Implementing shared-use of mining infrastructure to achieve the Sustainable Development Goals

Abstract

Many of the Sustainable Development Goals will only be achieved if the population has access to basic services, such as access to water, power, transport and telecommunications. However, in many developing countries there is a lack of infrastructure to guarantee these services and there are insufficient public funds to finance growing needs. In resource-rich countries, the mining sector can play a key role in increasing access to infrastructure. Mining–related infrastructure is often developed to serve the exclusive need of the investors, but if it is shared and developed to serve the broader needs and uses of the host economy it could fill some of the infrastructure funding gap, which is much needed to make progress towards achieving more than half of the SDGs. This chapter outlines how implementing shared-use mining–related infrastructure may contribute to the post-2015 agenda, by going through the relevant SDGs.

Key words: infrastructure, mining, development, SDGs, shared-used, public policy, funding gap

Introduction

According to the Africa Infrastructure Country Diagnostic conducted by the World Bank, Sub-Saharan Africa faces an annual infrastructure-funding gap of around US$31 billion (Briceño-Garmendia et al., 2008). Many of the Sustainable Development Goals (SDGs)[1], adopted on 25 September 2015 by the United Nations, will only be achieved if the population has access to basic infrastructure services, such as access to water, power, transport and telecommunications services. However, in many developing countries there is a lack of infrastructure to guarantee these services and there are insufficient public funds to satisfy growing needs.

In resource-rich countries[2], the mining sector can play a key role in increasing access to infrastructure, as operations require transportation, water, energy and telecommunications. This mining–related infrastructure is often developed to serve the exclusive need of mining companies, but if shared and developed to serve the broader needs and uses of the host economy, it could fill up to 9% of the infrastructure funding gap (McKinsey Global Institute, 2013).

[1] The 17 SDGs and their 169 associated targets shape the international community's development agenda for the next 15 years and form a common framework for achieving sustainable development. Building on the Millennium Development Goals (MDGs) that guided development over the last fifteen years, the SDGs are not only relevant for developing countries, but also developed countries given that they cover a wider range of issues, including an increased focus on the environment. The private sector is also given a more prominent role in helping to achieve the SDGs.

[2] For the purpose of this chapter, we use a broad definition of 'resource-rich', which also includes countries that have recently discovered mineral or fuel deposits.

This chapter outlines how shared-use of mining-related infrastructure could contribute towards achieving ten out of the 17 SDGs. The first section sets the scene by explaining the concept of shared-use and how it relates to the SDGs, the second section goes through the relevant SDGs in detail, and the third section delves into the challenges of implementation, before concluding in the fourth section.

Section 1: Shared-use infrastructure

The concept of shared-use

The concept of "shared-use" refers to the various ways to leverage extractive industry-related infrastructure investments in resource-rich countries for the broader benefit of the national and regional community. In opposition to the "enclave approach," the concept of "shared-use" seeks to integrate the mining sector within the rest of the economy through sharing the use of the infrastructure serving the mines.

To be beneficial for a country's long-term development, the extraction of depletable resources should involve investments in infrastructure and human capital that will support sustainable and inclusive growth. For infrastructure investments, countries face two non – mutually exclusive options: (1) optimizing the resource taxation potential of mining projects and reinvesting the tax revenues collected into infrastructure; or (2) requiring shared-use of infrastructure that is financed by the mining sector (CCSI, 2014). The first option is particularly relevant for mining, as in many resource-rich developing countries, mining is the only sector that generates sufficient cash flow to be able to pay for the construction of 'trunk' or 'backbone' infrastructure.

Shared-use infrastructure can be *multi-user,* whereby several mining companies use the infrastructure, or *multi-purpose* whereby non-mining users such as the agriculture, forestry or public sectors gain access to the infrastructure. Both should be promoted according to the country or region's economic conditions. Multi-user infrastructure enables mining companies to reduce the capital expenditure and operating costs of the mines, thereby leading to increased tax revenues to the government. It also has the potential to reduce the environmental footprint of the infrastructure development. Multi-purpose infrastructure has the potential to lower the costs of water, energy, transportation, and ICT services to other users, thereby promoting economic development in the region. Shared–use arrangements can result in economies of scale and economies of scope. Economies of scale occur when an infrastructure investment at a larger scale results in unit cost savings. Economies of scope refers to the situation when one type of infrastructure can be used to save costs for the development of another, such as laying the fiber optic cables needed for telecommunications infrastructure along a railroad.

The challenge in relation to achieving shared-use relates to the fact that mining concessionaires "have traditionally adopted an enclave approach to infrastructure development, providing their own power, water, ICT and transportation services to ensure that the basic infrastructure needed for their operations is reliably available" (CCSI, 2014). Countries therefore have often missed the opportunity to promote shared-use infrastructure and exploit potential synergies between any applicable national infrastructure plans and the mining sector's infrastructure plans.

Shared-use and the SDGs

The last twenty years have witnessed considerable efforts by academia to show the direct contribution of infrastructure access to growth, economic development and reduction of income inequality (UN Habitat, 2011), with access to ICT, followed by roads and power having the bigger impact (Estache, 2005). One study showed that infrastructure investments accelerated the annual growth convergence rate by over 13% in Africa over the 30 years preceding the study (Estache, 2005). Another study showed that improving transportation infrastructure could increase agricultural income by as much as 10% (Abdulai, *et al.*, 2005). "This reflects economic infrastructure's role in raising the productivity of the poor by improving their access to markets, local and foreign, reducing the risks of private investments which will provide them employment, and (…) better information about market opportunities and ways to improve livelihoods" (Willoughby, 2004). Calderon and Serven (2008) showed that the worldwide average inequality, measured by the Gini coefficient, was reduced by 3 basis points in 2001-2005 compared to 1991-1995 because of increased infrastructure development.

In this context, it appears clear that encouraging policies that will lead to an accumulation of infrastructure stock or improved infrastructure quality will contribute to achieving the SDGs. The next section outlines how shared-use infrastructure has the potential to impact ten out of the 17 SDGs. These ten SDGs have been selected considering that shared-use impacts them more directly. This is not to say that shared-use infrastructure does not have the potential to impact the other SDGs indirectly. All goals are interconnected and therefore contributing to one goal can also affect other goals. For example, we have not included SDG 3 – good health and wellbeing, and SDG 4 – quality education in this analysis, although increasing the access of health clinics and schools to electricity, transport, water and ICT infrastructure is likely to have a positive impact on these goals. Furthermore access to road infrastructure will greatly facilitate access to these facilities for surrounding populations.

The targets for each SDG that are particularly relevant to the nexus of the mining and infrastructure sectors are highlighted in the following section. In order to cover the variety of shared-use arrangements across infrastructure types, each goal features a case study involving one particular type of infrastructure. This is not to say that the other types of infrastructure do not also contribute to the goal discussed.

Section 2: Shared-use Mining Related Infrastructure by SDG

SDG 1 – No Poverty

SDG 1 focuses on eradicating extreme poverty by 2030 and warranting equal access to services and opportunities for all citizens. Target 1.4 is particularly relevant to shared-use and requires that "all men and women, particularly the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership, and control over land and other forms of property (…)."

Mining and its related infrastructure often require resettlement of communities living in the area of operation. Problems associated with resettlement can include joblessness, marginalization, food insecurity, loss of common land and resources, increased health risks, social destruction, violation of human rights, and disruption of formal education and access to basic public services (Mishra and Reddy, 2011), all of which are counterproductive to achieving SDG 1. Even the most careful company attempts to carry out resettlement programs in ways that minimize negative impacts on affected persons' development and human rights often fail to restore them to a position that is at least as favorable as the position they were in before the project began. When livelihood restoration programs fail — for instance, where the resettlement sites are isolated, and far from towns, markets, schools, and medical services — families are left worse off with often no ability to access other income opportunities (Lillywhite *et al.* 2015).

According to Stanley (2004) infrastructure development causes a lot more displacement of communities than mining itself. In Guinea, the 670 km-long Simandou railway corridor built by Rio Tinto for its iron-ore mine is estimated to occupy 8000 hectares of land and to have displaced 10,000 people (Els, 2015). Shared-use helps to avoid duplicating infrastructure when it is not needed: parallel railways, power, fiber optics lines are avoided, which reduces the amount of land impacted by infrastructure and, consequently, the potential number of people to be resettled.

In addition to the direct displacement caused by many large infrastructure projects mentioned above, there is also an indirect form of displacement that is often not addressed in formal resettlement operations. Indirect displacement stems from situations where the impacts of investments or related infrastructure make it untenable for persons to remain on the land on which they reside — for instance, where contamination of drinking water or the destruction of land used for farming causes households to leave their homes and lands to find healthier conditions elsewhere (FMO, 2011). As explained in SDG 6 and 12, shared-use in the context of water infrastructure can reduce instances of indirect displacement.

SDG 2 – Zero Hunger

SDG 2 aims to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture". Target 2.6, relevant for shared-used, requires "to increase investment, including through enhanced international cooperation, in rural infrastructure

(…), in order to enhance agricultural productive capacity in developing countries, in particular least developed countries."

The development of a commercial agriculture sector is highly reliant on agriculture-supporting infrastructure that connects to the trunk infrastructure (main roads, railways, power lines, and treatment facilities) such as feeder roads, irrigation systems and electricity distribution lines (BAGC, 2013). Furthermore, farmers can face constraints in accessing irrigation because such access is often reliant on diesel generators that can be three times as costly as the power grid. In many cases high transportation costs also prevent farmers from reaching markets and selling their goods at competitive prices. Furthermore, investments in water infrastructure such as small dams and storage reservoirs are needed to regulate water supply and avoid water shortages during the dry season. The Beira Agriculture Growth Corridor initiative has estimated that the average off-farm infrastructure cost in the Beira region in Mozambique is around $5,000/ha. Such cost is too high for small and medium-sized farmers to operate profitably (BAGC, 2013).

Trunk infrastructure developments, including multi-purpose infrastructure, by mining operations can be leveraged to reduce such costs for farmers. The construction of distribution lines from the trunk infrastructure built by the mining company is going to be less costly than having to also invest in trunk infrastructure or relying on diesel generators (see SDG 7). If water storage and treatment facilities are designed at additional capacity for agricultural uses, the cost is likely to be lower than having to invest in separate water management facilities (see SDG 6). Sharing access to railways and service roads with farmers can also improve access to markets.

Several case studies have evidenced how the agriculture sector can benefit from shared-use mining infrastructure.[3] For instance, towards the end of the 19th century in Western Australia, the rich gold deposits of Kalgoorlie led to mass immigration of workers. But Kalgoorlie was close to the desert and 600 km from the coast, and lacked sufficient water reserves to serve the growing demand from both the mines and the migrants. One visionary engineer devised a scheme to pump water from coastal dams and pipe it inland; this provided water not only to Kalgoorlie, but also to the intermediate region, converting marginal grazing land into one of the world's most productive wheat growing areas (Doepel and Bolton, 2013).

SDG 6 – Clean Water and Sanitation

Achieving SDG 6 means "ensur[ing] access to water and sanitation for all". Two of SDG 6's targets can be directly affected by shared-use infrastructure: Target 6.3, "by 2030 improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and increasing recycling and safe reuse" and Target 6.4 "by 2030 substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of

[3] More examples can be found in Toledano and Roorda (2014a)

freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity."

According to Moody's Investor Service (2013), about 70% of the mining operations of the "Big Six" mining companies,[4] are located in countries where water stress is considered to be at moderate to high risk. In such contexts, mining operations can aggravate the water stress of local communities and the environment by competing for water. Through shared–use arrangements, mining companies can avoid competing with the ecosystem. This can be realized by either diminishing the water footprint of mining companies (in quantity and/or quality) or by increasing the water supplies to the community from alternative sources (Toledano and Roorda, 2014a). We expand on the former arrangement under SDG 12 and the latter in this discussion of SDG 6.

To increase the sources of available water to themselves and to the community, mines can either realize the potential related to the fact that some part of the mining process require water of lower quality than that of human consumption, such as sea water in copper flotation processes, or they can treat sea water or residential waste/sewerage water (Toledano and Roorda, 2014a).

When a mine does the latter, economies of scale can be leveraged to increase the sources of water available to the communities. Freeport McMoRan's Cerro Verde expansion project is a good example. The company operates a copper mining project since 1994 southeast of Arequipa, Peru's second largest city. In order to receive the approval for the mine expansion plan, the company agreed to build a $400 million water treatment plant for the city of Arequipa with a capacity of around 83% of Arequipa's domestic sewage and industrial discharges (BTG Practical, 2016). The construction of the wastewater plant was completed in December 2015 and the mine expansion in May 2016. Prior to the plant, the city's wastewater was discharged without treatment into the Chili River, negatively affecting downstream communities whose livelihoods are primarily reliant on agricultural activities. Under the agreement, Cerro Verde can source an annual average of 1 cubic meter per second of the treated wastewater from the plant. The remaining water is discharged into the Chili River (Freeport-McMoRan, 2015).

SDG 7 – Affordable and Clean Energy

SDG 7 and its Target 7.1 focus on ensuring access to affordable, reliable, sustainable and modern energy for all. While access to energy is core to the fight against poverty, "[t]he availability of power lies at the core of a mine's development strategy; mining operators need to make sure that the energy demand of mining operations is met" (Toledano, 2013). Shared-use of mining–related power infrastructure will help to satisfy both the needs of the country and the mining industry.

[4] BHP Billiton, Rio Tinto, Anglo American, Vale S.A., Xstrata plc *and* Glencore International.

The mining industry adopts different strategies to meet energy needs, depending on several factors; such factors include: the power situation of the country, the project's energy demand, and the project's distance from the grid. When sourcing from the grid is too expensive or when there is no connection to the grid, the mining company will finance and build its own power generation facilities or source from a third-party (an independent power producer). When sourcing from the grid is less inexpensive as compared to self-generation, the mining company will either source from the grid or finance/co-finance the upgrade of the power infrastructure with the public utility. Each of these sourcing arrangements is conducive to shared-use arrangements (Toledano, 2013 and CCSI, 2014).

The main reason for this lies with the premise of leveraging economies of scale in the context of constructing either a power plant or the backbone infrastructure. Economies of scale render the marginal MegaWatt (MW) produced less expensive than the averaged unit cost of a new power plant; similarly economies of scale make the last-mile infrastructure less expensive than the average unit cost of the backbone infrastructure. Thus shared-use enables regions and communities to access a more robust power system with extended coverage. Robustness combined with broader coverage leads to energy access that is both reliable and affordable.

Shared-use can also enable a wider adoption of renewables in the energy mix through the deployment of mini-grids. Many mining companies are now considering this type of off-grid solution to ensure a smaller environmental footprint and reduced energy costs; this is facilitated by the fact that production costs of alternative energy sources are falling rapidly, and will often be less than the cost of importing diesel used for generators (Kirshke, 2016).

A case study illustrating the benefits of one of the shared-use arrangements comes from the Democratic Republic of Congo (DRC). Despite having a huge hydropower potential of 40,000 MW, the DRC has a limited installed capacity of 1,775 MW, with an electricity grid that only reaches 11% of the population and is characterized by intermittent electricity supply and regular power outages (Banerjee et al., 2014). The energy-intensive copper mining industry in the Katanga region, on which DRC is highly dependent, is constrained by this lack of regular power supply. The power outages, coupled with the high cost of diesel, mean that less copper is produced, and the cost of production is higher.[5] Given the long-term nature of the mining operations and their consistent power needs, a number of mines, including those operated by GlencoreXstrata Plc, have agreed to invest in upgrading the national electricity grid through a series of measures including the repair of two turbines at the Société Nationale d'Electricité's (SNEL) Inga 2 hydropower plant and the improvement of about 2,000 km of transmission lines. By doing so, the mines ensure more reliable access to power. This power will also be cheaper than the self – procured diesel costing up to 48 c/kWh, whereas the hydro-based power is sold by SNEL at around 3.5 c/kWh (Maennling et al., 2016).

The commercial arrangement that Glencore and SNEL devised to conduct this investment is as follows: in 2012, through its subsidiary Katanga Mining Ltd., GlencoreXstrata signed

[5] In 2012 power shortages resulted in a loss of 250,000 tons of copper: this led to lost exports worth US$1.8 billion translating into a loss in GDP of US$700 million (4.4% of GDP) and a loss in tax revenues of US$250 million (1.6% of GDP) (Banerjee et al., 2014).

an agreement with SNEL for a US $283.5 million investment in the above mentioned power infrastructure upgrading. A large part of this amount will be reimbursed by SNEL through utility bill credits payable by Katanga mining and its affiliates that will also benefit from the additional and more reliable electricity produced. According to the agreement signed between SNEL and Katanga mining, 10 percent of the excess power generated (i.e., the power above what is needed by the mines) will be generated and sold back to SNEL. Accordingly, grid-supply is expected to reach 450 MW of power capacity once the investment is completed (Maennling et al., 2016).With an upgraded backbone infrastructure, SNEL will be able to plan for the construction of distribution lines to the communities.

SDG 9 – Industry, Innovation and Infrastructure

SDG 9 is about "build[ing] resilient infrastructure, promot[ing] sustainable industrialization and foster[ing] innovation". Shared-use will be particularly impactful on Target 9.8, which aims to "significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020".

The World Bank has estimated that a 10% increase in high-speed Internet connections is associated with a 1.3% increase in economic growth in developing countries and is critical to foster innovation (World Bank, 2009). Despite this, an estimated 4.4 billion households, mainly in developing countries, still lack access to the Internet, let alone high-speed Internet (Ferdman, 2014).

ICT is employed in all phases of a mine's life, from exploration to operation and closure. Instantaneous access to video, voice and data communications enables the mining company to use materials and human resources more effectively, reduce waste and delays, and improve the safety of employees (Toledano and Roorda, 2014b). ICT can also make mining operations more efficient.

Shared-use may expand telecommunications and broadband access to surrounding communities therefore contributing to the realization of SDG 9. Economies of scope may be leveraged along the longitudinal infrastructure (which includes railways, roads, pipelines and power lines) built to serve the operations of a mine. Shared-use arrangements can be designed where the mine builds its own ICT infrastructure along its longitudinal infrastructure, where telecommunications companies add ICT capacity along the mine's infrastructure, or where an infrastructure logistics company builds the infrastructure for the mine. If clearing the right of way and excavation is undertaken for another longitudinal infrastructure type, the additional cost of laying out fiber optic cables can be reduced significantly. Roughly 80% of the costs associated with laying out fiber optic cables are related to excavation (Toledano and Roorda, 2014b). Examples of where such economies of scope were leveraged include: (1) CEC Liquid Telecom's laying fiber optic cables along the power lines of the mines in the Zambian copper belt and leasing the capacity to telecommunications operators; and (2) Compania Minera Antamina in Peru leasing part of

the fiber optic cable laid to control its slurry pipeline to Telefonica de Peru for it to bring telecommunications services to the surrounding areas (Toledano and Roorda, 2014b).

SDG 12 – Responsible Consumption and Production

SDG 12 highlights the importance of reducing our ecological footprint by changing the way that resources and goods are produced and consumed. Target 12.2 – *"By 2030 achieve sustainable management and efficient use of natural resources"* – is directly linked to both mining projects and associated infrastructure projects. Building and operating shared-use infrastructure, as opposed to building multiple infrastructures at a lower capacity in the same region, will reduce the amount of resources required. For example, it requires less material to build a multi-user railway line at a higher capacity than building two railway lines that serve individual mining projects.

The most relevant natural resource and opportunity to share infrastructure in relation to SDG 12 is water. Responsible consumption may result from shared-use water infrastructure arrangements as described in SDG 6, but may also result from putting in place strong environmental regulations that incentivize water reuse. A good illustration comes from Victoria, Australia where under the *Environment Protection Act 1970* companies should only consider the disposal of the water used (as any industrial waste) as a last resort measure after exhausting measures such as avoidance**,** reduction**,** reuse**,** recycling**,** treatment.

It has been estimated that combined with a sound water management system, water reuse enables the mining industry to almost halve its daily freshwater intake (Szyplinska, 2012). Consequently, water licenses should only be granted once mines have adopted a water efficiency policy that determines the mine's net demand after recycling, retreating and reusing water. In some regions of Chile, where water consumption is estimated to be six times greater than water renewal, the Chilean government has prohibited mines from benefiting from the granted water licenses and rejected new mining projects planning on using freshwater (Edwards et al., 2013). Some of the bigger mining operations have been embarking on desalination projects to cope with this situation.

Companies in Brazil and China provide additional illustrations that responsible consumption through water efficiency mechanisms is possible. At its Sossego metallurgical plant in Brazil, Vale recycles 99.99% of the water used to produce copper concentrate: it saves 900,000 cubic meters of freshwater annually whereas this water had previously been pumped from a nearby river. This makes up enough water to supply a town of with 25,000 inhabitants for six months. In China, at its Dexing mine, Jiangxi Copper Company partnered with BioTeQ Environmental Technologies to construct a water treatment plant that both treats and recovers copper from the wastewater. Within its first six months of operation, the plant treated 3 billion liters of wastewater and recovered 700,000 pounds of copper, which covered the treatment costs (Toledano and Roorda, 2014a).

SDG 13 – Climate Action

SDG 13 requires stakeholders to take urgent action to combat climate change and its impacts. Target 13.3 foresees the integration of *"climate change measures into national policies, strategies and planning"*. Private sector stakeholders should align their strategies accordingly. Mining companies can contribute to SDG 13 through three channels, namely by moving away from thermal coal extraction, reducing emissions from operations, and integrating climate resilience in all aspect of operations. Sharing infrastructure investments has the potential to lower emissions; as in the case of SDG 12, the construction of shared infrastructure at a larger capacity, as opposed to constructing two or more pieces of infrastructure for use by a single mining company, is likely to reduce the required inputs and with it the associated emissions during the construction phase.

During operations, shared power infrastructure is particularly relevant for SDG 13. Mine self-supply power plants are often based on heavy fuel oil (HFO) or diesel (Banerjee et al., 2014). These types of power plants are provide sufficient and reliable power to mining projects at a relatively low up-front capital cost, but have high operating costs and produce relatively high levels of emissions.

If a mining project can secure reliable power at a reasonable price from the public utility, this would be the preferred option, as highlighted in the above discussion of SDG 7. This could also significantly reduce CO2 emissions of the project, given that HFO and diesel are among the most polluting power sources. In Liberia, the World Bank estimated that by 2030, mines could represent more than 80% of national power demand (World Bank, 2011). To satisfy this demand, the study assesses different power generation scenarios and finds that energy costs could be reduced from US$0.15 per kilowatt hour in a self-supply scenario to US$0.08 per kilowatt hour in a scenario where one large hydropower plant is built to serve the mining projects and the rest of the economy. Estimates suggest that, compared with self-supply systems, an integrated system could save up to 2000 tons of CO2 emissions per annum or 22,000 tons of CO2 over the lifetime of the mine.

SDG 14 – Life Below Water

SDG 14 focuses on the conservation and sustainable use of the oceans, seas and marine resources. Target 14.5 aims to, *"by 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on best available scientific information"*. A large proportion of marine pollution comes from land-based sources; shared water infrastructure solutions are relevant to address water discharge of mining projects on land (see discussions of SDGs 6 and 12, above). Mining water discharge has had disastrous effects all over the world. A most egregious and recent example comes from Brazil where in 2015, two Samarco[6]-owned dams containing by-products of iron mining collapsed, causing many casualties in the surroundings and water contamination of

[6] A joint venture between BHP and Vale

nearby rivers which led to the suspension of water supply in several cities depending on those rivers (Rezende, 2015).

Shared port infrastructure can also contribute to achieving the SDG 14. Ports impact the marine environment through the terminal infrastructure and shipping activities. Adverse impacts include: (1) the clearing and modifying of coastal habitats; (2) dredging leading to loss of species and changes in habitat within the port area, along the port channel and where dredge material is disposed; (3) the risk of chemical and oil spills due to shipping activity; and (4) noise pollution disturbing marine life (Queensland Government, 2012). While shared port infrastructure may not reduce all these potential adverse environmental impacts, a significant share of it can be curbed by "common" infrastructure investments. For example, one multi-purpose port could benefit from the same dredged channel and wave breaker. Different piers would still be required, but the overall marine impact of an additional piers and/or terminals are smaller than building two separate ports.

This fact is illustrated by the ports strategy of the state government of Queensland, Australia. Queensland is the largest coal exporting state in Australia and is also home to the largest coral reef in the world, which is declared a World Heritage Site. Seaborne coal demand grew significantly during the commodity super cycle leading to new mining projects, port expansions and increased shipping activity along the Great Barrier Reef. Due to concerns about the adverse impacts of shipping activity on the fragile reef ecosystem, the Queensland Government highlighted in its ports strategy that port development would be restricted to existing port limits given that "few, larger port areas will mean less disruption to the environment and marine wildlife than would occur if new port areas were established."

SDG 15 – Life On Land

Shared-use mining infrastructure can both positively contribute to SDG 15, as well as having adverse impacts, including accelerating biodiversity loss and deforestation. Particularly Target 15.2 – *"by 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally"* and Target 15.5 – *"take urgent and significant action to reduce degradation of natural habitat, halt the loss of biodiversity, and by 2020 protect and prevent the extinction of threatened species"* are relevant to the impacts of mining on SDG 15.

As discussed under SDG 9, above, combining longitudinal infrastructure rather than building two separate systems can significantly reduce the infrastructure footprint of the mining industry. Forests need to be cleared on either side of a transmission, road and railway network in order to avoid falling trees causing damage. For Cameroon's Mbalam iron ore project it has been estimated that it would require at least a 100-meter wide transport corridor for the proposed 508km railway and adjacent maintenance road to transport iron-ore to the point of export. This would result in the clearing of 5,080 hectares of forest (Rainbow Environment Consult, 2011). A double track system to increase

capacity and service multiple mining projects in the region would only marginally increase the footprint of the existing railway as compared to building two separate railway lines.

However, shared-use infrastructure may render projects viable that would not have gone ahead without multiple actors working together. The Tridom region where the Mbalam iron ore project is located provides a useful example. While the mining company is planning to use heavy fuel oil generators for power self-supply purposes, it would welcome the possibility of tapping the potential Chollet Dam hydropower project in the Republic of Congo, which would only be viable if several mining projects in the region were to move ahead. While potentially having a positive impact on the SDG 13 due to reduced greenhouse gas emissions, the development of such a dam would flood large parts of habitat rich pristine rainforest in the region (Bottrill, 2013).

The biggest potential adverse impact of shared-use infrastructure on SDG 15 though is that improved road infrastructure, in particular, but also railway infrastructure may unlock economic activity and create access to areas that previously were not easily accessible by humans. Forest degradation and habitat loss may result through incursion into forest areas for agriculture, artisanal mining, and other potentially harmful activities (Hund and Megevand, 2013). In order to minimize such adverse impacts, countries should implement land-use planning strategies that set out "no-go" zones and plan transport corridors accordingly.

SDG 17 – Partnerships for the Goals

To achieve the SDGs, partnerships among all stakeholders are necessary and, as highlighted in the introduction, it is envisaged that the private sector will play a greater role than was set out in the previous MDGs. Particularly Target 17.16 – *"enhance the global partnership for sustainable development complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technologies and financial resources to support the achievement of sustainable development goals in all countries, particularly developing countries"* is relevant for the question of partnerships and shared-use.

The necessity to collaborate in order to achieve shared-use mining infrastructure cannot be overstated. There are a number of stakeholders involved in realizing shared-use infrastructure. Apart from the government (various ministries and agencies at the national level, as well as, potentially, regional or local governments), utility companies, and the relevant mining company that will build the infrastructure, other private sector players need to be involved. These include the subsequent mining companies and companies from other sectors that want to access the infrastructure and will require access terms that are economically viable. It may also include companies that could benefit from economies of scope due to the construction of the infrastructure as discussed in the above consideration of SDG 9. Financiers will also need to be part of the discussion given that large-scale infrastructure projects will generally not be financed through equity. Land owners and communities affected by the infrastructure development will need to be meaningfully consulted to build a shared consensus regarding potential infrastructure projects over their

lands, overcome information asymmetries as well as to avoid adverse impacts on their human rights. An added layer of complexity occurs when the infrastructure crosses country borders given that the neighboring country will also need to be part of the negotiations to discuss transit tariffs and/or access provisions.

Given the numerous players involved and the complexity of shared-use infrastructure agreements, these projects may provide an opportunity to create lasting partnerships beyond the construction of the infrastructure project itself and can act as a driver to regional integration (Gözde et al, 2016). The Maputo Development Corridor, which connects South Africa's mining region to Maputo port is a case in point. It set up a multi-stakeholder group in 1997 to facilitate public and private actors of South Africa, Mozambique and Swaziland to oversee infrastructure projects, build public sector capacity on trade facilitation, research policy measures to enhance investment around the corridor, and facilitate cross-border development initiatives. The multi-stakeholder group also involved local governments, informal entrepreneurs and affected communities in its undertakings (Byiers and Vanheukelom, 2014). To improve operational efficiency of railway transport along the Maputo corridor, a Joint Operating Center was inaugurated in Maputo in September, 2014, which houses operators from Maputo port, the Mozambican railways company, the South African railways company and the Swazi railway company. To ensure the effectiveness of the Center, the operators have aligned investment plans, maintenance and safety standards, as well as skill development initiatives. It is expected that these measures will enhance adherence to scheduled train movements across rail and port facilities throughout the corridor. Transnet is also looking to roll out similar initiatives on the North-South Corridor (Zimbabwe, Zambia, DRC, and South Africa) and the East West Corridor (Botswana and South Africa) (Breakbulk, 2014).

Section 3 – Roadblocks to shared-use infrastructure

While the implementation of shared-use infrastructure can contribute to achieving the SDGs as outlined in the previous section, it is fraught with challenges and trade-offs. This section addresses why mining companies may be against sharing infrastructure investments, the potential trade-offs that need to be made in order to achieve shared-use, and pre-conditions that need to be put in place in order to make shared-use infrastructure work.

The Competitive Nature of the Mining Sector

The competition that exists between large mining companies is a roadblock to the implementation of multi-user arrangements, particularly if there are no strong regulatory requirements and clear policy guidelines in place. The Australian experience shows that mining companies will use all strategies to avoid implementing shared-use policies, including "aggressive legal challenge, engineering and design features, pre-emptive access arrangements, capacity management and mergers and acquisitions" (Collier and Ireland, 2015). When large multinational mining companies compete to supply different grades of ore to their consumers, their natural behavior is to use their monopoly power on the infrastructure in the region to acquire further regional concessions at a lower price. Moreover large-scale mining companies are often price makers and so view it as in their interest to restrict regional production to receive higher prices for their products.

Trade-offs involved when negotiating shared-use infrastructure

Governments and companies negotiate over the allocation of economic rent (the estimated excess profits over the minimum required return to induce investment). This negotiation will entail fiscal and non-fiscal obligations, such as local content and shared-use of infrastructure (CCSI, 2014). Depending on the country's objectives, the government can prioritize one type of benefit over another. If strategic, the government can prioritize shared-use infrastructure in the negotiations. If this comes at a significant cost to the company however, the Government should be prepared to concede on another negotiation point, such as the fiscal terms.

From the perspective of the company, two important factors will determine its willingness to embark on shared-use arrangements: (1) the extent to which the infrastructure is costly and strategic; and (2) whether multi-purpose access to infrastructure will unlock economic development and help preserve the company's social license to operate. Rail infrastructure is considered to be most strategic and costly given that it makes up a significant proportion of total capital expenditure and third party access may adversely impact operations. From the perspective of the government, "shared-use in the context of expensive infrastructure such as rail and ports is worth the price of foregone revenues if (1) there are significant economies of scale or scope so that the provision of extra capacity is inexpensive, and (2) a real market for that marginal low-cost capacity exists"(CCSI, 2014).

Given the potential cost imposed on the company in implementing shared-use and the price paid by the government in terms of both foregone tax revenues and establishing a regulatory authority to enforce shared-use of the mining-related infrastructure, governments should prepare for the negotiation by conducting a detailed cost-benefit analysis of the negotiation package. As mentioned above, negotiating shared-use should proceed from a planning effort for infrastructure expansion and public-private coordination, and in response to a predicted demand.

Pre-conditions for shared-use infrastructure may not be in place

Several pre-conditions are needed to successfully determine whether shared-use requirements make sense and to implement shared-use if deemed appropriate.

Planning and coordination. An infrastructure master plan across sectors that outlines infrastructure requirements is necessary to identify synergies and opportunities for shared-use between the mining sector and other users. These plans should be based on future demand forecasts of potential users of the infrastructure to determine the economic importance of implementing shared-use. Furthermore, as outlined during the above discussion of SDG 17, implementing shared-use infrastructure involves many players and interests, which need to be consulted and including in coordination efforts.

Legal Framework. To realize infrastructure–mine synergies, countries need to provide a sufficiently predictable regulatory environment to attract investments by mining companies and infrastructure companies. In some instances, it might mean the liberalization of certain segments of infrastructure that traditionally fall under the scope of prerogatives of the state-owned utility (train operations, power generation, water treatment facilities, telecommunications services). In other instances it means the clarification of the rules (including guiding principles to set access tariffs; identification of the role and responsibility of the infrastructure owner, infrastructure operator, national government and local government; procedures in case of disputes; and cost sharing mechanisms). When the legal framework is not sufficiently developed, adapted and implemented, critical elements may be left to negotiation. This can complicate planning efforts for governments and create an uncertain environment for the investor. It is also generally advisable for the government to keep the right of way or servitude along the longitudinal infrastructure (such as roads, pipelines, power lines and railways) in order to be able to monetize the right of way to other infrastructure types and optimize infrastructure development (Gozde et al., 2016).

Regulation. Implementing shared-use requires regulatory oversight. The regulator must: (1) monitor the tariffs charged by the operator (this could be the mining company, a special purpose vehicle company (SPV) or the state owned rail company) to third parties on a non discriminatory basis; (2) define the access charges between the infrastructure owner and operator if the two are separated; (3) determine technical standards, necessary improvements or expansion; (4) assess complaints and manage arbitration; and (5) guarantee the implementation of open access infrastructure. Independence and transparency in regulatory processes are required to gain trust from the private sector; in advanced jurisdictions the regulatory bodies are therefore often independent institutions.

For countries where resources and institutional capacity is limited, intermediary solutions, such as outsourcing regulatory functions to a third party or expert panel can work well (Eberhart et al., 2011).

***State-owned utility*.** In many shared-use arrangements, the power and water utilities, as well as state-owned railway, port and telecommunications companies will be the main partners of the mining company and associated infrastructure companies. Therefore their reliability, financial health and creditworthiness are essential and will determine the range of possible arrangements, which the mines and the private sector will be willing to engage in (CCSI, 2014).

Conclusion

Significant progress has been made to promote the mining sector moving away from its enclave model towards sharing its infrastructure investments. This chapter highlights the importance of continuing this trend by outlining how shared-use infrastructure can play an important role in contributing to the development framework that countries worldwide have agreed to for the next 14 years. Transport, power, water and ICT investments by mining companies can provide a springboard to economic development, particularly in resource-rich countries with large infrastructure financing gaps. If shared, these investments can improve access to services and unlock economic potential in areas that were previously unconnected. To minimize the potential adverse impacts of shared-use infrastructure on the SDGs, countries should plan these investments taking into account environmental and human rights considerations.

It is noteworthy that shared-use water arrangements play a dominant role in achieving a number of SDGs. With increasing pressure on water resources due to increasing demand from the mining and non-mining sectors, as well as exacerbated flooding and draught events caused by climate change, shared-use water solutions deserve particular attention by all stakeholders in mining jurisdictions in the years to come.

The commodity price downturn has put many mining projects and associated infrastructure projects on hold. The squeeze on mining projects' margins has also exacerbated competitive pressures among mining companies. Given that the relative position of mining projects on the global cost curve will determine how the owners of those assets will withstand the downturn and which new projects will become viable (Collier and Ireland, 2015), access to low-cost infrastructure solutions has become an important factor in deciding whether a project is profitable or not. There is therefore an added incentive for controlling companies to try and limit their competitors' access to infrastructure in order to gain market share.

In such an environment of heightened competition it is even more important for governments of resource-rich countries to enforce shared-use infrastructure solutions given that the public cost to the mineral producing country of such competitive behavior outweighs the benefits. Furthermore, coordinated large-scale shared-use infrastructure investments have the potential to create economies of scale and reduce the overall costs of the services to the mining sector of a country. As this chapter highlights, above and beyond the monetary aspects, such shared-use solutions will also go a long way to help to achieve each SDG and the 2030 Agenda.

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