreliable, costly and CO2-intense electricity

2 Unreliable power, rolling loadshedding reliant on carbon-intense generation, costly tariff increases

Not cost competitive

3 SA's mining is comparatively expensive due to structural and local problems

Uncompetitive policy with heavy com. dev.[1] needs

4 Uncertainty in policy; need to streamline processes and enhance transparency

Wanting talent pool

5 Funding for skills development and capacity building is limited

Poor perception of South Africa

6 Overarching perception of South Africa as a complicated location for investment

Illegal activities and corruption

7 Illegal mining, criminal activities and corruption threated safety and security

Unreliable infrastructure

8 Deteriorating transport infrastructure (ports, rail) limits competitiveness

Aging mining sector

9 Various assets are nearing end-of-life, requiring substantial investment

Addressing roadblocks to growth for South African mining

Limited exploration activity

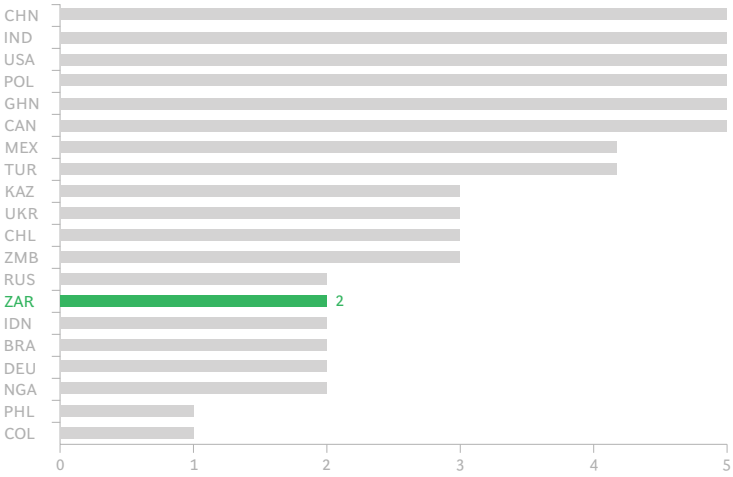
Poor quality geo-maps and suboptimal cadastral system setup inhibit exploration for high-demand resources.
According to SNL data on mining exploration maps, South Africa scores poorly relative to international benchmarks with a score of 2, significantly lower than China (score of 5), as well as an average of 3.2 across the sample of countries[1]. This problem is exacerbated by an antiquated cadastral system that is hard to access, with limited data granularity and poor data formats. This poor quality of prevailing geo-mapping and an outdated cadastral system cause a lack of exploration appetite, limiting the country's ability to uncover new deposits and identify new future-relevant mineral types to drive growth in the industry.

A renaissance in exploration is required to breathe new life into South Africa's mining industry. This resurgence in exploration will rest on improved analytics and new technologies applied to exploration, such as AI, which can enable more effective, cheaper, and faster exploration efforts.

[1] Sample of countries selected based on value of mineral production, excluding mostly petroleum-producing countries.

Exhibit 2 - Poor quality geomaps constrain exploration – AI as a mitigation measure

South Africa has poor quality maps relative to international peer group…



… but AI-based approach can increase exploration efficiency in the short run

Source: SNL data, BCG and analysis

Deep-dive: AI to enhance exploration success
An example of an emerging, analytically driven approach to increase efficacy and cost of exploration is combining satellite imagery (e.g., from Descartes) with drilling data sourced from mining companies. BCG is developing an integrated Artificial Intelligence (AI) approach to bring those two sources together, which helps to enhance exploration success even in the absence of diligent (cost- and time-intensive) geo-mapping efforts.

Expensive, unreliable, and unsustainable electricity

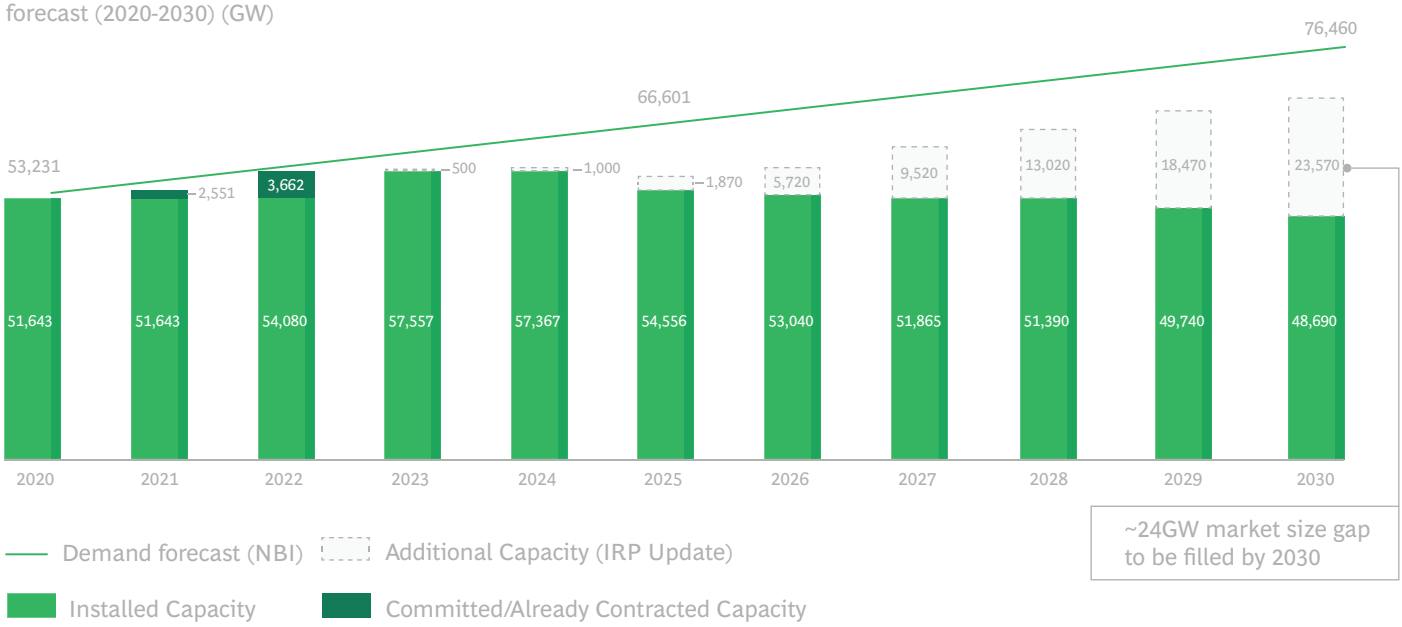
South Africa's electricity is costly, unreliable, and unsustainable, with costs the fourth highest among its peer group of mining countries, a record ~1600 hours of load-shedding in 2022, and coal-fired plants making up ~80% of installed capacity.

South Africa's unreliable electricity supply is a major barrier to growth in the mining sector – with ~1,600 hours of load-shedding and ~500 hours of load curtailment in 2022. Unfortunately, load-shedding is a reality the country likely must cope with for the foreseeable future as electricity demand growth expectations at ~2% CAGR meet supply constraints due to closures of aging coal plants and projections of worsening EAF towards 2025. Meanwhile, the building of renewable electricity and alternative energy sources will take time to fill the gap.

Exhibit 3 - Electricity supply gap expected to widen

Demand growth and supply constraints expected to create a widening supply gap

Electricity capacity – planned decisions vs demand forecast (2020-2030) (GW)



Source: Eskom annual report; Adjusted IRP data; IEA Data Services; CSIR Energy Centre; IPP Projects website, NBI-BCG Analysis

South African electricity is also among the most expensive of its peer group of mining countries, with costs per kWh higher than Australia and the fourth highest in our sample. With the recently approved tariff hike of ~19% by the National Electricity Regulator of South Africa (NERSA), these costs will only continue to rise. Additionally, the high prevailing share of coal power generation in South Africa's energy mix will penalise local (mining) companies. As key regions adopt carbon border taxes and other instruments in the fight against climate change, the relative competitive position of materials mined and processed in South Africa decreases. This creates a clear imperative for the South African mining sector to transition towards cleaner and more reliable sources of electricity, such as through renewable self-generation. South Africa's current energy policies enable electricity to be generated by businesses for their own consumption, and miners are already seizing the opportunity for cleaner, more reliable electricity. For example, Gold Fields was among the first with a 40 MW solar build at its Westonaria-based South Deep facility, while larger projects have been initiated by Anglo American (with a pipeline of ~600 MW of projects in partnership with EDF Renewables) and Rio Tinto (~150 MW for Richards Bay Minerals assets). To further facilitate investments in renewable generation for their facilities, mining companies will benefit from policy support from the government to fast-track licensing applications and provide regulatory certainty on embedded generation. Even with today's policy landscape, though, investments in renewable energy sources by mining companies can make a meaningful difference.

International cost competitiveness

South African competitiveness in international markets is diminished by high costs and low productivity – but this can be turned around by new technologies and advanced analytics.
Digital technologies, especially in labour-intensive industries like mining, are often perceived as primarily reducing jobs in the respective sector. However, digital technologies applied to mining operations can enable substantial improvements in productivity and recovery, conserving mining operations' competitiveness and ensuring they are commercially sustainable in the future. In addition, specific digital interventions such as enhancing recovery can be net-positive. Embracing the digital transformation will allow the mining sector to remain a sustainable employer in South Africa and advance towards higher-skilled job profiles and safer working environments.

Artificial intelligence (AI) and advanced analytics have several high-potential use cases in the mining sector that South African miners should prioritise to boost international competitiveness. Mining companies that invest in AI and advanced analytics in their maintenance and operations activities seek to unlock significant value from increased productivity. Critically, these tools can also be designed to work even with limited or incomplete data sets and can positively impact a variety of mining companies with differing levels of digital maturity. Jointly with mining clients, BCG has successfully applied these tools in global mining contexts with two key use cases explored in this paper: advanced analytics in mining operations and AI in maintenance activities.

Use Case 1: Advanced analytics in mining operations at Endeavour.

Operations processes have the potential for significant improvements in their performance and efficiency thanks to advanced analytical models, and mining companies that invest in advanced operational optimisation can unlock a step-change in their cost competitiveness. One example of a mining company that has embarked on an ambitious journey to unlock the value-at-stake in digital operations solutions is Endeavour, one of the largest miners in the West African region. BCG and Endeavour together built advanced AI and analytics tools to increase the productivity of gold mining processes, especially in blending and milling – boosting throughput and enhancing recovery.

To improve the performance of Endeavour's blending facilities, BCG applied an optimisation model that defines the best blend to process based on key process constraints. Specifically, the model is provided with a "budget" or monthly target for gold production, as well as key process criteria, such as limitations on the levels of copper or arsenic in blending mixes. Using Machine Learning, the model is also able to estimate the gold produced by a blend, incorporating both linear and non-linear effects of external factors, such as rock quality and even rainfall. This model was able to substantially improve blending efficiency, increasing gold recovery rate by ~2 percentage points.

BCG also built a "digital twin model" based on Machine Learning to optimise Endeavour's SAG mill. This model uses a data-driven approach, including information about the mill itself and other constraints to estimate the throughput of material and predict optimal parameters to maximise throughput. The model offers several advantages over a manual process, improving operator reaction times and allowing for a greater understanding of the mill's behaviour, while also increasing throughput by ~2% relative to historic levels.

Case Study | AI and analytics boost productivity & recovery

	Blend Optimisation	SAG Mill Optimisation
Description	A Machine Learning and optimisation model to **maximise gold production** by defining the best blend to process, respecting process constraints	A Machine Learning and optimisation model to **maximise gold production** by defining the best blend to process, respecting process constraints
Benefits	• Move from manual selection of daily blend to automatic selection based on process constraints and targeted production • Increase ability to have longer-term view, e.g., have full vision of monthly budget	• Improve operator reaction time with data driven approach • Optimise throughput under operational constraints • Understand SAG Mill behaviors better and enable real-time adjustments
Impact	**+1.9pp** recovery	**+2%** Throughput

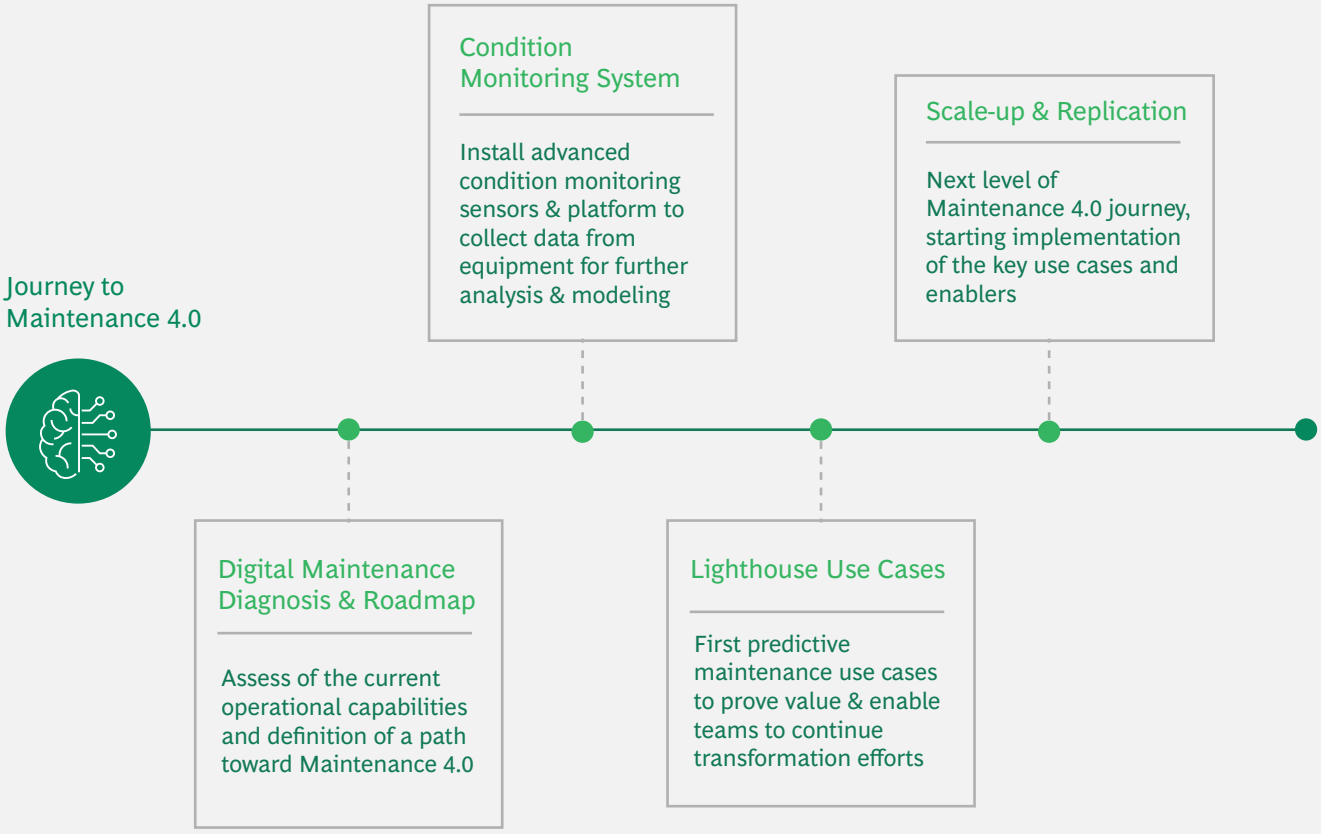
Source: BCG case experience

Use case 2: AI in maintenance.

Process optimisation is not the only part of mining companies' operations that can be improved through AI and advanced analytics. Maintenance is a critical part of a mining company's operations, with improper maintenance contributing to costly unplanned outages. Knowing when maintenance is needed – and what maintenance is most pressing – is critical.

To improve the quality of their maintenance operations, BCG has invested in capabilities to build AI-based maintenance models. This offering starts with an initial assessment of current operational capabilities, with a defined path towards Maintenance 4.0, through the installation of advanced condition monitoring systems to collect detailed equipment data and linking this data to AI tools with initial predictive maintenance use cases. AI-based predictive maintenance employed in this way can unlock substantial value by preventing equipment outages and optimising maintenance time: with an estimated 5-10% increase in production and >20% savings in maintenance and spare parts costs on lines where the model is applied. This experience will be delivered to other clients by BCG as a journey to Maintenance 4.0 (Figure 5).

Case Study | The journey towards AI-drive maintenance at a mining company



Tangible business value associated with AI-driven maintnance

5-10%
Production increase[1]

>20%
Maintenance & spare parts costs savings

[1] On lines where model is applied, not total production

Source: BCG case experience

South Africa will need support to reinvigorate the local mining sector

South Africa's mining sector will not be able to develop without support, in both investments and partnerships.
South Africa's mining industry faces several critical roadblocks to sustaining and strengthening its role as a substantial contributor to economic growth and social advancement in the country. Nonetheless, a step change is possible by focusing on the biggest roadblocks impeding growth: limited exploration, unreliable electricity, and uncompetitive costs. In these areas, mining companies have the capacity to unlock significant value by making the right investments in new exploration solutions, renewable energy, and advanced technologies.

While these problems are solvable, support will be required from international partners to achieve the required progress in a timely manner. Local miners will require support in the form of investments and commercial assistance, as well as non-financial support in the form of skills and technology transfers.

International partners willing to make these changes happen and embark on this journey with South Africa's mining industry can unlock significant value. South Africa is abundant in high-value materials, hence international partners can tap into a diversified source of supply for critical minerals. In this way, partnering with South African mining companies to support their development can be a win for international stakeholders, for South Africa's miners, and the broader South African economy.

About the Authors

Tycho Möncks is a Managing Director and Partner and core member of BCG's Industrial Goods practice, focused on metals and mining. Since joining BCG in 2007, Tycho has supported mining clients globally across a broad range of functional topics including strategy, operations, and organization. As a member of BCG's global Mining Leadership Team, Tycho drives the firm's mining practice in Africa, Europe, and the Middle East.

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