



INTERGOVERNMENTAL FORUM
on Mining, Minerals, Metals and
Sustainable Development



NEW TECH, NEW DEAL:

Mining policy options in the face of new technology

EXECUTIVE SUMMARY

THE COMING NEW TECHNOLOGIES

Throughout the history of mining, technological innovation has played a vital role across all cycles of mining projects. The new wave of technological adoption is a combination of evolutionary and revolutionary technologies, with an increasing focus on the latter.

An acceleration in investments in disruptive technologies in recent years has seen the large-scale mining sector finally catching up with a dynamic that has already advanced in many other sectors. The reasons for this shift include more difficult geology, declining ore deposits, the need to reverse a secular decline in productivity, the need to improve safety for mine workers, a need to manage environmental impacts, and—more recently—a reaction to pressures from the COVID-19 crisis.

The technologies in question are a suite of different innovations brought from other fields that work together in concert:

- Enablers of digitization such as radio-frequency identification (RFID) sensors, wearables, drones, and satellites.
- Users of big data such as machine learning and artificial intelligence.
- Integrators of big data such as 5G, the Internet of Things (IoT), systems management software, and blockchain technology.
- Process improvers such as automated machinery, electric vehicles, digital twins, water management and tailings recovery technologies, and renewable energy generation.

IMPACTS OF NEW TECHNOLOGIES

LABOUR IMPACTS

The impacts of new large-scale mining technologies vary according to the type of technology, the type of operation, the level of countries' development, and their social context, among other things. The labour impacts are hard to assess with certainty. But there will probably be fewer jobs in some fields, due to labour-replacing innovations such as automation, drones, and



the IoT. This means high risk for low- and semi-skilled occupations, and less risk for unskilled and highly skilled/specialized occupations. At the same time, there will be new higher-paying jobs created in high-skilled occupations such as information technology and engineering. It is worth noting that the large-scale mining sector will also have to face increasing competition from other sectors, such as the technology industry, that already attract more interest among the younger generation of workers. The final effects are more nuanced than a simple loss of jobs; they involve a dynamic restructuring wherein some jobs are lost, some are redefined, and some new jobs are created. A key tension is that the new jobs created may not be based in mining-affected communities or may not be accessible to locals who lack the requisite skills.

WOMEN'S PARTICIPATION IN THE MINING WORKFORCE

Technological change will affect women's participation in the mining workforce. Historically, the mining sector's overall workforce has been dominated by male workers for reasons that include the physical nature of the work, restrictive legal frameworks, cultural barriers, skills barriers, and gender-blind policies and work environments. Some aspects of the new technologies might erode those barriers, including the ability to work in urban remote operation centres. But others may jeopardize the work of semi-skilled women in communities that are mining dependent.

FISCAL IMPACTS

New technologies that reduce the workforce may have important negative fiscal impacts, reducing payroll taxes received by host governments. They may also increase revenues, given the higher pay earned in new jobs created—but only if those employees pay taxes in-country. The impacts on corporate income taxes are also uncertain and will be highly context specific. The shifting locus of value added along the value chain to foreign providers of new technologies and information services lowers taxable activities in host countries and creates a risk of increased opportunities for base erosion and profit shifting.

IMPACTS IN ARTISANAL AND SMALL-SCALE (ASM) OPERATIONS

New technologies will have a very different set of impacts in artisanal and small-scale (ASM) operations. If large-scale mining sheds low-skilled workers, many will flock to the informal sector, with social and environmental impacts that depend on the national policies and capacity for managing ASM. ASM producers may also face price pressures from increasingly efficient large-scale mines. The adoption of basic technologies in the ASM sector holds great promise for efficiency, worker safety, and environmental performance—areas in which ASM has traditionally struggled to perform. But productivity-enhancing technologies in particular also hold great risks for one of the areas in which ASM has traditionally outperformed large-scale mining: employment of large numbers of low-skilled workers, including a large share of women and youth. The potential gendered impacts are noteworthy, given the large presence of women in ASM in many developing countries.



ELEMENTS OF A NEW DEAL

If new technologies do lead to lower employment and other erosion of the value that mining activities bring to local communities and host countries, what policies might governments consider to rebalance the traditional “deal”? The policies assessed here fall into four broad categories:

- Policies aimed at ensuring that whatever employment is available in the mine of the future, and among suppliers, is contestable by locals.
- Policies aimed at leveraging mining activity as a route to ensuring economic diversification, and a reduced dependence on the large-scale mine as a provider of employment-related benefits.
- Policies aimed at rethinking tax revenue mechanisms from large-scale mining operations, and the possibility that such revenues might be used for local development purposes.
- Policies that find solutions to the challenges of new technologies in those technologies themselves.

EMPLOYMENT IN THE MINE OF THE FUTURE

Policies aimed at employment in the mining sector must clearly include a focus on redressing a troubling mismatch between existing locals’ skills and the skills needed in the mine of the future. This calls for a partnership approach, with universities and training institutions working closely with the mining industry to design and regularly review the training curricula, and governments consulting mining companies to better understand what skills are needed in light of investment plans. It also calls for good baseline data on the state of skills and the skills needed in future, with special attention paid to challenges and opportunities for women, locals, and marginalized populations. Almost all countries need to increase levels of spending on education, and increase the delivery of foundational skills in sciences, technology, engineering, and math, especially for women. A focus on lifelong learning is needed to equip workers for inevitable change. Governments should consider incentives for mining companies to conduct training, as well as mandatory training policies. Mining companies have a role to play as well, beginning preparation and discussions early in the process of transformation, and participating in training and upskilling. They will increasingly need to compete with other sectors to recruit and retain educated workers, in particular young women, with transferable skills.

Governments might also turn to familiar local content tools such as requirements to employ local workers, or obligations to procure local goods and services. However, while lower employment levels may make such policies more urgent, they also make them more challenging. Setting attainable employment or procurement targets might involve hitting a sinking target when dealing with technologies that lower the total number of workers employed and also the amount of employee-related goods and services needed.

New types of procurement needs will emerge. Governments must therefore work with mining companies to understand those needs, to prepare local suppliers to embrace the opportunities as they arise, including by ensuring that the skills initiatives discussed above also target suppliers. Such policies need to be informed by a baseline knowledge of new technologies in the pipeline and their impacts on job numbers, job descriptions, and skills required.



GOVERNMENT-LED EFFORTS AT TRANSITION SUPPORT

Government might also employ policies aimed at leveraging mining operations to foster diversification and employment outside the mining sector. These policies should ensure that new opportunities secure decent jobs and protect the right of workers. One set of policies supports incentivizes or collaborates with mining companies to engage in social impact investing: investment made with the intention to generate positive, measurable social and environmental impact alongside a financial return. Such investments by mining companies differ from environmental, social, and governance (ESG) or corporate social responsibility (CSR) spending in that they aim to foster self-sustaining profitable entrepreneurial activities in non-mining sectors, such as agriculture or light industry. These efforts amount to regional economic development projects, with the best examples to date being highly collaborative.

In scenarios where new mining technology retrofits displace a significant number of workers, governments should support workers with transition strategies that involve protective policies, such as unemployment benefits, though these depend on fiscal capacity that does not necessarily exist in many developing countries. They can also mandate employer and payroll contributions to schemes such as pension funds, wage insurance, or social insurance funds that can be accessed by workers to support their transition paths. Governments can also pursue proactive policies to create new economic opportunities in mining-dependent communities; there are a few successful examples of such transition efforts, including Germany's transition away from coal dependence.

Local procurement policies can also foster diversification, especially if they are focused on building capacity in suppliers that are not specific to the mining sector. Such policies will be challenged by the reality that new technology may decrease opportunities for local procurement for some types of goods and services, but this just underscores the need for any such policies to be mainstreamed in national industrial policy and diversification efforts that go beyond the mining sector.

RE-EXAMINING TAXATION

If new large-scale mining technology decreases employment-related benefits, one possible line of policy response involves increasing taxes assessed on mining operations and somehow using the revenues to compensate affected workers (and communities) and to facilitate transition. This could be akin to a windfall tax on the profits made from new efficiencies since most new technologies will increase the efficiency of operations. But efficiency is not synonymous with increased profitability, and it is not clear that it will lead to significant and sustained profits over time to serve as a viable basis for such taxes. While some first movers may make additional profit from increased efficiency, eventually, the adoption of new technologies will be industry wide and will be counted as a simple cost of doing business. Even today, operations adopting new technology may simply be trying to maintain existing profits in the face of declining ore grades and more complex deposits; some mines of the future would not be viable at all using conventional technologies.

Regardless of whether technology increases profits, increased taxes could be a way for mining companies to replace the value that was formerly brought through employment, and they may eventually simply become the cost of running the mine of the future. However, if increasing taxes is the only policy pursued, it casts governments as the sole agents in the challenge of translating mining activity into well-being for affected workers and communities. This risks



missing the opportunities described in other policy options, for effective collaboration, and for harnessing the capabilities and resources of mining companies.

TECHNOLOGY AS A SOLUTION

Finally, there is a suite of policies and initiatives that seek to find ways in which some technologies might offer new kinds of benefits to workers, local communities, and host countries to offset the disruptive impacts of the new model of mining.

LOCAL INNOVATION TO SUPPORT LARGE-SCALE MINING OPERATIONS

While most of the development of cutting-edge technologies and digital solutions for the large-scale mining sector is led by a handful of global technology companies, there is room for local technology development, which, if properly supported, leads to new avenues of economic development. Local technology providers can deliver tailor-made solutions to locally specific problems by developing new technological solutions or by adapting existing technologies to local conditions and needs, leveraging their local knowledge and connections to provide customized solutions in niche areas. Supporting such firms starts at a broad level with designing national innovation systems and providing an enabling innovation environment, but also includes institutional support and financing for start-ups and small and medium-sized enterprises (SMEs) that are challenged to raise traditional finance. Considering that women entrepreneurs are mostly SME owners, such support can have a positive gendered impact.

LARGE-SCALE MINING TECHNOLOGY IN SUPPORT OF LOCAL ECONOMIC DIVERSIFICATION

As part of social impact investment efforts (or as stand-alone efforts), mining companies should consider sharing some technological solutions with nearby communities to support resilience and create new development opportunities. The cost to mining companies of the “last-mile” investments for the benefit of communities may not be high if they are integrated into the upfront design of the projects. For communities, however, the benefits can be game-changing because technologies are enablers of economic opportunities, social improvements, and environmental management. Local agricultural productivity, for example, might benefit from geographic information system (GIS) mapping of local soil and hydrology conditions, drones, and Internet connectivity. In addition to providing economic benefits, this can have significant impacts on livelihoods and food security for local communities.

TECHNOLOGY AS A BOON FOR ASM

ASM could benefit in multiple ways from technologies that for the most part are not sophisticated or costly and that are appropriate to the scale of the sector: mechanical crushers, grinders, and washers, for example, or the use of blockchain or analytical fingerprinting. These sorts of technologies could improve productivity, worker health and safety, and environmental outcomes, and could help verify responsible supply chains. Governments could support such technology uptake as part of broader programs of ASM support and recognition, including through affordable financing and outreach, support for local manufacturing of machinery, and brokering deals with large-scale mines to transfer machinery that may be obsolete to them. A major caveat, however, is that enhancing the efficiency of ASM also involves displacing unskilled and semi-skilled workers, often including a high percentage of women.



SHARED CONNECTIVITY

Mining companies should consider sharing high-speed connectivity with local communities. To be effective, such efforts would need to be part of a broader initiative and would be most appropriately carried out in concert with local and national governments. As a complement to broader government programs, access to high-speed Internet can be a powerful enabler of development. For example, when coupled with training and access to hardware, it can be a powerful tool for delivering education to remote communities. Similarly, it can be an invaluable aid to the delivery of rural health care through telemedicine. Connectivity is also a foundational enabler of various entrepreneurial activities.

SUPPLYING LOCAL COMMUNITIES WITH DATA OF INTEREST

The data-rich mine of the future will involve real-time flows of information from ubiquitous sensors. Some of that data might be of acute interest to local communities. Examples of this type of data include tailings dam stability readings and outflow water-quality readings. Granting nearby communities access to these flows of data in real time would be enormously valuable to those affected and could help build a robust social licence to operate. Local agricultural producers might also benefit from mining company data such as that gathered in GIS mapping and aerial surveying.

USING MINE-LEVEL DATA TO AID TAX AUTHORITIES

New technologies may bring opportunities to improve government oversight of the mining sector and resource governance overall. The digitalization of operations will mean that mine sites will have access to significant volumes of real-time data. Tools for monitoring the flow and quality of minerals extracted could strengthen government revenue collection by providing detailed information to governments on the grade and quantity of extracted ores. Lack of that information underlies the difficulties many governments face in properly evaluating their mineral resources and in trying to prevent base erosion and profit shifting. That data could also help tax authorities better analyze the tax gap, determine audit priorities, and negotiate fiscal terms. It can also help address corruption.

CONCLUSIONS

The wave of new technology washing over the large-scale mining sector will change the face of the industry, just as technological change has already disrupted sectors like retail, entertainment, and communications. As in those cases, the changes will involve costs and benefits. Our concern is not so much how those costs and benefits balance out, but rather how they are distributed. In those cases where mining-affected communities and resource-rich host countries see costs in terms of lost employment for which they are not compensated in terms of benefits, it is a critical matter of development and of social licence to operate.

Our survey of policies to address this challenge does not discover any silver bullets—there is no single policy solution. High on the list is a focus on education policy, skills training, and educational institutions. This will involve close collaboration between governments, companies, and institutions of learning to help ensure that locals can fill the jobs of the future, will remain adaptable to continued change, and can help drive innovation and entrepreneurship that diversifies away from the mining sector. It is an opportunity to address gender gaps in education and skills for future mining jobs.



Also promising are the many ways in which governments and mining companies might use new technologies as a solution to the problems that some technologies might unleash to bring benefits to local communities and regions. We see great promise—but also daunting challenges—in changing usual practices for collaborations to foster diversification away from the large-scale mining sector, and in a model that looks more like impact investment than like CSR spending, i.e., designed to create sustainable, profitable non-mining-related enterprises in ways that build on existing strengths and resources.

Other policy solutions seem more difficult or fraught with uncertainty. Increasing taxation may be the basis for government support to affected workers and communities, for education systems, and for efforts at transition, but it should probably not be pursued as an exclusive policy solution. Local content policies in procurement and employment are critically important, but they may involve shooting at a sinking target, as opportunities shrink for both employment and procurement. Where new supplier opportunities arise, local content strategies will have to be redesigned, including through more systematic inter-industry collaboration.

All of these policies need to be built on better information—about jobs at risk, skills mismatches, profitability, and future demand for goods and services—than many governments have now. None of it can happen through governments acting alone: the watchword is collaboration.

All of this sees mining policy moving increasingly to intersect with broader industrial policy, including being strategic about the transition to a low-carbon future, of which mineral resources will be key, forced to do so by the changing nature and potential of mining's contributions to national economies. This is a path that probably should have been followed anyway, but the advent of new technology now makes it even more important.



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