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Leveraging the Mining Industry's Energy Demand to Improve Host Countries' Power Infrastructure

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CCSI Policy Paper

Perrine Toledano **
September 2012

Key Points

- 1 Mining operators need to make sure that the energy demand of mining operations is met, especially in remote areas, where there is little or no connectivity to national grids.
- 2 To address electricity deficit, the mining industry has adopted different solutions depending on the power situation of the country, the projects' energy demand, and the projects' distance from the grid. For a mining company, the goal is to maximize cost-savings.
- 3 For a host country, the challenge is to maximize welfare gains to ensure that this mining demand for power, which often translates into investment in power infrastructure, is leveraged to build a more robust power generation and electric transmission system as well as accelerate rural electrification.
- 4 Both, cost savings and welfare gains can be met simultaneously if sound regulations and efficient coordination mechanisms are in place.



Leveraging the Mining Industry's Energy Demand to Improve Host Countries' Power Infrastructure

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Introduction

Problem Statement

The World Bank estimates that African investment needs in infrastructure would cost US\$93 billion per year, only half of which is for the power sector.¹ As shown by the following table, some countries will need to more than double their existing generation, simply to meet the demand from mining customers, not to mention increased demand from local under-served populations.

Estimate of additional electricity consumption from mineral projects in selected sub-Saharan African countries likely to come into production by 2019.

	Estimated annual consumption (GWh)	% of 2008 generation capacity
Angola	24	1%
Botswana	260	44%
Burkina Faso	550	93%
Cameroon	560	10%
CAR	190	119%
Congo-Brazzaville	250	56%
DRC	5600	75%
Côte d'Ivoire	320	6%
Eritrea	280	104%
Gabon	480	24%
Ghana	720	9%
Guinea	1500	163%
Kenya	100	1%
Lesotho	210	105%
Liberia	500	147%
Madagascar	670	60%
Malawi	80	5%
Mali	360	73%
Mauritania	530	96%
Mozambique	160	1%
Namibia	780	35%
Niger	290	145%
Senegal	790	35%
Sierra Leone	870	1450%
South Africa	6900	3%
Tanzania	440	10%
Zambia	2400	25%
Zimbabwe	260	3%
TOTAL	26074	8%

Source: USGS report²

¹ C. Briceño-Garmendia, K. Smits, V. Foster, "Financing Public Infrastructure in Sub-Saharan Africa: Patterns, Issues, and Options," Africa Infrastructure Sector Diagnostic Background Paper No. 15 (Washington D.C.: The World Bank, 2008).

² D. I. Bleiwas, "Estimates of Electricity requirements for the recovery of mineral commodities, with examples applied to Sub-Saharan Africa", USGS (2011), available at: <http://pubs.usgs.gov/of/2011/1253/report/OF11-1253.pdf>

According to the Africa Infrastructure Country Diagnostic conducted by the World Bank, Africa faces an annual infrastructure funding gap of US\$31 billion.

At the same time, mining companies operating in sub-Saharan Africa are increasingly concerned about the limits or absence of electricity, increasing power costs, and more stringent power regulations. In South Africa, the lack of power has already heavily impacted the mining industry. In 2008, because of the power crisis, AngloGold Ashanti, for example, lost 270,000 ounces of gold production. After a five day shutdown, the authorities ordered the country's largest mineral producers to restart operations using no more than 90% of the previous power supply, in order to avoid new blackouts.³ Indeed, in South Africa, the energy intensive mining sector accounts for approximately 17% of the national electricity consumption.⁴

The 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. This is especially the case in remote areas, where mining companies are developing large projects with little or no connectivity to national grids and very limited options for electricity supply.

To address these energy problems, the mining industry has adopted different solutions depending on the power situation of the country, the projects' energy demand, and the projects' distance from the grid:

- When sourcing from the grid is too expensive⁵ or when there is no grid, industry finances and builds its own power generation facilities or sources from a third-party that is a private power generator (Situations 1 and 2)
- When sourcing from the grid is less expensive than own generation, industry either sources from the grid or finances/co-finances the upgrade of the power assets under various arrangements with the public utility (Situation 3).

For a mining company, the goal is to maximize cost-savings. For a host country, the challenge is to maximize welfare gains by leveraging any investment in power infrastructure development for the electrification needs of the country. This could be through connecting the mine to the grid and incentivizing the company to produce extra capacity to sell to the public utility in order to increase supply and reduce the electricity cost, or by requiring that the privately- financed network is open to third-party access, so that towns and populations between the mine and the grid benefit from the privately financed distribution lines as well.

Both, cost savings and welfare gains can be met simultaneously if sound regulations and efficient coordination mechanisms are in place.

³ AngloGold Ashanti, "AngloGold Ashanti's response to the power crisis," available at: <http://www.anglogold.com/subwebs/informationforinvestors/reports08/power-crisis.htm>

⁴ Republic of South Africa, Energy Efficiency Strategy for South Africa (Pretoria: Department of Minerals and Energy, April 2004).

⁵ On average in Africa, the cost is 18 cts/kWh average for grid-supplied power and 40 cts/kWh when firms pay for backup generators to avoid blackouts, Source: P. Fairley, "Power Potential and Pitfalls on the Congo: Developing Africa's Cleanest and Largest Hydropower Opportunity," *Earthzine* (March 8 2010) <http://www.earthzine.org/2010/03/08/power-potential-and-pitfalls-on-the-congo-developing-africa%E2%80%99s-cleanest-and-largest-hydropower-opportunity/>

Without appropriate regulation, the opportunity for the country will be missed. In DRC, for instance, after the development of the mining project of Tenke Fungurume, the surrounding communities suffered from increased power supply shortages.⁶ The mining company refused to share its power generation infrastructure with the city, despite repeated requests from the local population. For a variety of reasons, the project has now become so controversial that the government threatens to expropriate the company.⁷

Without appropriate coordination mechanisms within the mining industry or between the industry and the government, scale economies will be lost. In Liberia, a World Bank study suggests that a single cost-effective large-scale power plant supplying all the mining sites, with a built in surplus to be sold to the state-owned utility, instead of many smaller decentralized thermal power plants, could result in “aggregate savings of US\$ 1.6 billion in lifecycle energy costs over the next 20 years”.⁸

Therefore to take advantage of the opportunity of the investments of the mining industry in power infrastructure, and make sure that the country benefits from those investments, an appropriate planning, regulatory and commercial framework is needed. If power assets are leveraged and designed to contribute to the development of public infrastructure at the national, regional or community levels, the incremental capital cost of building additional capacity could be reduced and the economic and social spillover effects can extend far beyond the mining sector.

The purpose of this Policy Paper is to distil good practice principles observed in power infrastructure development leveraging the mining industry’s energy demand around the world, informed by expert opinion.

Context and Research Questions

The case for public private coordination for investment in power assets

Coordination within the mining industry and between mining companies and the government can result in significant economic gains. Indeed the underlying fact is that the marginal capital cost of additional generation capacity is generally lower than the cost of building a whole new power plant.

According to calculations based on U.S. Energy Information Administration data,⁹ for example, the overnight capital costs per kilowatt installed for a coal power plant of 1,300MW are roughly 10% lower than a plant which has half the same size (650 MW).

⁶ P. Kumwamba and A-S Simpere, “Soul mining: the EIB’s role in the Tenke-Fungurume Mine, DRC” (Kinshasa and Paris: Action Against Impunity For Human Rights – Friends of the Earth France, August 2008), available at: www.bothends.org/uploaded_files/Soul_Mining.pdf

⁷ “Partners give ground to agree Tenke Fungurume terms,” *Mining Journal*, October 22, 2010, available at: <http://www.mining-journal.com/finance/partners-give-ground-to-agree-tenke-fungurume-terms>.

⁸ World Bank, “Leveraging investments by natural resource concessionaires,” Infrastructure Policy Notes, World Bank for the Republic of Liberia (Washington D.C.: The World Bank, 2011)

⁹ BCS, “Mining Industry Energy Bandwidth Study,” Report to U.S. Department of Energy (June 2007), available at: http://www1.eere.energy.gov/manufacturing/industries_technologies/mining/pdfs/mining_bandwidth.pdf

This, in part, reflects the fixed costs in constructing a power plant (obtaining land, permits, design etc.) As a result, if we consider the capital cost of the incremental 650MW (in the big power plant of 1300MW) and we compare this capital cost with the capital cost of the first 650MW, we obtain a 20% reduction to the ultimate consumer in the capital cost of the additional 650MW generated from that plant.

According to the International Energy Agency (IEA), hydro power plants could also provide significant economies of scale. In terms of run-of-rivers plants¹⁰, investments costs decrease from US\$ 2- US\$ 4 million/MW to US\$ 2 - US\$ 3 million/MW as power plant capacity increases from less than 10MW to 10-100MW. In terms of dams and reservoirs¹¹, which tend to have more capacity, investments costs decrease from US\$ 2-US\$3 million/MW to less than US\$ 2 million/MW as power plant capacity increases from 100-300MW to more than 300 MW.¹²

Moreover, for hydro-plants, as most of the generation cost is associated with the depreciation of fixed assets, the generation cost decreases if the projected plant lifetime is extended or capacity is expanded. According to the International Renewable Energy Agency (IRENA), average installed costs for adding extra capacity or renovating the hydroelectric power plants range from US\$ 500/kW to US\$ 1,000/kW, a smaller investment per kilowatt than for building a new power plant. This suggests that there could be additional economies of scale if a plant was refurbished or upgraded.¹³

Therefore this is often more economically rational to coordinate investments in power generation operating in a country in order not to miss scale economies: one bigger power plant serving a mining area is often less expensive to all users than many individual power plants set up at each mine site.

Avenues to leverage the mining industry's energy demand will depend on the commodity and mine type

Energy requirements vary considerably for each commodity. According to a US Department of Energy study¹⁴, coal mining and metals mining (iron, lead, gold, zinc, and copper) have roughly equivalent energy needs, requiring around 160,000 Btu/ton (0.05MWh/ton) of material handled. However, when recovery ratios (percentage of valuable ore within the total mined material) are taken into account, metals mining is generally much more energy intensive than coal mining, as coal mining has a recovery ratio of 82% on average, while for metals, the average ratio is approximately 4.5%.

¹⁰ Run-of-river: this type of project normally has no or very little storage capacity. Generally, small plants are more likely to be run-of-river facilities.

¹¹ Dams and reservoirs are of two types – 1) reservoir: this type of power plant has the ability to store water in a reservoir in order to de-couple generation from hydro inflows. Reservoir capacities can be small or very large ; 2) pumped storage: this type of scheme uses off-peak electricity to pump water from a lower elevation reservoir to a higher elevation so that the pumped storage plant can generate power at peak times and enhance grid stability. "Renewable energy technologies: cost analysis series," Volume 1: Power sector, International Renewable Energy Agency (IRENA), Working Paper (2012), available at:

http://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_Analysis-HYDROPOWER.pdf

¹² "Renewable Energy Essentials: Hydropower," International Energy Agency (IEA) (2010), available at:

http://www.iea.org/papers/2010/Hydropower_Essentials.pdf

¹³ IRENA, "Renewable energy technologies: cost analysis series," 2012, op. cit.

¹⁴ BCS, "Mining Industry Energy Bandwidth Study," 2007, op. cit.

Among metals, gold and silver have the lowest recovery ratio of 0.005%. Further technological improvements are in great demand in the mining industry, as they reduce the quantity of waste material handled and improve energy efficiency in the industry.

Energy use in mining also depends on the extent to which the commodity must be beneficiated or processed, and also on whether it is underground or surface. Due to a significant increase in hauling requirements, ventilation, water pumping, and other operations, underground mining operations require significantly greater amounts of energy than surface mining operations. According to the same U.S. Department of Energy study mentioned above, underground coal mining in the United States, for example, requires 325,000 Btu/ton of coal recovered, compared to 55,000-77,000 Btu/ton for surface operations. The US Geological Survey's estimates for coal energy needs in sub-Saharan Africa are between 185,000 Btu/ ton for underground and 61,000 Btu/ton for surface mining.¹⁵

According to the same U.S. Department of Energy study, the major energy sources used in the U.S. mining industry include diesel fuel accounting for 34%, followed by onsite electricity at 32%, and natural gas at 22%. Coal and gasoline supply the rest of the energy.¹⁶ Electricity is generally used for ventilation systems, water pumping, and crushing and grinding operations, while diesel fuel is used for hauling and other transportation processes.¹⁷ This breakdown of energy sources can of course differ in other areas such as in Africa but the idea remains that electricity is one of the energy sources used by the mine. *Its portion in the energy needs of the mining industry is however significant enough to be an opportunity for the host country to leverage in order to improve its power infrastructure.*

Avenues to leverage the mining industry's energy demand will depend on the energy sources of the country

Sourcing electricity from the grid in a country rich in hydropower sources is cheaper than in a country relying on thermal sources.

According to EIA estimates¹⁸, U.S. average Levelized Maintenance & Operation Costs for hydro power plants are US\$10/MWh, less than the US\$32.6/MWh for conventional coal plants. Those numbers contribute to a smaller total system levelized cost of hydropower than thermal power (US\$ 89.9/Mwh and US\$ 99.6/Mwh respectively).¹⁹

Hydropower, when associated with storage in reservoirs, can store energy sometimes over years and can supply big quantities of energy at cheaper costs than any other energy source. Hence, sourcing electricity from a hydro-grid is cheaper than sourcing

¹⁵ Bleiwas, "Estimates of Electricity requirements for the recovery of mineral commodities, with examples applied to Sub-Saharan Africa," 2011, op. cit.

¹⁶ BCS, "Mining Industry Energy Bandwidth Study," Report to U.S. Department of Energy," 2007, op.cit.

¹⁷ U.S. Department of Energy, "Energy and Environmental Profile of the U.S. Mining Industry," (2002), available at: http://www1.eere.energy.gov/manufacturing/industries_technologies/mining/pdfs/overview.pdf

¹⁸ "Levelized Cost of New Generation Resources in the Annual Energy Outlook 2012", U.S. Energy Information Administration (EIA) (January 23, 2012), available at: http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

¹⁹ A. Sharma, "Hydro Power Vs Thermal Power: A Comparative Cost-Benefit Analysis", *International Journal of Arts and Sciences* 3(9): 125 - 143 (2010); See also Wood Mackenzie, "Clarifying specific concession models that are competitive," Report to Greenland Development Inc. (GDI, 2009); See also IRENA "Renewable energy technologies: cost analysis series,' Volume 1: Power sector" (2012), op. cit.

from a thermal grid or thermal power sources (such as diesel generators or coal-fired power plant) even in countries where the grid is not functional and the non-industrial demand is low such as in DRC (see box 23). Of course many countries will rely on a grid based on a mix of hydro and thermal energy sources especially given that hydro facilities require massive amounts of water and can be rain-dependent.

In addition to the regulatory framework, the type of available energy source as well as the type of mine will determine the power sourcing options for the mine and the potential for leveraging those options for the benefit of the host country.

Research questions and summary of issues

A worldwide survey of existing institutional arrangements of power sourcing options for mining companies shows the existence of several common barriers that hinder the incidence of mutually beneficial coordination either between mining companies and the government or within the mining industry itself:

1. Planning in the mining industry utilizes a different time-span from that of government agencies, making coordination of investments difficult.
2. Mining companies may perceive reliable power supply and earlier access to power as a competitive advantage, which makes resource pooling and joint strategy formulation within the mining industry rare.
3. Mine investors generally have little incentive to construct power plants with greater capacity than their mine's demand if no incentivizing regulatory and commercial framework is in place. For instance, appropriate legislation for mining companies' power generation does not always exist or does not properly address the possibility of selling electricity to the grid.
4. Mining often takes place in remote areas and building the distribution grid up to the mine concession results in an expensive undertaking that the government cannot always afford and that the mine is not always interested in financing. In this situation, the only way for the country to benefit is for the mine site community to be supplied in electricity by the mine. When this is not required by the contract and not part of an integrated local plan, this is often not a sustainable solution.

The rest of the Policy Paper will highlight situations where those barriers have been lifted, *differentiating between the following cases:*

- *there is no grid or the grid is too remote from the mining area (Situation 1),*
- *sourcing power from the grid is more expensive than own-generation (Situation 2),*
and
- *sourcing power from the grid is less expensive than own-generation (Situation 3).*

The table below summarizes the different issues presented in this Policy Paper.

Situation	Mining reaction	What can the country do?	Possible institutional arrangements	Issues tackled in the paper
<i>There is no grid or the grid is too remote from the mining area</i>	Builds and owns own generation	Encouraging the mine to provide the mine-site community with access to electricity	-The mine helps the community with off-grid solutions as part of CSR -The mine helps the community upon contract requirements - The mine and the local government share responsibility to give the mine-site community access to electricity - The mining energy demand is leveraged to expand the grid up to remote areas	-How to encourage mining companies' contribution to the electrification of the community? -What should laws and contracts require? -What is the breakdown of responsibilities between the government, the company and the community? - If the grid is expanded, who is financing the expansion?
<i>Sourcing power from the grid is more expensive than own-generation</i>	Builds and owns own-generation or buys from a third-party	Encouraging production of excess capacity and sale to the grid	-The mine doesn't produce extra-capacity and only meets its own needs - The mine sells excess power to the utility - The mine sells excess power to end-users - The mine serves as an anchor customer for third-party investment in power generation	- What are the different elements of an appropriate regulatory framework to encourage the production of surplus to be sold to the grid: power sector reform, IPP, PPA, independent regulator? -What are the advantages of connecting the mines to the grid for the mines and for the grid? -How can governments encourage group power plants?
<i>Sourcing power from the grid is less expensive than own-generation</i>	Sources from the grid and relies on back-up generators for security	Encouraging more consumption of the mine's own generation or encouraging the mine to invest in expanding and upgrading power assets to avoid a grid reaching capacity	-The mine buys all power from the grid -The mine is encouraged to consume more of its generators to alleviate the grid -The mine upgrades or expands the grid network and gets refunded or gets bills credits -If allowed, the mine builds and operates the additional network capacity -The mine resorts to smart technology to be producer and consumer	-What are the existing commercial arrangements with the public utility to encourage more consumption of the idle capacity of own-site generators? -What are the existing commercial arrangements with the public utility to encourage the mining investment in the creation or upgrading of power assets? -What types of technological models are available to boost mining companies' participation in the electricity market either as a producer, consumer or both?
<i>Cross-Cutting Issue</i>	Coordination: <ul style="list-style-type: none"> - What are the benefits of more coordination? - What kinds of coordination mechanisms exist between the company and the country? - How can countries align the power generation investments of individual mining projects with the national plan when mining plans are time-sensitive and public-private coordination takes time? - What are the consequences of the lack of coordination? 			

1. Situation One: There is no grid or the grid is too remote from the mining area

In the situation where there is no grid, mining companies are forced to construct their own generation facilities. Without an established distribution/transmission system, the only way for host governments to benefit from mining investments is to encourage or require mining companies to supply electricity to local communities, either by building a micro-grid around the mine site, or through the provision of off-grid distributed power

systems. In this situation, the challenge for the government is to articulate a plan stating when mining companies' contribution to development stops and when government's prerogatives start.

Relying on off-grid supply to local communities

Some mining companies insist on the provision of local electricity as part of their corporate social responsibility. In Papua New Guinea, for example, some neighboring villages have been supplied with a few solar panels, but such endeavors are not part of any mandatory or systematic program. As a matter of fact, the government of Papua New Guinea has even tried to make the local provision of electricity a contractual requirement but the loose language leaves the requirement to company's judgment call (see box 1).

Box 1: Papua New Guinea – Loose legal language and companies' corporate social responsibility programs

In Papua New Guinea, a standard mining development contract drafted in 2010²⁰ introduces the possibility for the mining company to generate electric power in excess of the project's needs in order to meet local rural requirements but also stipulates that "[t]he Company (Joint Venturers) shall under no circumstances be required to increase the capacity of its electric power supply facilities or transmission facilities beyond that required by the Approved Proposals for Development to meet the needs of any other users or to construct or maintain any off-site grid or distribution system."

Given this loose requirement, companies either invest in electricity generation exclusively for their own needs, or in some isolated cases, supply electricity to local communities as part of their corporate social responsibility program. As an incentive, the government also grants tax credits (Infrastructure Tax Credit Scheme (ITCS)) in exchange of spending up to 0.75% of the value of the project's gross sales on approved infrastructure projects.²¹

The owners of Lihir Gold Limited, for example, contracted with the Australian company Rainbow Power Company to install a US \$164,000 project, including 8 solar panels, 12 batteries, and 6 fluorescent lights on some villagers' homes on Lihir Island.²² The operation was advertised as part of the corporate social responsibility initiatives of the company.

Even if some of those projects have significantly contributed to the economic development of local communities, such projects are few and far between. Rarely do they fit into a systematic approach or into any regulatory framework. For instance in Guinea in the Siguiri mine, the company coordinated a plan with the local government to equip the community with electricity, but only after protests (see box 2).

²⁰ Standard Mining Development Contract Draft between the Independent State for Papua New Guinea and (name of the company) (2010), Article 5.7, available at:

<http://www.mmdaproject.org/presentations/PNG%20Full%20Revised%20Standard%20MDC.pdf>.

²¹ G. Hancock, "Sustainability of mining impacted communities in Papua New Guinea. Fiscal revenue sharing mechanisms: Status and Practice," Workshop on sustainability and the governance of mining revenue sharing on April 4-5, 2001 (Washington, D.C.: World Bank, 2001), available at:

<http://siteresources.worldbank.org/INTOGMC/Resources/miningtaxationghancock.pdf>.

²² Rainbow Power Company, "Solar power for village homes," available at:

<http://www.rpc.com.au/products/services/faq-info/lihirarticle23oct.html>.

Box 2: Guinea – AngloGold Ashanti forced to procure the community with electricity to save its social license to operate

In Guinea, “AngloGold Ashanti commissioned a new electric power line from Siguiri mine to the nearby town, and provided two Caterpillar generator sets to give the community 1.2MW of power”,²³ explains the World Gold Council on its website, but this initiative came as a result of villagers’ protests against AngloGold Ashanti for failing to provide services to the local community. With the electricity provision to the community, the company and the local government came up with a plan featuring the following breakdown of tasks between the parties:²⁴

- The government is responsible 1) for the design of the power transmission line and circuitry (the approval of the mine’s Engineering Department is needed to ensure compatibility and define boundaries); 2) for the maintenance of transformers, the overhead line and line switches for transmission reticulation; 3) for fuel supply to the generator sets.

-The company is responsible for providing the generators to the town, maintaining the generator sets and the switchgear, shut the plant down once every week for three hours to conduct maintenance on the sets. The mine is entitled to disconnect power generation to Siguiri town in emergencies to ensure that there is no disruption in production at its operations.

Although this plan comes after protests, the merit of this plan between AngloAshanti and the local government is to articulate the responsibilities of both the company and the government, notably in terms of responsibility for operations and maintenance. This latter responsibility is often not borne by the company, not planned for by the government and consequently the investment of the mine in the community is often not sustainable.

Requiring the provision of local electricity supply under the concession agreement

Another solution used by host countries to make sure that mining investments in electricity generation would benefit local communities has been to require mining companies to supply local electricity as a condition to the granting of the mining concession. In Liberia, for example, the government requires the mining company building a power plant to design excess capacity for neighboring communities (see box 3).

Box 3: Liberia – Contractual Requirement to designing excess capacity for the community

In Liberia, the government negotiated with the Putu project’s mining operator the following clause: “the Power Plant shall be designed to generate a quantity of electric energy in excess of the electric energy required by the Company for Operations to supply third party users located within a 10 km radius thereof on a 7 days per week, 24 hours per days basis in accordance with third party user demand from time to time. The Company may charge residential users reasonable rates for their power usage based

²³ World Gold Council, “Sharing utilities: mines extend water and power to communities,” (2012), available at: <http://www.goldfacts.org/en/society/utilities/>

²⁴ AngloGold Ashanti, “Guinea Report 2008”, p/ 28-29. , available at : http://www.anglogold.co.za/NR/rdonlyres/4A3DD0C1-6C99-46D8-B6E8-1E105D53B1BA/0/guinea_report_2008.pdf

upon their ability to pay. The Company may charge businesses commercially reasonable rates for their power usage. The Company shall provide electric power free of charge to non-profit organizations and Government agencies.”²⁵

Moreover, section 19.3(d) requires the Power Plant to be designed and constructed in a way that allows expansion “on a commercially feasible basis to have twice the electricity generating capacity required to service Operations.”

Developing model concession agreements mandating the provision of electricity within a certain radius would increase certainty for investors, as well as put all mining companies on an equal footing with regards to their corporate social responsibility programs.

Those mandatory requirements should stem from a policy framework encouraging, targeting and planning around the decentralized energy generation of the mines. Indeed this decentralized energy can be an essential opportunity for the remote communities from the grid given its advantages: efficiency is improved at the facility level (capacity is tailored to the demand), losses on the transmission lines are reduced (given that higher voltages are hard to carry over long distances, a reduction in the haulage distance increases efficiency), smaller technologies such as renewable energies are easier to develop for logistic reasons.²⁶ However without a policy framework, decentralized energy will not benefit the communities.

In Papua New Guinea, mining companies call on the state to create a framework that would give an incentive to wider private participation. In particular, their criticism focuses on the lack of operating and maintenance budgets from the local governments, insufficient subsidies to end-users hampering the development of viable commercial markets, and the lack of “Community Service Obligation” (CSO) financing.²⁷

In addition, this policy framework should consider the question of sustainability of the investment beyond the closure of the mine: who is ensuring the maintenance of the system? What is the succession plan for the power infrastructure after the mine closes? Should the community pay for the electricity? and if so, at which reasonable charges?

As part of the answers to those questions, the framework should consider whether the energy demand coming from the mine cannot and should not be leveraged to expand the grid to these remote areas to connect those islands of mine-based decentralized energy.

Leveraging the mining’s energy demand to assess the expansion of the grid to remote areas

- Feasibility

²⁵ Mineral Development Agreement between the Government of the Republic of Liberia and Putu Iron Ore Mining, Inc., dated as of September 2, 2010.

²⁶ A. B. Lovins and H. L. Lovins, *Brittle Power: Energy Security for National Security* (Andover, Massachusetts: Brick House Publishing Company, 1982) pp. 223, 231, 232.

²⁷ Asian Development Bank, “Town Electrification Investment Program, Sector Assessment (Summary): Energy,” available at: <http://www2.adb.org/Documents/RRPs/PNG/41504/41504-01-png-ssa.pdf>.

Expanding the grid to connect the different mines raises a series of financial and technical challenges that are specific to each country and case. The overall costs depend both on the load of power that each connected mine needs and the distance: the greater the power needs of the mine and the shorter the distance, the lower the levelized unit cost of power transmission.

In Liberia, for example, connecting concessions and their power generation assets to the grid would be economically effective for only some of them (see box 4).

Box 4: Liberia – Expanding the grid is not economically rational for all concessions

In Liberia, for example, a World Bank report estimates that annual iron ore production requires 10 to 20 MW/million tons. As for gold, a small to -medium sized mine consumes 30 to 50 MW/million tons annually. Under this scenario, the levelized unit cost (LCOE)²⁸ of power transmission according to the report, is less than half a dollar cent per kilowatt-hour for an iron ore mine and less than one dollar cent per kilowatt-hour for a gold mine.²⁹

Because of the small differentials in power generation costs between grid power and power produced at mines, it would be cost-effective to expand the national grid and incorporate mining projects. The grid expansion would allow the mines to either buy from the grid or sell to the grid.

On the other hand, because agriculture and forestry concessions demand much less electricity (1 MW per concession maximum), connecting those operations to the grid would be uneconomical in most cases and powering them through their own-power based on biomass residuals would be a more cost-effective solution.³⁰

- Financing the grid expansion

Connecting mines' own-site generation to the grid is also beneficial for the mine. The advantage lies in the increase in reliability and elimination of the need to buy energy storage, since the excess electricity can be sold back to the grid. Therefore the question is who is financing the grid expansion? It will depend on the arrangements with the public utility but as a general rule, financing the grid expansion often relies on state participation, especially when it comes to connecting remote areas. Public participation is particularly justified in a context where the infrastructure is used by the public. In Quebec, where the strategy is to leverage mining companies' presence to expand the grid to remote Nunavik, the participation of the provincial government depends on the "value of the benefit granted and the level of risk involved" (see box 5).

Box 5: Quebec – Equity interest in exchange of infrastructure

Quebec government hopes to extend the transmission grid to Nunavik to supply mining operations in the territory. The extension of the electrical grid toward Nunavik will seek to fulfill a number of objectives: the provision of power to mining operations across the

²⁸ Levelized costs represent the present value of the total cost of building and operating a generating plant over its financial life, converted to equal annual payments and amortized over expected annual generation from an assumed duty cycle

²⁹ Those assumptions, however, are very case sensitive and the study assumptions were that for an iron ore mine, power demand would be 100 MW and for a gold mine, it would be 30 MW.

³⁰ World Bank, "Leveraging investments by natural resource concessionaires," 2011, op.cit

territory; the connection of various Nunavik communities to Hydro-Québec's main electrical grid, which will replace current electrical production generated by local thermal power facilities with clean, renewable hydropower; and the integration of future hydroelectric installations in Nunavik.³¹

In Quebec province, mining companies are responsible for the provision of their own infrastructure where access to existing networks or grids is limited. However, while public infrastructure projects may help lure mining investments in northern Quebec, the provincial government will determine the government's participation in infrastructure development along common good and shared use criteria.³² The size of the government interest "will depend on the value of the benefit granted and the level of risk involved."³³ Quebec has already notified thirteen developers of its government's interest in taking a stake in their projects.³⁴

Financing the grid expansion is a very expensive undertaking for a country and the challenge is often to earmark enough revenues for it. In Brazil, wire charges (i.e. fees paid to access transmission lines, levied on generators) feed public benefits funds, which then invest in energy efficiency, renewable energy, energy-related research and development, as well as assistance to low-income customers in electricity provision.³⁵ The example of Brazil provides an additional way to leverage the mining generation: wire charges could be collected from the mines when they connect to the grid. As will be seen further in Situation 2, those charges should be reasonable enough to work as an incentive for the mine to connect to the grid.

2. Situation Two: There is a grid and sourcing from the grid is more expensive than own-generation

In the situation where the electricity provided by the grid is more expensive than own generation, mining companies have a clear incentive to invest in their own power generation. Therefore, the challenge for host countries is to develop incentives for the mining industry to build additional generation capacity and increase domestic supply to the grid, which would help reduce the cost of the grid electricity in return.

In the context of difficult geopolitics, increasing domestic supply is particularly encouraged. In the case of Mongolia, for example, mining companies invest in own-built generation because the government is searching to gain independence from the neighbors (see box 6).

³¹ F. Tomesco, "Quebec Aims to Boost Mining With Infrastructure in Budget," *Bloomberg News* (March 21, 2012), available at: <http://www.businessweek.com/news/2012-03-20/quebec-aims-to-boost-mining-with-infrastructure-in-budget>

³² "Les infrastructures reliées aux projets, c'est l'affaire des minières," *Les Affaires* (February 18, 2012), available at: <http://www.lesaffaires.com/archives/generale/les-infrastructures-reliees-aux-projets-c-est-l-affaire-des-minieres---jean-charest-premier-ministre-du-quebec/541038>

³³ Tomerco, "Quebec aims to boost mining with infrastructure in budget," 2012, op. cit.

³⁴ Québec and Its Natural Resources, Finances Québec, Budget 2012-2013, available at: <http://www.budget.finances.gouv.qc.ca/Budget/2012-2013/en/documents/resources.pdf>

³⁵ See Brazil Law No. 10848 of 2004. See also G/ de Martino Jannuzzi and A. Poole, "Public benefit funds are not enough to secure energy efficiency and energy R&D activities: Lessons from Brazil," (2006), available at: <http://www.fem.unicamp.br/~jannuzzi/documents/1692006ACEEE.pdf>

Box 6: Mongolia – Avoiding foreign dependence

The Oyu Tolgoi mining project, a joint venture between the Government of Mongolia, Ivanhoe Mines, and Rio Tinto, will start commercial operations in 2013. It will produce 450,000 tons of copper and 330,000 ounces of gold per year. It needs 600 MW for its operations at peak production.³⁶ For now, diesel generators provide the necessary energy, but Oyu Tolgoi LLC has been allowed by the government of Mongolia to build a 600 MW dedicated coal-fired power plant.³⁷

The project developers had also planned to build a 220 kV 170km transmission line through the desert to connect the project to the Chinese grid and sign an additional power purchase agreement with the governments of China and Mongolia to allow Chinese electrical power to be imported into Mongolia.³⁸ But this project has raised concerns from the government of Mongolia for two reasons. First, the government does not want to rely solely on one source of power, and wants to develop and control its own generation capacity. Second, receiving electricity from China would mean higher costs of electricity supply than local power plants.³⁹ As a result, it has been agreed that the transmission line to China will be considered as a “stop-gap measure.” In addition, the government of Mongolia foresees that any private line which connects to the Central Electric System and which is of or above 220 kV must be state-owned.⁴⁰ Moreover, Oyu Tolgoi mining contract even foresees that all the electric power must be sourced from within Mongolia after four years of mine life.⁴¹

Those private initiatives occur in a context where the government is focused on the development of a Programme for an Integrated Power Energy System. Its goal is to extend the power supply to all the country’s areas, build additional power projects under PPP/BOT agreements, reduces exports and increases its power independency from its neighbors China and Russia.⁴²

In Chile, similarly, the government seeks independence from its neighbors after Argentina started, in 2004, to substantively reduce natural gas exports to energy – poor Chile. But interestingly as opposed to Mongolia, instead of requiring investment in own-generation, the government asked the mining industry to invest in energy efficiency (see box 24).

As we saw in Introduction, mining companies can benefit from a gain in marginal cost if extra capacity is built. Yet even if the marginal capital costs are lower, an appropriate

³⁶ The International Bank for Reconstruction and Development / The World Bank, *Southern Mongolia Infrastructure Strategy* (Washington D.C.: The International Bank for Reconstruction and Development / The World Bank, 2009), available at: http://siteresources.worldbank.org/INTMONGOLIA/Resources/SMIS_July.pdf

³⁷ A. MacDonald, “Ivanhoe to build Oyu Tolgoi power plant by 2017,” *Market Watch* (December 9, 2011), available at: <http://www.marketwatch.com/story/ivanhoe-to-build-oyu-tolgoi-power-plant-by-2017-2011-12-09>

³⁸ Ivanhoe Mines, “Ivanhoe Mines announces 2011 financial results and review of operations – Oyu Tolgoi copper-gold-silver project on track to start initial production in third quarter of 2012,” 2012, op. cit.

³⁹ IBRD/World Bank, “Southern Mongolia Infrastructure Strategy”, 2009, op. cit.

⁴⁰ Oxford Business Group, *The Report: Mongolia 2012* (2012), p. 117

⁴¹ P. Ker, “Rio Tinto in Mongolian power struggle,” *Brisbane Times* (March 21, 2012), available at: <http://www.brisbanetimes.com.au/business/rio-tinto-in-mongolian-power-struggle-20120321-1vj1f.html>

⁴² IBRD/World Bank, “Southern Mongolia Infrastructure Strategy”, 2009, op. cit.

legal and regulatory regime is needed to encourage the mining investment in power generation beyond their own needs.

Developing the appropriate regulatory framework

- Need for a power sector reform?

To induce more investment in additional generation, most emerging and developed countries have gone through a power sector reform since the 1980's (starting with Chile) to unbundle the natural monopoly activities (transmission, distribution) from the competitive ones (generation, trading, supply) as well create a competitive wholesale and/ or retail market⁴³. The principal features of this standard model of reform are "1) stand-alone transmission company, 2) privately-owned, competing generation companies that bid into a bulk/wholesale power pool, 3) supply competition for all or part of the retail market, 4) third-party access to transmission and distribution on non-discriminatory, transparent terms, 5) independent and transparent regulator".⁴⁴

Realizing the insufficiency of public funds for new generation as well as the poor performance of the state-owned utilities, Sub-Saharan Africa has also gradually followed the trend of power sector reform and according to the World Bank Africa Infrastructure Country Diagnostic (AICD) covering 24 countries in Sub-Saharan Africa, all those countries besides a few exceptions enacted a power sector reform law: "three-quarters introduced some form of private participation in power; two-thirds corporatized their state-owned power utilities; a similar number established some kind of regulatory oversight body; and more than a third have independent power producers in operation."⁴⁵ However the impact of the reform has remained limited and the general model is a hybrid model whereby the national state-owned utility, still vertically integrated, holds a dominant market position, by imposing a single buyer requirement and keeping its own generation plants (this situation is now contested by mining companies in South Africa – (see box 13)). The private participation though limited however exists, notably in the form of Independent Power Producers (IPPs). While waiting for the power sector reform to be furthered beyond the hybrid model⁴⁶, countries in Sub-Saharan Africa can still create regulatory incentives to leverage the electricity demand of the mines and encourage companies to generate extra capacity to be sold back to the grid: those incentives include strong IPP and PPA legislations as well as an independent regulator mechanism regulating tariffs and access charges to ensure IPPs' power sales happen on equal terms with existing generators.

⁴³ A wholesale market is a market where a generator does not sell directly to the end-users, but to public and/or private retailers, including, for example, transmission and distribution companies.

⁴⁴ S.Hunt, Making competition work in electricity, (New York: Wiley:2002)

⁴⁵ A. Eberhard, V. Foster, C. Briceño-Garmendia, F. Ouedraogo, D. Camos, and M. Shkaratan, "The State of the Power Sector in Sub-Saharan Africa," Africa Infrastructure Country Diagnostic, Background Paper 6, (Washington, D.C.: World Bank, May 2008)

⁴⁶ Note, that in its report in 2003, the World Bank recognizes that the standard model of power sector reform is not necessarily applicable to developing countries after championing it for years. See Private Sector Development in the Electric Power Sector: A Joint OED/OEG/OEU Review of the World Bank Group's Assistance in the 1990s (Washington, D.C.: World Bank, 2003)

- Developing IPP legislation licensing generators to sell to the grid

An IPP is an entity, which is not a public utility, but which owns facilities to generate electricity for sale to utilities and sometimes end users. Developing an IPP legislation is therefore necessary when the public utility cannot afford investments in additional power generation and transmission, and when the mining investments in power generation can supplement the public utility's investments. South Africa and its public utility Eskom are in the throes of this reform (see box 7).

Box 7: South Africa – Endeavors to increase private participation in the power sector Although Eskom, the State-owned power utility, does not have exclusive generation rights in South Africa, it generates approximately 95% of the electricity used⁴⁷ and maintains the national grid. In 2009, IPPs generated less than 2% of the electricity produced in South Africa.⁴⁸ Prior to the 2008 electricity crisis, self-provision was seen to be prohibitively expensive and risky, but that is changing because of a better local understanding of the available technologies, a substantive increase in Eskom tariffs and a deterioration of electricity supply by Eskom. The government has implemented reforms to facilitate investments by IPPs. Eskom has been suffering from severe financial losses and can't afford generation investments any longer. A law has been passed in Electricity Regulation Act No. 4 of 2006 (the Act)⁴⁹ and under the pressure of the mining sector and of the energy industry more generally, a new law is being discussed to improve market conditions for private participants (see box 13).

Before developing IPP legislations, some countries such as India have developed the Captive Power Plant (CPP) status for those entities willing to generate power for their own needs, but with *no* intention to sell to the grid. India provides for an interesting illustration (see boxes 8, 9 and 17) of a country that faced with systematic power shortages, under-capacity of the national power network and limited impact of the reform of the power sector⁵⁰ decided to leverage companies' own generation. For this reason the Indian government has progressively changed the CPP legislation to allow CPPs to sell to the grid and operate as IPPs (see box 8).

Box 8: India – The regulatory framework and economics of CPPs

The Central Government has supported the development of an independent power generation industry under its National Electricity Policy of 2003⁵¹ and has subsequently

⁴⁷“Company announcement: Coal supply agreement executed with Eskom,” *Mining Weekly* (March 6, 2012), available at: <http://www.miningweekly.com/article/company-announcement-coal-supply-agreement-executed-with-eskom-2012-03-06>.

⁴⁸ Reegle, “Energy profile: South Africa,” available at: <http://www.reegle.info/countries/south-africa-energy-profile/ZA>

⁴⁹ Government of South Africa, Electricity Regulation Act No. 4 of 2006, available at: <http://www.energy.gov.za/files/policies/Electricity%20Regulations%20on%20New%20Generation%20Capacity%201-34262%204-5.pdf>.

⁵⁰ Hansen identified factors for a successful standard power sector reform and noticed that they haven't been fully present in India: functioning transmission grid with adequate capacity and regular maintenance regime, high regulatory capacity, robust legal system and enforceable contracts, robust distribution companies, both physically and financially, slow demand growth, restriction imposed on the monopoly power of the incumbent. See: C. Hansen, “Bottom Up Electricity Reform Using Captive Generation: A Case Study of Gujarat, India,” (Oxford Institute for Energy Studies, March 2008)

⁵¹ Government of India, Electricity Act of 2003, available at: http://www.powermin.nic.in/acts_notification/electricity_act2003/pdf/The%20Electricity%20Act_2003.pdf

progressively lifted the licensing requirement for electricity generation.⁵² In addition in 2008, the National Electricity Act of 2003 was altered to authorize the sale of electricity at the Indian Energy Exchange (IEX), through which CPPs can sell to both companies and State Electricity Boards. The idea was to create a platform for the quick sale of electricity to users that would be faced with shortages of power.⁵³

In this regulatory context, the economics of CPP happens to be more favorable compared to that of traditional grid generators for three reasons. First, CPPs may be able to pass on increased feedstock costs to consumers via the end product being manufactured by the parent plant,⁵⁴ whereas traditional generators generally have to absorb any increase in feedstock costs. Second, Indian CPPs have been able to sell on a spot basis, taking advantage of power shortages. Third, Indian CPPs generally employ cogeneration (using the waste heat from industrial processes such as cement manufacturing), which increases the efficiency and lowers the marginal cost of power production. Since CPP power costs can be half that of grid generators, many companies prefer buying electricity from CPPs rather than electricity from the public grid, which is more expensive.⁵⁵ In addition the 2010 Indian regulation⁵⁶ allows a renewable energy supplier to sell to a distribution licensee at a price to be fixed at the “pooled cost of power purchase”, meaning the weighted average price of electricity generation (including cost of self-generation) that the distributor has purchased from all energy sources to the exclusion of renewable energy sources (which includes cogeneration): the generator can therefore keep the profit margin if renewable energy is cheaper to produce than the average.

For these reasons, some Indian CPP operators have reported large profits. For example, Jindal Power (a subsidiary of Jindal Power and Steel) almost sells half of the electricity produced in its CPPs.⁵⁷ Jindal Power plans to add another 2,400MW of generating capacity to its existing plant. Essar Group, currently uses 85% of its 1,600MW power for captive purposes (steelworks and refining operations), and sells 300MW to the state electricity authority pursuant to a 20 year power purchase agreement, based on a 13% return on equity. Any increase in fuel or other costs is passed on to the customer. Essar Group has announced plans for a 10,000MW expansion plan mainly focused on non-captive off-take that would reduce captive use to just 20%.⁵⁸

Regardless of the distinction between IPP and CPP, one of the key elements lies in the regulation of licensing, be it for the development of the generation facility or for electricity trade. The regulations applicable to licensing, the nature of the licensing

⁵² See Electricity (Amendment) Act of 2007, available at http://www.powermin.nic.in/acts_notification/electricity_act2003/pdf/Electricity_Act_2007.pdf

⁵³ “Power to the captives”, *Forbes India* (October 27, 2009), available at: <http://forbesindia.com/article/breakpoint/power-to-the-captives/6102/1>

⁵⁴ “Fuel crisis hinders ambitions of captive power,” *Business Standard* (February 14, 2012), available at: <http://www.business-standard.com/india/news/fuel-crisis-hinders-ambitions-captive-power/464604/>

⁵⁵ “Power to the captives”, 2009, op.cit

⁵⁶ Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, 2010, available at:

http://cercind.gov.in/Regulations/CERC_Regulation_on_Renewable_Energy_Certificates_REC.pdf

⁵⁷ “Fuel crisis hinders ambitions of captive power”, 2012, op. cit.

⁵⁸ “Power to the captives”, 2009, op. cit.

administration and the speed of its process will more or less create market incentives for the firms to invest in additional generation. The process can also be simplified by forgoing the licensing requirement for the generation stage, as it is the case in India, although Indian authorities still require a license for interstate electricity trading⁵⁹ and the CPP operator still needs to comply with a series of technical requirements to ensure the quality of the electricity supplied.

- Developing Power Purchase Agreement (PPA) legislation

Where capacity expansion is required, the investment costs must be recoverable and revenue streams sufficiently definite into the future to enable the owner to obtain financing on reasonable terms. Therefore, regulations may allow providers and customers to enter into long-term contracts whereby the customers (the utility or other users) commit to buying a minimum amount of capacity from the owner over a longer period. This is generally preferred by infrastructure service providers as it provides more certainty and is usually necessary to obtain financing for the investment required. Therefore developing the appropriate framework for such contracts that are called Power Purchase Agreement (PPA) in the power sector is a key factor to ensure the participation of mining companies in electricity generation. In addition to indicating who would buy the power, “a strong PPA details quantity and cost of power bought, dispatching of plants, fuel metering, interconnection, insurance, force majeure, transfer, termination, change of legal provisions, refinancing arrangements and dispute resolution mechanisms”.⁶⁰

A first type of PPA arrangement is signed between the mining company, as electricity generator and seller, and its purchaser. As an increasing number of mining companies decide to vertically integrate with power operations, this arrangement is more and more common in the mining industry. Firstly, the purchaser under the PPA can be the public entity as a single buyer, this is the case in most of the countries in Africa. Secondly, if the system is structured as a wholesale market, the PPA can be signed with the entities owning the distribution lines.

In markets that went through further reforms and that are qualified as being retailed markets, the PPA can also be signed directly between the mining company and a large-scale user, either another large-scale industrial entity or a group of customers that offers guarantees of sufficient financial capacity as well as demand stability to constitute a profitable client under the PPA. When the utility’s financial capacity is limited or not creditworthy and the generator can count on the presence of large customers, the absence of single-buyer requirement is usually an incentive for mining companies to invest in extra-capacity. The challenge of this arrangement is that generators would “capture” large-scale end-users, thus leaving the public utility with low-income customers, and therefore lower revenues as in the case in India (see box 9).

⁵⁹ Central Electricity Regulatory Commission (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2008, No. L-7/143/158/2008-CERC.

⁶⁰ K. N. Gratwick, and A. Eberhard, “An Analysis of Independent Power Projects in Africa: Understanding Development and Investment Outcomes,” *Development Policy Review* 26 (3): 309-338 (2008), available at: http://regulationbodyofknowledge.org/wp-content/uploads/2013/09/Gratwick_An_Analysis_Of.pdf

Box 9: India – Discrimination against CPPs to save the business model of the utilities

India's CPPs are facing problems. Firstly, local governments are quite resistant, as there have strong vested interests in their state-owned generating and distribution companies; some state policies even discriminate against captive power plants by levying various charges (such as charges for grid support, high sales tax, etc.) that discourage market entry and distort the market in favour of the incumbent. Secondly, regulators in certain states are beginning to clamp down on CPPs, fearing that too great of a migration of industrial customers away from grid generators toward CPPs will damage the Indian cross-subsidization model, whereby industrial customers pay a higher tariff to subsidize residential and agricultural customers. For example, in the Maharashtra state, the government plans to raise the maximum electricity duty charged on CPP owners (including alternative energy producers) by four times, as well as the duty charged on electricity produced by CPPs to third-parties.⁶¹ The idea is to hamper the development of CPPs, because if industrial users all use power generated by CPPs, the public electricity provider will not have any customers but below-poverty line end-users and farmers. Finally, the Indian state of Gujarat elected to charge CPPs a fee for using the distribution network, and made them provide in-kind compensation for transmission losses; for example, to sell 1MWh to a customer, the CPPs had to provide 1.11MWh into the grid.⁶² This has made CPP economics difficult and given no incentive to the distribution company to reduce losses.

A second type of PPA arrangement is signed between the mining company, as a purchaser and a seller, a third-party electricity generator that can provide both power and ancillary services (e.g. transmission system monitoring, voltage control, scheduling and dispatch, metering and billing, etc.). In jurisdictions where this status exists, this third party generator will be an IPP. Three reasons explain why a mining company would contract with a third party:

- the third party provides cheaper electricity than the public provider,
- the public provider does not provide sufficient electricity,
- the mining company decides that electric generation is not part of its business model.

Under this model, the IPP bears the risks and obligations associated with ownership, including commercial risks and maintenance obligations (see box 10). The mining company can have an equity stake in this IPP to keep some control over the development and management of the generation facilities.

Under this model, the mining industry serves as anchor customers for third-party investments in power generation. (See also the example of Zambia in box 18.)

Box 10: South Africa – Anglo American and its IPP

To power its platinum mine that requires a secure power supply for continuing operations as well as future expansion, Anglo American is seeking to sign for a 450 MW coal-fired power project with an IPP in Emalahleni municipality, South Africa. It is a build-operate-and-own project planned to start commercial operations in 2015. This

⁶¹ Indianpowersector.com, "Maharashtra Plans to Raise Duty on Captive Power Plants," (December 2011), available at: <http://indianpowersector.com/2011/12/maharashtra-plans-to-raise-duty-on-captive-power-plants/>; "Additional Duty on Captive Power Generation Irks Industrialists," *Indian Express* (March 4, 2010)

⁶² Hansen, "Bottom Up Electricity Reform Using Captive Generation: A Case Study of Gujarat, India", 2008, op.cit.

project “navigate[s] the relatively uncharted territory related to third-party use of the transmission and distribution system”.⁶³

Tasks among the different parties are allocated as follows:

(1) Role of Anglo American. Anglo American provides the land, the coal (the developer will have access to the discard dumps of Anglo American Thermal Coal),⁶⁴ and the water (coming from Anglo American’s Emalahleni Water Reclamation Plant from BHP Billiton’s closed South Witbank mine). Anglo American is also the loan facilitator, in charge of securing financing through international loans (Capex US\$ 1 billion).⁶⁵

(2) Role of IPP. Anglo American plans to sign a Coal Supply Agreement and a 25-year Power Purchase Agreement with the IPP to buy its entire capacity. In addition, Anglo American will sign Supplementary Supply Agreements with Eskom to use the electricity produced at the IPP plant for the mining operations.⁶⁶ In parallel, the IPP signed Connection, Transmission, Use of System and Operating Agreements with Eskom to allow the IPP to sell its electricity to Eskom, and an agreement was also signed between Anglo American and Eskom in order for Anglo American to off-take power from a substation to be built by Eskom.⁶⁷

(3) Role of the public electricity provider. Under the government’s electricity strategy laid out in its Integrated Resource Plan,⁶⁸ Eskom is in charge of determining the terms of the connection agreements, the timing of the infrastructure, the use of System costs (Anglo American criticizes this legal framework and judges that the costs are too high by international standards, and that there is insufficient support to guarantee a fair allocation of costs.)

(4) Role of other public agencies. The National Energy Regulator of South Africa (Nersa) and the Department of Energy provide support to facilitate the contractual arrangements for third-party use (regulatory framework, appropriate pricing, timing of connection), and they must approve them.

Interestingly, Anglo American states that some of the project’s goals, in addition to serving for self-generation, include the need to contribute to local development, i.e. community needs, skills transfer, the development of secondary industries, as well as the provision of affordable electricity services “at no additional cost” to Eskom, the National Treasury or the consumers of South Africa, and to regional development.⁶⁹

In the case of Exxaro, this is the mining company itself that engages in the business of either third party generator or facilitator given the high expected proceeds and the opening of the power market in South Africa. For this purpose Exxaro created the subsidiary Exxaro Energy (see box 11).

⁶³ T. Creamer, “First power from Anglo American’s proposed discard-coal IPP targeted for 2015,” *Mining Weekly* (July 14, 2011) available at: <http://www.miningweekly.com/article/first-power-from-anglo-americans-proposed-discard-coal-ipp-targeted-for-2015-2011-07-14-1>.

⁶⁴ M. Creamer, “Questions stream in ahead of Anglo American thermal coal’s IPP deadline,” *Mining Weekly* (October 19, 2011), available at: <http://www.miningweekly.com/article/reams-of-questions-stream-in-ahead-of-anglo-american-thermal-coals-ipp-deadline-2011-10-19>

⁶⁵ Ian Hall, “Khanyisa Project,” AngloAmerican Integrated Resource Plan public hearing presentation (December 2010), available at: http://www.doe-irp.co.za/irpJHB/ANGLO_AMERICAN_THERMAL_COAL.pdf

⁶⁶ Hall, “Khanyisa Project,” 2010, op. cit.

⁶⁷ Creamer, “Questions stream in ahead of Anglo American thermal coal’s IPP deadline,” 2011, op. cit.

⁶⁸ Integrated Resource Plan 2010, Draft Rev. 2 Report, p. 22 – IRP Projects, paragraph 3 (section 6.a.)

⁶⁹ Hall, “Khanyisa Project,” 2010, op. cit.

Box 11: Exxaro – The development of an energy business for third-parties

Exxaro Energy owns and operates the power generation on behalf of hosts, which then buy Exxaro's electricity under a PPA.

Two of the strategic branches of Exxaro Energy are Exxaro Onsite and Exxaro IPPs.

- Exxaro On Site is a joint venture between Exxaro (51%) and Prana Energy (49%), a developer of clean power-generation facilities. 9 projects are forecast from 2012 to 2018 for total capacity of 400 to 600 MW. Exxaro On Site does project management, feasibility, securing of funding and construction, and then sell the power back to the host companies.⁷⁰
- Exxaro IPPs does not hold equity in the IPPs and does not finance them, but facilitates their creation so that Exxaro can sell coal to them and then secure for them the offtake agreements as well as obtain access to the grid on the basis of Eskom's generation being unbundled from the transmission entities as is envisaged by the reform (see box 13).⁷¹

- Setting up an independent regulator

Given that the public utility is a state-owned entity engaged in commercial activity, it is uniformly recognized that private participation in the power sector necessitates an **independent regulator**. In order to encourage the mining industry participation in the power market, this independent regulator will have the following mandates:

Mitigating risk: Where the seller under the PPA is an IPP that must invest in sufficient generation capacity, the regulator must be capable of assessing risks. Risks, for example, include delays in payment, which will increase capital costs and therefore electricity prices. Risk mitigation is particularly necessary in the situation where there is a non-viable state-owned single buyer with whom, in Africa, the PPA is typically signed. As a result, most IPPs accept PPAs only with utilities with sovereign guarantees, such as escrow accounts, currency conversion, repatriation of profits, guarantees against nationalization and expropriation, and political risk insurance offered by multilateral organizations such as the World Bank.

Regulating the tariff charged by the PPAs: The regulation of tariffs charged by the mining company selling under the PPA is necessary whatever the structure of the power market (vertically integrated with private participation, wholesale market or retail markets).

This might be considered as a price capping process for the mining companies selling electricity, but it also ensures the viability of the market. It is to be noted for instance that the cost of bulk power supply is generally 50 to 70% of the distributor's total supply costs.⁷² Therefore, captive customers supplied by a distributor who is the purchaser in

⁷⁰ Martin Creamer, "Exxaro expects to wheel electricity from four coal IPPs," *Mining Weekly* (July 2, 2010), available at: <http://www.miningweekly.com/article/exxaro-expects-to-wheel-power-to-customers-from-four-coal-ipp-2010-06-21>

⁷¹ Creamer, "Exxaro expects to wheel electricity from four coal IPPs," 2010, op. cit.

⁷² J. Besant-Jones, B. Tenenbaum and P. Tallapragada, "Regulatory review of power purchase agreements: A proposed benchmarking methodology," (Washington, DC: The International Bank for Reconstruction and Development/ The World Bank Group, 2008), available at:

the PPA must be guaranteed that the price at which the distributor will buy the electricity will not be too high. In addition in Sub-Saharan Africa where 28 IPPs have been counted as of 2008, the price charged by the IPP under a PPA ranges from US\$ 0.04/kWh to 0.40/kWh⁷³, with the upper bound being often unaffordable for Sub-Saharan Africa public utilities.

One possibility is to cap PPA tariffs, like in the state of Andra Pradesh in India where the capped price is based on benchmarking specific parameters of the power generation process⁷⁴ but this method requires a micro-level regulation that may be too costly for regulators. The alternative is an overall benchmarking method, as used in Nigeria.

With the capping process, the challenge for the regulator is to avoid artificially fixing low prices, since this would prevent distributors from finding willing suppliers and hamper the long-term development of the electricity supply. A solution is to have a softer system where the regulator does not fix artificial prices, but reviews the prices that have been fixed by the parties, and issues comments on their reasonableness. See the case of Nigeria in box 12.

Box 12: Nigeria – A soft regulatory framework, but focused on risk mitigation

The primary role of the Nigerian Electricity Regulatory Commission (NERC) is to issue generation licenses and fix retail tariffs for electricity end-users.⁷⁵ For this purpose, it reviews PPAs for which parties are free to set terms, ensuring that prices are not too high and that risks have been appropriately allocated. It also requires the purchaser to sign a declaration stating that it can afford its financial obligations under the contract. The justification is that the prices and terms fixed in the PPAs, if inappropriate, can have a negative impact on electricity prices paid by the public, even if end-users are not parties to the agreement. The parties to the agreement are not required to follow the comments of the NERC. But if they do not, they risk being forced to prices set by the NERC. Indeed, the NERC caps the price at which distribution companies can sell to their captive customers under the NERC's planned multiyear tariff setting mechanism. As distribution companies themselves need to comply with this capped price fixed by the NERC, they cannot afford buying from generators at unreasonably high prices.

There are two exceptions to this review procedure. The NERC will not review the PPA where the customers of the purchaser under the PPA are not captive, i.e. where they have alternative sources of electricity. In addition, the NERC will not perform a risk assessment for suppliers generating a capacity of under 100 MW, but it will still request information on prices in order to assess potential impacts on general market prices.

The NERC is currently being asked to adopt more specific criteria to assess the fairness of tariffs. Those criteria could be based either on the "distributor's current average cost

http://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1266613906108/ESMAP_337-08_Regulatory.pdf.

⁷³ Besant-Jones, Tenenbaum and Tallapragada, "Regulatory review of power purchase agreements: A proposed benchmarking methodology," 2008, op. cit.

⁷⁴ Besant-Jones, Tenenbaum and Tallapragada, "Regulatory review of power purchase agreements: A proposed benchmarking methodology," 2008, op. cit.

⁷⁵ Nigerian Electricity Regulatory Commission, "Public Consultation on a Notice of Proposed Rulemaking (NOPR) for Review of PPAs to Supply Captive Customers," (Abuja: Nigerian Electricity Regulatory Commission, December 2006)

of power”, on a “percentage of the current end-user tariff,” on a “percentage of the utility’s total costs,” or on the “percentage of the utility’s total power distributed that would come from the new PPA”.⁷⁶

Across the world, PPA regulation is conducted differently with various levels of efficiency. The following table gives an overview of the possible ways to regulate PPAs in terms of conduct or performance.

Possible approaches to regulatory review of power purchase costs

Type	Regulatory Action	Regulatory efficiency	In force in following countries:
Conduct	Assist in negotiating PPAs	Lengthen the negotiation process	Kenya (Second wave of IPPs)
	Ex-ante PPA review	Reduce the need for regulatory intervention during the term of the PPA	Andhra Pradesh (India) and United States (1980s and early 1990s) and Panama
	Standardized/model PPA	Reduce transaction costs, ensures better visibility but parties still need to set the contract price and duration	Proposed in Pakistan and India
	Mandated competitive procurement guidelines ⁷⁷	The efficiency of those guidelines depends on the independent monitor ensuring the compliance	Proposed in Laos and Florida
	Independent procurement monitor		Issue public reports Southeastern United States: the affiliate problem ⁷⁸
Performance	Administratively specify a maximum price	Finding the right level is generally not in the capacity of the regulator	Chile: too low Pakistan: too high initially (did not benefit from competition) Nigeria: proposed as the generation component of the MYTO ⁷⁹
	Tie maximum price to competitive power sales	Works if the regulator can assess the competition correctly	Chile: maximum price in “nonfree” market can be no higher than 15% of “free” market price
	Benchmarking of overall power purchase costs of distribution companies	Ensure objective pricing standards – works if there are multiple distribution companies – works if not a lengthy process	Colombia and Netherlands;
	Benchmarking of individual PPAs		Proposed in Nigeria (2006)

Adapted from Besant-Jones, Tenenbaum and Tallapragada⁸⁰

Fees charged to access the network: In addition, power sector regulations include regulations of tariffs charged to access the distribution and transmission systems (which include wheeling charges⁸¹ and stand-by fees⁸² charged for utility’s services).

⁷⁶ Besant-Jones, Tenenbaum and Tallapragada, “Regulatory review of power purchase agreements: A proposed benchmarking methodology,” 2008, op. cit.

⁷⁷ Guidelines for Competitive Power Procurement issued for long-term power purchases by a single buyer or other entities such as distribution companies that are captive customers of the generation source.

⁷⁸ In the Southeastern United States, competitive procurement used to be required, but the problem is that distributors would pass on their costs to their suppliers and favor their affiliates. This system is only efficient if a regulator independently monitor compliance with the guidelines for procurement.

⁷⁹ Multi-Year Tariff Order: annually adjusted multiyear tariff that establishes the generation component of a maximum national retail price – applied in Nigeria.

⁸⁰ Besant-Jones, Tenenbaum and Tallapragada, “Regulatory review of power purchase agreements: A proposed benchmarking methodology,” 2008, op. cit.

For independent generators to be incentivized to connect to the grid, they should be guaranteed non-discriminatory prices, in particular in a context where the utility (or if a private company owning the transmission lines also owns generation facilities) might be tempted to increase its prices for competitors, and favor electricity produced by its own generators. Eskom, the South African public utility has been criticized by mining companies for exercising this kind of discrimination (see box 13).

Box 13: South Africa – Mining companies are asking for the unbundling of Eskom

The South Africa Electricity Regulation Act No. 4 of 2006 requires the generator to sell its electricity to Eskom, acting as “Single Buyer.” Mining companies have been pressuring the government to come up with laws that would be more favorable to independent production, without the single buyer requirement. Mining companies criticize the fact that they are required to sell their electricity to Eskom and that guarantee mechanisms are not set up to help them negotiate fair terms with Eskom for access to its electricity distribution network. To overcome this stumbling block, the plan is therefore to unbundle Eskom’s generation activities from the distribution network and put the latter in the hands of an independent agency, probably a state-owned entity. Eskom would then compete with other producers to sell their power to the independent agency at agreed tariffs and on an arm’s length basis.⁸³ The Electricity Regulation Second Amendment Bill of December 19, 2011⁸⁴ has been developed to address this criticism but has not yet been passed as of September 2012.

As said earlier the solution to the access issue and to the problem of the discriminatory price of interconnections in most electricity markets has been to unbundle and create a whole sale market to guarantee arm’s length negotiations between distribution companies and private generators. However, starting with an independent regulatory agency to oversee the system and resolve access and tariffs disputes (as described in box 14 for the case of Australia’ Northern Territory with its vertically integrated power utility) is already a fundamental step towards encouraging the participation of mining company’s own generation in the power market.

Box 14: Australia – Mechanism to resolve access dispute⁸⁵

The Utilities Commissioner is in charge of the regulation of the transmission and distribution businesses of the vertically integrated Northern Territory’s power utility, the Power and Water Authority (PAWA). The regulation consists in conciliating and arranging arbitration in any access dispute, monitoring compliance with the Electricity Networks (Third Party Access) Code of the Northern Territory, registering access

⁸¹ Wheeling charges are the rent paid to the owner of the transmission and/or distribution network for its use by third party.

⁸² Customers who receive their electricity from the grid are charged for their overall, continuous consumption. However, customers connected to the grid with onsite, non-emergency generation need additional services, such as system control, quality control, scheduling and un-scheduling of their connection to the system; they are therefore charged stand-by fees also called backup service fees.

⁸³ Claude Harding, “South African mines might start generating their own power,” *How We Made It In Africa* (February 3, 2012), available at: <http://www.howwemadeitinafrica.com/south-african-mines-might-start-generating-their-own-power/14794/>.

⁸⁴ Government of South Africa, Electricity Regulation Second Amendment Bill of December 2011, available at: <http://www.energy.gov.za/files/policies/ElectricityRegulationSecondAmendmentBill.pdf>.

⁸⁵ Adapted from Productivity Commission, *Review of the National Access Regime*, Report No. 17 (Canberra: Productivity Commission, 2001), available at: http://www.pc.gov.au/__data/assets/pdf_file/0020/18173/access.pdf

agreements and determining a revenue cap that will apply to the parties of the PPA. The revenue cap is set at a level allowing the electricity supplier to raise sufficient revenues to cover its operating costs, finance necessary new investment, and get a satisfying return on past investment. In addition, PAWA must produce a set of reference tariffs for standard network access services, which must then be approved by the Utilities Commissioner. Individual access charges are left to commercial negotiation but should remain within limits set by the annual revenue cap and subject to the reference tariffs.

In Western Australia where the utility is also vertically integrated, the regulatory regime requires the utility to provide indicative access prices calculated so as to recover the capital costs of providing the transmission and distribution network, capital investment in new works and a reasonable rate of return. The regulatory regime also requires the utility to make spare capacity and new capacity available to newcomers on a “first come, first served” basis, “so long as such investment is commercially viable.”

Planning for the supply and demand on the networks with IPPs: Intimately attached to sound policy and regulatory frameworks are coherent power sector plans. Ideally those plans would include “setting a reliability standard for energy security; completion of detailed supply and demand forecasts; a least-cost plan with alternative scenarios; and clarifying how new generation production will be split between the private and public sectors as well as the requisite bidding and procurement processes for new builds”.⁸⁶ Those plans would allow the regulation of the quantity and quality of electricity on the network in the short term and long term.

Indeed, with the new connections from the mining’s own generators comes the challenge of regulating the supply and demand of electricity. Where too little or too much energy in the network create dysfunctions in the power supply, it is essential to have a regulator to control volume on the network and order generators to either connect or disconnect, depending on the needs of the network, with sufficient notice. The regulator must find back-up supply in the case of shortages. In the case of expected surpluses, the regulator must order generators to engage in rerouting, load alterations, shedding (cutting off loads).

The regulator could resort to access charges to regulate the quality of the system. If the access charges are based on small duration availability rather than differentiating between peak and off-peak times, it will encourage generators to undertake internal demand management to reschedule production (where possible) to lower cost times, which in aggregate smooth power consumption, reducing power prices in peak times and closing supply gaps⁸⁷.

⁸⁶ Gratwick, “An Analysis of Independent Power Projects in Africa: Understanding Development and Investment Outcomes,” 2008, op.cit.

⁸⁷ Hansen, “Bottom Up Electricity Reform Using Captive Generation: A Case Study of Gujarat, India”, 2008, op.cit.

Summary: Policy and regulatory framework necessary to encourage the contribution of mining companies to the increase in generation capacity in the host country

Favorable investment Climate	Stable macroeconomic policies
	Legal system allows contracts to be enforced, laws to be upheld, arbitration
	Good repayment record and investment grade rating (for the public utility)
	Requires less (costly) risk-mitigation techniques to be employed which translates into lower cost of capital and hence lower project costs and more competitive prices
Clear policy Framework	Framework enshrined in legislation
	Framework clearly specifies market structure and roles and terms for private and public sector investments (generally for single buyer model, not, yet, wholesale competition in African context)
	Reform-minded 'champions', concerned with long run, lead and implement framework
Clear, consistent and fair regulatory supervision	Improves general performance of private and public sector assets
	Transparent and predictable licensing and tariff framework improves investor confidence
	Cost-reflective tariffs ensure revenue sufficiency
	Consumers protected
Coherent power sector planning	Energy security standard in place; planning roles and functions clarified
	Vested with lead, appropriate (skilled, resourced and empowered) agency
	Takes into consideration hybrid market (public and private stakeholders and their respective real costs of capital) and fairly allocates new build opportunities among stakeholders
	Has built-in contingencies to avoid emergency power plants or blackouts

Source: Adapted from Gratwick, K. N., and A. Eberhard. 2008⁸⁸

Encouraging group power plants

It is often the case that, when the upfront costs are substantive, companies benefit from partnering because of the related economic gains in terms of risk sharing and economies of scale. The partnership takes the form of joint ownership with other companies (being generators, electricity users or equity providers) of either a specific power plant (the consortium model or the special purpose vehicle model – to further diminish the financial risk exposure of the owners) or a company owning a portfolio of energy-related projects (the joint venture model). Having a local partner (private or state-owned) or a Development Finance Institution in those structures have been said to reduce the political risk.⁸⁹

Brazil (box 15) and Finland (box 16) present interesting examples of company partnership to finance massive hydro and nuclear plants.

Box 15: Brazil – Joint - investments to face the energy crisis

In 1999, the U\$240mn Igarapava hydroelectric power plant in Brazil began full operations with a total capacity of 210MW. The power generation project is a private sector consortium of mining and power companies: Companhia Siderurgica Nacional (CSN) (17.9%), CVRD (Vale) (38.2%), Cia Mineira de Metais (23.9%), Minas Gerais

⁸⁸ Gratwick, "An Analysis of Independent Power Projects in Africa: Understanding Development and Investment Outcomes," 2008, op.cit.

⁸⁹ Gratwick, "An Analysis of Independent Power Projects in Africa: Understanding Development and Investment Outcomes," 2008, op.cit.

integrated power company Cemig (14.5%) (former state-owned utility) and Mineração Morro Velho (5.5%). The project helped CSN, a Brazilian steel producer, gained an important competitive advantage with electricity costs around US\$5/MW, whereas sourcing from Eletrobras, the Brazilian state-run utility had a cost of US\$38/MW.⁹⁰

The energy crisis, in 2001, gave the mining sector a stronger incentive to invest in power generation. The aluminum industry was one of the most affected, accumulating losses of more than US\$ 500 million by the end of 2002, due to energy rationing, reduced production and export losses.⁹¹ Mining companies, therefore, decided to increase joint investments to ensure power supply and increase gains from economies of scale. In 2001, a consortium of mining and steel mill industries won the 35-year Santa Isabel hydroelectric concession. The consortium, Gesai, includes the following members: Companhia Vale do Rio Doce (43.85%), Billiton Metais (20,60%), Alcoa (20%), Votorantim (10%) and Camargo Correia (5,55%). The power plant has an installed capacity of 1,087 MW and costs approximately US\$ 720 million.⁹²

In Finland, the Mankala structure is a Finnish financing structure under which several industrial customers pool their resources to finance their shares in a generating facility. This structure mitigates the electricity market risk, since the revenues of the generator are secured by long-term off-take agreements with its owners (see box 16).

Box 16: Finland – The Mankala pooling structure

Fennovoima is a Finnish company owning nuclear power plants generating more than 2,500 MW. It has 68 shareholders, including the mining company Talvivaara Mining Company, which owns a share of 60 MW.⁹³ Altogether, Fennovoima's shareholders use more than one third of the national electricity consumption. Shareholders pay for the fixed and variable costs of generation in exchange for at-cost electricity and return rates according to their respective shares.⁹⁴

The second example is Tellisuuden Voima Oyj (TVO), structured as a non-profit organization. All the shareholders are jointly liable for TVO's annual fixed costs, even in cases where electricity is not produced. Those costs amount to 80 to 85 % of the total costs and include debt installments and interest payments. In addition, shareholders also need to pay TVO's variable costs according to the proportion of their off-take.⁹⁵ But according to Standard and Poor's, TVO suffers from high financial risk ratios and

⁹⁰ "CSN open to offers for 7% Light stake," *Business News Americas* (May 30, 2000), available at: http://www.bnamericas.com/news/electricpower/CSN_Open_to_Offers_for_7*Light_Stake

⁹¹ "Mineradoras investem em autogeração," *Gazeta Mercantil* (November 9, 2001), available at: <http://www.fiec.org.br/acoes/energia/informacoes/bcoexperiencias/mineradoras.htm>

⁹² IBAMA, "Estudo de Impacto Ambiental-EIA do Aproveitamento Hidrelétrico- AHE Santa Isabel," available at: http://siscom.ibama.gov.br/licenciamento_ambiental/Hidreletricas/Santa%20Isabel/EIA/Textos/EIA%20SANTA%20ISABEL%20-%20Tomo%20I.pdf

⁹³ Fennovoima, Press Release (March 14, 2012), available at: <http://www.fennovoima.com/en/press-releases/current/changes-in-fennovoima-s-ownerships>

⁹⁴ "Mankala makes a move," *Nei Magazine* (October 27, 2009), available at: <http://www.neimagazine.com/story.asp?sc=2054511>

⁹⁵ A. Stenqvist and T. Tsoneva, "Finnish utility Teollisuuden Voima assigned 'BBB/A-2' ratings; Outlook stable," (Stockholm: Standard and Poor's, 2012)

therefore proposes that TVO sell its surplus to the Nordic spot market “at a price above its full production cost.”⁹⁶

Through joint-projects, companies can, not only, scale up their contribution to the domestic power supply but also diminish the environmental footprint of the power project. In Liberia, for instance, the World Bank has assessed that a collective hydro-based solution over individual coal-fired plant could potentially save at least 22,000 tonnes of carbon dioxide emissions over the life of the mines.⁹⁷

Despite the business case for coordination between mining companies when it comes to investment in infrastructure, coordination doesn't often happen because either companies perceive earlier access to power supply as a competitive advantage or because information asymmetry is not shared within clusters of power-intensive industry. This lack of coordination can generate a loss for the host country both in terms of unnecessary duplication of infrastructure as well as wasted scale economies. Therefore there is a need for the government to create coordination mechanisms and encourage group power plants in mining areas.

3. Situation Three: There is a grid and sourcing from the grid is less expensive than own generation

In a scenario where electricity provided by the grid is less expensive than self-generated electricity, mines will all buy electricity from the grid. In this situation, there is a risk for the grid to reach capacity and become unreliable. The challenge is therefore to find mechanisms to increase generation and grid capacity and avoid unsteady electricity supply. To be able to continue accessing cheap electricity, mines will generally work with utilities under various commercial arrangements to either sell distributed generation⁹⁸ or create/ upgrade generation, transmission and distribution capacity to meet their demand. The challenge is to find the commercial framework to leverage the mining energy demand that generates cost savings for the mining industry and welfare gains for the host country. Different commercial arrangements are presented in this section.

Compensating companies for using the idle capacity of their back-up generators

According to the World Bank, mining firms tend to build their own backup generating capacity regardless of the supply from the public grid, to ensure elevators, air pumps, and other safety devices remain fully operational at all times.⁹⁹ Accordingly, this backup power capacity also represents a potential source of generating power if needed, although this supply is expensive.

In India, steady increases in demand have outstripped the ability of the utilities to provide reliable power in many regions. At the same time, when they do not rely on co-

⁹⁶ Stenqvist and Tsoneva, “Finnish utility Teollisuuden Voima assigned ‘BBB/A-2’ ratings; Outlook stable,” 2012, op. cit.

⁹⁷ World Bank, “Leveraging investments by natural resource concessionaires,” 2011, op. cit.

⁹⁸ Distributed generation refers to own-site generation or decentralized energy as a source of electricity for the grid.

⁹⁹ V. Foster and J. Steinbuks, “Paying the price for unreliable power supplies: In-house generation of electricity by firms in Africa,” Working paper (Washington D.C.: The World Bank, 2008), p. 16.

generation as seen previously (box 8), companies have also developed their own diesel backup generating capacity to adapt to frequent interruptions of supply. As the supply shortage grew more severe, an innovative commercial model was adopted in the city of Pune to utilize companies' backup generating capacity to cater to peak demand (see box 17).

Box 17: Pune, India – Using unused back-up supply to power the neighborhoods¹⁰⁰

In 2006, the city of Pune in the state of Maharashtra was suffering from load shedding for two to three hours per day. There was an estimated shortfall of 90MW of generating capacity, whereas the top 30 industrial operators in Pune had unutilized captive capacity of 100MW. In this context, the Confederation of Indian Industries (CII) (more than 9,000 different companies, including mining companies and energy producers) proposed to the Maharashtra Electricity Regulatory Commission that the operators utilize more of their idle capacity and less of the grid power to meet the shortfall.¹⁰¹ Of course, the industrial users wanted to be compensated for having to use more expensive captive power compared to cheaper grid power – the captive plants were mainly powered by liquid fuels such as diesel, which has a much higher variable cost than the grid. The CII proposed that industry be compensated for generating its own power by being paid the difference between the grid high-transmission tariff and its generating cost. The compensation costs were to be borne by consumers in Pune, in return for no load-shedding. The State regulator approved the model and set the “reliability charge” at Rs. 0.42/kWh to be levied on all consumers of more than 300 kWh/month within Pune Urban Circle, serving as an incentive to lower energy consumption.

However, the Pune model ran into sustainability issues as the demand within Pune soon exceeded the captive capacity by 2008. The Maharashtra State distribution company ultimately franchised out the distribution and supply of electricity within Pune to Tata Power, which was tasked with generating 40MW of distributed energy and sourcing sufficient energy from elsewhere to meet the deficit in Pune.

The success of this model relies on large captive capacity and on the willingness of consumers to pay for increased reliability. In addition, Pune-specific factors, such as low distribution losses (16.5% in Pune), high collection efficiency and a relatively high share of industrial and commercial consumption, have been critical for the success of the model since they've helped keep the reliability charges acceptable to beneficiaries.¹⁰² This model is however a short-term solution in the sense that the supply remains limited to industrials' idle capacity and can be quickly outstripped by growing demand. The long term solution goes beyond distributed generation and looks rather at creating and financing additional supply as well as improving energy efficiency. See further details below.

¹⁰⁰ Adapted from IDFC, “Innovative partnership approach to mitigating load shedding: The ‘Pune Model’ and beyond,” *Policy Group Quarterly* (December 2008)

¹⁰¹ See *In the Matter of Indian Industry (CII) Proposal to use Captive Power to mitigate load shedding in Pune Urban Circles of MSDECL*, Case No. 29 of 2005, available at: http://www.mercindia.org.in/pdf/06_Order_dt_25_01_2006_CN_29%20of%20of%202005.pdf

¹⁰² IDFC, “Innovative partnership approach to mitigating load shedding: The ‘Pune Model’ and beyond,” 2008, op.cit

The utility and mining companies share the financial burden of additional generation and transmission capacity

- Mines pay back through utility bills or negotiate lower utility bills if they invest. Most simply, the utility can finance the cost of additional generation, with repayment over time through tariffs from the customer, the mines. This is the case in the interesting case of Zambia (see box 18), where the utility supplying most of the mines of the copper belt is a private independent power transmission network. To attract investments, often electricity tariffs are subsidized for mines as it used to be the case in Zambia. It shouldn't be the case as it endangers the financial capacity of the utility to pursue the necessary investments.

Box 18: Zambia – Mines pays back for the investment in new hydro-power generation through higher tariffs

In March 2012, Zambian independent power transmission group, Copperbelt Energy Corporation Plc, supplying power bought from Zesco, the public utility, to most of the mining operations on Zambia's copperbelt, and the Nigeria financial institution Africa Finance Corporation (a hybrid investment bank and multilateral development financial Institution established by treaty amongst sovereign states) have signed a deal to finance the construction of two hydro-power projects in Zambia. Under this deal, the projects that will be developed include the Kabompo Gorge Hydro Power Project in North-Western Zambia at a cost of US\$150 million and the Luapula Hydro Schemes in Luapula Province at a cost of US\$1 billion. The Kabompo project is expected to bring development opportunities to the area and would also connect into the main Zambian electricity grid through a transmission line to the nearest ZESCO substation at Lumwana.¹⁰³ The Luapala project is a cross-border project with DRC. CEC signed a MoU with DRC's public utility SNEL in April 2012 to cooperate in the feasibility study.¹⁰⁴

Electricity has been a major issue in Zambia with the copper industry growth being constrained by available electricity supply. State utility, Zesco, has resorted to rationing power to residents but according to CEC, these projects could help bring a power surplus of about 6000 MW by 2016.¹⁰⁵

However CEC warns that industrial electricity tariffs will need to increase by 20-30% per year to reach cost reflectivity and support new investments in generation.¹⁰⁶ Mines have been protected by a stabilization agreement between 2008 and 2011 stipulating that mines will not suffer from an increase in tariff during that period. In 2011, with the tariff stabilization ending, Zesco has increased its bulk supply tariff to CEC by 30%, which has been approved by the independent regulator. Zesco and CEC need to negotiate a

¹⁰³ S. Ngosa, "Zambia: Hydro Energy to Power North-Western Province," *allAfrica.com* (30 May 2012), <http://allafrica.com/stories/201205310087.html>

¹⁰⁴ World Bank, Project paper on a proposed second additional grant and restructuring to the Democratic Republic of Congo for the Southern African power market project and restructuring for the Southern African power market program (sapmp), (June 2012), available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/06/12/000333037_20120612002430/Rendered/INDEX/691150PJPR0P120Official0Use0Only090.txt

¹⁰⁵ G. Chanda, "CEC, AFC sign \$1.2bn hydro-power project," *The Post Online* (16 March 2012), http://www.postzambia.com/post-read_article.php?articleId=25881

¹⁰⁶ CEC, Annual report 2012, available at: <http://cecinvestor.com/investor/annual-reports/>

five-year framework for further tariff increase to reach cost reflective level for the bulk supply tariffs.¹⁰⁷

In the U.S., mining companies and utilities work out different ways to build new transmission lines and substations to procure electricity to mining sites (see box 19).

Box 19: United States – Sharing the financing of new distribution lines and substations

In the U.S., mining companies generally source their electricity from the grid. The mining companies will generally assume a portion of the cost of constructing the connecting line from the closest utility line. For a connected load of up to about 1,000 horsepower, or about 745,700 watts, it is known to be cheaper to let the utility provide a primary substation. For loads over 745,700 watts, constructing a private primary substation to transform incoming power to usage voltages may be more economical in exchange of more favorable rates.¹⁰⁸

- Mines invest themselves in distribution networks and operate them

When 1) sourcing power from the grid is not expensive, 2) the demand from the mine is substantial and 3) in addition the power market is vertically separated, there might be a business case for the mining customer to own and operate the distribution network, in addition to generation capacity, to ensure readily available electricity supply for the mine. This is the case of BHP and its Olympic Dam project in South Australia (see box 20).

Box 20: South Australia – BHP Billiton financing and operating distribution lines

BHP Billiton's mine at Olympic Dam, South Australia, will be the largest uranium producer by 2020 and the largest open-cut copper mine in the world. BHP-Billiton owns and operates an AC network comprising a 275 kV transmission line, a 132 kV transmission line, associated substations and distribution works that supply its project.¹⁰⁹

BHP wants to expand the mine to process six times more minerals. With the planned developments, there would be additional electricity needs of 650 MW, i.e. 10% of South Australia's base-load demand. In addition to building a gas fired power station and its related pipeline, one of the options that BHP is considering for electricity supply is financing a new 270 km 275 kV transmission line linking the project to Port Augusta, designed with spare capacity to meet the rising demand for electricity in the region, i.e. at Olympic Dam but also in the Roxby Down area. BHP plans to provide 50 MW to the copper mining company OZ Minerals for the development of its Prominent Hill mining project (130 km away from Olympic Dam).¹¹⁰

¹⁰⁷ Press Statement ERB Approves the ZESCO/CEC Application to Review Tariffs (9th August 2011), available at: <http://www.erb.org.zm/press/statements/CECTariffApproval2011.pdf>

¹⁰⁸ U.S. Department of Energy, "Energy and Environmental Profile of the U.S. Mining Industry," 2002, op.cit

¹⁰⁹ Electricity Supply Industry Planning Council, Annual Planning Report, June 2007, available at: http://s3.amazonaws.com/zanran_storage/www.esipc.sa.gov.au/ContentPages/43291790.pdf

¹¹⁰ BHP Billiton, "Olympic Dam expansion EIS: Energy and greenhouse gases," Information sheet, available at: <http://www.bhpbilliton.com/home/aboutus/regulatory/Documents/Olympic%20Dam%20Supplementary%20EIS/Information%20Sheets/Olympic%20Dam%20EIS%20Energy%20And%20Greenhouse%20Gases.pdf>

This private participation in the power assets is an opportunity for the country but when the network relies on private financing, the challenge is in the implementation of third-party access to existing transmission networks, while maintaining incentives for primary investors to build new networks if needed. Enforcement of third-party access requires an access regime as designed in Australia (see box 21) or as considered in the US (see box 22).

Box 21: South Australia – Access regimes¹¹¹

Network operators participating in the national electricity market as in South Australia are required to comply with the access arrangements in the National Electricity Code (NEC). The code is jointly administered by the Australian Competition and Consumer Commission (ACCC), the NEC administrator and State regulators:

- The ACCC is responsible for assessing applications for changes to the access provisions of the code; assessing undertakings submitted by individual network service providers; and regulating network pricing for transmission services.
- The NEC administrator is responsible for the development and enforcement of the access provisions, managing any changes to the code and liaising with the ACCC.
- The State regulators are responsible for distribution networks, retail licenses, safety and environmental standards and regulating network pricing for distribution services.

The inherent problem with third party access is preserving the advantage of the party that paid for the upfront costs and would like to keep priority access for its capacity. This is the topic under discussion in the United States (see box 22).

Box 22: United States – Discussion on access regime for generators’ lead lines

In April 2012, the Federal Energy Regulatory Commission (FERC) issued a Notice of Inquiry (NOI)¹¹², requesting comments from market participants. The NOI targets generator’s lead lines that are built and owned by generators to transmit power from generation projects to the transmission network. Now, a generator does not have to file an Open Access Transmission Tariff (OATT) unless it receives a request for interconnection from a third-party and the FERC treats the generators’ lead lines on a case by case basis with no blanket access regime for those lead lines. “The Commission seeks to explore whether, and, if so, how the Commission should revise its current policy concerning priority rights and open access with regard to [lead lines of generation developers]”. In particular, the Commission seeks options for addressing priority rights of generation developers for their future capacity on lead lines: should third-party interconnections be accommodated through an OATT framework or through an extension of the Large Generator Interconnection Agreement (LGIA) framework in which the existing LGIA provisions that govern third-party use of a transmission provider’s interconnection facilities would be extended to the lead lines of generators.

The other challenge of a privately-financed distribution network in a context of low electricity access is ensuring that the new line is designed with additional capacity and meets the demand of the not-yet connected towns on the way; which requires the coordination of a mine’s development plan with that of the country.

¹¹¹ Adapted from Productivity Commission, *Review of the National Access Regime*, op.cit

¹¹² "Open access and priority rights on interconnection facilities," 139 F.E.R.C. § 61,051, 18 C.F.R. § 40 (2012), available at: <http://www.ferc.gov/whats-new/comm-meet/2012/041912/E-3.pdf>

Additional generation through energy efficiency

- Sharing the burden of asset upgrading

Additional generation capacity can come from the upgrade of existing assets or the expansion of the grid network, rather than through building additional generation capacity. This is particularly true in countries whose power source is hydropower given that hydropower plants are a lumpy investment (see Introduction). The question is determining the party responsible for financing this upgrade.

When sourcing power from the grid is not expensive and the demand from the mine is substantial, the mine is often interested in mobilizing its financial and technical capacity to contribute to the capital cost of the asset and to be compensated through reduced (or zero) tariffs. This has been the case in the DRC, where the electricity source is hydropower (see box 23).

Box 23: DRC – When mining companies upgrade existing electric infrastructure

In March 2012, Katanga Mining Ltd. announced that it signed an agreement with SNEL, DRC's public utility, for a US \$283.5 million loan to upgrade the DRC's electricity generation and transmission networks. US\$189 million will be reimbursed to the company by its affiliates at the mines of Kansuki and Mutanda which will utilize a substantial part of the new electricity produced. According to the agreement, 10% of the power generated will be extra and sold back to SNEL. US\$261.8 million of this investment will be reimbursed through utility bill credits and SNEL will additionally pay interests on the loan. According to Katanga Mining, the new 450 MW capacity to be reached by the end of 2015 will allow a 310,000 tonne/year copper production.¹¹³

- Using the potential of smart technology

With the dissemination of better technologies, additional generation capacity is more and more sought through energy efficiency with a reduction of transmission and distribution losses using techniques such as better isolation, retrofitting of lines and interconnection. In addition, smart grid technologies can improve energy efficiency by allowing the provision of electricity on demand, while traditional systems are designed to carry a constant level of electricity, regardless of whether it will be consumed at the end-user level or not. The mining industry has become an adapter of this technology: for instance, the Rocky Mountain Institute, recently contracted with the mining company Rio Tinto to improve the efficiency of its operations and energy infrastructure with its expertise in smart grid technology;¹¹⁴ the Oyu Tolgoi project in Mongolia (see box 1) signed a \$15 million with the engineering company ABB to upgrade the distribution lines leading to the mine with Flexible Alternating Current Transmission Systems (FACTS). FACTS “allow more power to reach consumers with minimal environmental impact, lower investment costs and shorter implementation times than the traditional alternative

¹¹³ Katanga Mining Limited, “Katanga Mining signs agreements to develop future power supply,” Press release (March 29, 2012), available at: <http://www.katangamining.com/media/news-releases/2012/2012-03-29.aspx>

¹¹⁴ A. Mclvor, “Mining and energy,” *Cleantech Magazine* (September/October 2010), available at: <http://www.cleantechinvestor.com/portal/fuel-cells/6422-mining-and-energy.html>

of building new power plants or transmission lines. They also help address voltage and frequency stability issues and enable the transmission system to run more efficiently.”¹¹⁵

With demand and response mechanisms, and smart grid technologies in general, mining companies could evolve from simple consumers of electricity to dynamic and proactive producers, becoming a “prosumer”.¹¹⁶ As a prosumer, one is not only taking electricity from the grid, but also feeding the grid with electricity, enabling it to be connected while having the ability to operate in isolation when needed, which increases security and reliability of the system. This model requires coordination between the mining industry and the public utility to finance this tremendous upgrade that consists in installing a smart grid, dynamic pricing signals on which the selling mining company can rely, storage facilities to ensure reliability and interconnection, standard distributed resource interconnection policies for each grid operator, and high-tech telecommunication infrastructure.¹¹⁷

Those smart technologies would also benefit from better coordination within the mining industry. In Chile, the government’s efficiency targets worked as an incentive for companies to coordinate to co-invest in research on energy efficiency and share results (see box 24).

Box 24: Chile – Coordination among private companies to improve energy efficiency

Due to the energy crisis in Chile, the new government recently announced targets of energy efficiency improvements among industrial users in the country: reducing projected energy consumption through 2020 by 12%,¹¹⁸ targeting especially the mining industry, which accounts for 38% of all power produced on the central SIC and northern SING grids.

The private sector, as a response, decided to join forces and in 2006 created the Mining Working Group for Energy Efficiency, a voluntary affiliation of the 13 largest mining companies of the national market in addition to other participants, such as the Chilean Chapter of the International Copper Association, the Mining Council, Country Programme for Energy Efficiency and the Mining Ministry. Its objective is to promote energy efficiency research through technology development and innovation, disseminate results, evaluate pilot projects, and foster a culture of energy efficiency within the mining companies of the working group.¹¹⁹

¹¹⁵ ABB, “ABB wins \$15 million power transmission order in Mongolia,” Press release (January 27, 2011)

¹¹⁶ See A. Toffler, *The Third Wave* (1980); Marshall McLuhan and Barrington Nevitt, *Take Today* (1972), p. 4.

¹¹⁷ Webinar organized by the Clean Energy Solutions Center, “Measuring the ‘smartness’ of the electricity grid” (June 26, 2012), available at: http://www.esat.kuleuven.be/electa/publications/fulltexts/pub_2072.pdf

¹¹⁸ James Fowler, “Mining chief labels efficiency targets ‘unfeasible,’” *Business News Americas* (April 20, 2012), available at: <http://www.bnamericas.com/news/mining/mining-chief-labels-efficiency-targets-unfeasible1>

¹¹⁹ Asia Pacific Energy Research Centre, “Compendium of energy efficiency policies of APEC economies,” (2010), available at: <http://www.ieej.or.jp/aperc/CEEP/Chile.pdf> ; See also Mesa Minera Eficiencia Energetica available at: <http://www.mesaminera.cl/index.php/la-mmee/ique-es-mmee>

4. Cross-cutting issue: Public- Private Coordination

Whether miners make significant purchases of electricity from the national grid or sell their extra-capacity to the grid, it represents an opportunity for the country's power infrastructure. In the first case, it ensures stability of demand and incentives to increase the supply; in the second case, it allows cheaper grid electricity. For these opportunities to be maximized there is a need of coordination and integration of the companies' plan into the government plans. More coordination and planning at the outset could better realize opportunities of shared platforms and scale economies.

For instance, prior to the civil war in Liberia, for example, Bong mines used to buy electricity from the grid during one part of the year and sell during the rest. During the wet season, Bong mines would purchase Mount Coffee hydropower energy from the national grid (LEC) and sell thermal power to LEC during the dry season. The arrangement was mutually advantageous: it allowed LEC to sell excess capacity from hydropower in the wet season and Bong mines to benefit from cheaper electricity. At the same time, by purchasing electricity from Bong mines in the dry season, LEC could benefit from economies of scale in generating thermal power.¹²⁰

In Panama, a new project expects to supply power to the grid during the first years, which mutually benefits the company and the country, but will buy from the grid after its tenth year of operation (see box 25), giving time to the country to build the required infrastructure.

Box 25: Panama – Sourcing from own-generation or the grid according to circumstances

Cobre Panama Project aims to be the largest private investment in Panama. With a total investment of more than US\$5 billion, the mine will produce 255,000 tons of copper per year.

The project involves a 300MW thermoelectric plant as well as a transmission line from the plant to the mine, connected to the Llano Sanchez substation on the Panamanian grid.¹²¹

During the first nine years, the power plant will supply 100% of the mine's electricity requirements and will sell the excess, around 40-50MW according to the company's projections, to the National Integrated System (Sistema Integrado Nacional, SIN)¹²² obtaining utility bill credits in exchange. The power plant is expected to produce electric power at an average life-of-mine cost of ¢US4.43/kWh, resulting in significant cost savings for the company compared to an average cost of ¢US10/kWh in Panama.¹²³

The cost savings will also translate into lower energy costs to the customer since in the

¹²⁰ World Bank, "Leveraging investments by natural resource concessionaires," 2011, op.cit

¹²¹ "Mina de Cobre Panamá iniciará construcción este año," *Latino Minería* (March 2012), available at: <http://www.latinomineria.com/2012/03/mina-de-cobre-panama-iniciaria-construccion-este-ano/>

¹²² Minera Panama, "The electrical transmission line of Llano Sanchez will contribute energy to the national grid," Press release (February 27, 2012), available at: <http://www.minerapanama.com/en/news/item/104-desarrollo-social-y-ambiental>

¹²³ Minera Panama, "Mina de Cobre Panama," Basic engineering summary report (May 2012), available at: http://www.inmetmining.com/Theme/Inmet/files/pdf/2012/Cobre%20Panama%20BESR%20-%20Rev%20B_v001_l9917m.pdf

Panamanian spot market, electricity price is given by the cost of production of the last generating unit dispatched.¹²⁴

The mine will also buy from the grid 1) during power plant maintenance activities, which happens normally during the wet season when there is an oversupply of energy on the grid and 2) when the energy requirements will increase as the mine start to access lower grade ore – which will happen after the tenth year according to companies' plans.¹²⁵ The company anticipates that within ten years, the electricity from the grid will be cheap enough and their demand so high that sourcing from the grid will be more economical.

It remains unclear if the Liberian and Panama situations are the result of integration of companies' and government's plans, but the two situations reveal that coordination results in cost savings for both parties.

Coordination can also take the form of a government bringing support to the mining industry by supplying the feedstock to increase the capacity of own-generation plant beyond the needs of the project. Saudi Arabia (box 26) and Afghanistan (box 27) are two illustrations.

Box 26: Saudi Arabia – Mutually beneficial partnership

Saudi Electricity projects an increase from 193GWh in 2009 to 251GWh in 2013 in the country power consumption. Markets estimates also suggest that desalination capacity in the country needs to double over the next 20 years to cover drinking water alone.¹²⁶

A joint venture project with the American aluminum producer Alcoa and Ma'aden, a 50% Saudi Government company, will help the government increase power generation and desalination capacity. The US\$10.8 billion project includes a bauxite mine, an alumina refinery, an aluminum smelter and a rolling mill. To ensure sufficient power and water supply, Ma'aden signed an agreement with the state-owned companies, SEC (Saudi Electricity Company) and SWCC (Saline Water Conversion Corporation) and to construct a joint power and desalination plant in RasAz-Zawr that will generate 2,400 MW of electricity and 11.025 million cubic meters of desalinated water a day. Ma'aden will use 1,350 MW of electricity and 25,000 cubic meters of desalinated water a day, while SEC and SWCC will use the remainder. The larger scale of the project will benefit from economies of scale, and therefore increase energy efficiency. The joint project will also benefit from water supply and delivery of electricity six months earlier than the original schedule.¹²⁷ The project was originally powered with fuel oil at a cost of US\$40/MWh, but the government allocated a supply of gas to the project, reducing the cost of energy to US\$/24MWh. With the support of the government, Ma'aden is set to

¹²⁴ Irina Falconett and Ken Nagasaka, "Analysis of the electric power sector restructuring in a cost-based dispatch environment," 3(2) *International Journal of Electrical and Power Engineering* 85-93 (2009), available at: <http://www.medwelljournals.com/fulltext/?doi=ijepe.2009.85.93>

¹²⁵ "Mina de Cobre Panamá iniciaría construcción este año," 2012, op. cit.

¹²⁶ R. Sinha and N. Moumen "Saudi Infrastructure – Mining: the third pillar of the economy," (HSBC Global Research, July 2010), available at: <http://www.research.hsbc.com/midas/Res/RDV?p=pdf&key=ytfpc3nbuw&n=271876.PDF>.

¹²⁷ "SWCC, Ma'aden and SEC to establish joint power and desalination plant at Ras Az Zawr," Press release (October 17, 2009), available at: http://www.maaden.com.sa/en/news_details/26; and Ma'aden, Presentation for the U.S.-Saudi Business Opportunities Forum of April 29, 2010, available at: <http://www.slideshare.net/USSABC/bajba-infrastructure-panel-3-sent>

become the world's lowest-cost producer of aluminum and di-ammonium phosphate fertilizer (DAP).¹²⁸

In Afghanistan, a country with low electrification rates, the government agreed to supply adequate coal to some mining projects. On the counterpart, those companies will use their expertise to build transmissions lines to important cities and deliver electricity at cost (see box 27).

Box 27: Afghanistan – Free coal in exchange of power infrastructure

In 2008, the Ministry of Mines from Afghanistan signed a US\$ 3.3 billion deal with China Metallurgical Group Corporation (MCC) to explore and process Aynak copper deposits in the Logar province.¹²⁹ From May 2008 to August 2010, both parties negotiated and signed five ancillary agreements, including contracts dealing with security, water, power and coal mines, other minerals, and a railway. The power and coal mining ancillary agreements envision MCC to build and operate a 400MW coal fired power plant and the coal mine to feed it. MCC will also pay for the transmission system to bring the power to the grid and to Kabul City: a 220KV two-circuit high-tension transmission line, with total distance of 280km. Transmission lines will be constructed to deliver 200MW to Aynak while the other 200MW will be distributed on the national grid in Kabul for use by ratepayers.¹³⁰

According to the power supply agreement, the government is responsible in providing sufficient coal reserves to MCC with no less than 100 million tons of coal to meet the demand for constructing a 400MW thermal power plant. About three coal mines will provide the 1.2 million tons per year of coal to the project. Another mining project in the country, Hajigak, employs the same design but in this case, 50% of the power will also be provided to the community at cost.¹³¹

The main purpose of those projects is to provide power to the mining projects and supply the surplus capacity to the government at cost price in order to promote local economic development.

The benefits of coordination and integration of companies' plans into government plans can also be observed when looking at the counterfactual. While the government strategy remains in disconnection from the mining industry's plans, Chile suffers from a continuous energy crisis (see box 28).

Box 28: South of Chile – Mines suffer from a non-integrated grid

In the early eighties, Chile drastically privatized its electricity sector and created a competitive environment. However, after years of underinvestment, the electrical grid

¹²⁸ Sinha and Moumen, "Saudi Infrastructure – Mining: the third pillar of the economy," 2010, op. cit.

¹²⁹ World Bank, "Mineral resource tenders and mining infrastructure projects guiding principles," Case Study: The Aynak Copper Deposit, Afghanistan, Extractive Industries for Development Series No. 22 (Washington D.C.: The World Bank, 2011), available at: <http://siteresources.worldbank.org/INTOGMC/Resources/EIT122weboct17.pdf>.

¹³⁰ World Bank, "The Afghanistan Mining Sector as a Driver of Sustainable Growth: Benefits and Opportunities for Large-Scale Mining", (Washington D.C.: The World Bank, 2011), available at <http://documents.worldbank.org/curated/en/2011/02/16240684/afghanistan-mining-sector-driver-sustainable-growth-benefits-opportunities-large-scale-mining>

¹³¹ World Bank, "Mineral resource tenders and mining infrastructure projects guiding principles," Case Study: The Aynak Copper Deposit, Afghanistan, 2011, op. cit.

has become costly and fragile. As a result, the Chilean copper industry has to rely on more expensive forms of energy, such as diesel, which are twice as expensive as coal.¹³²

Chile's mining industry has been asking for grid integration for many years since it would enable projects in the north to access cheaper power from hydroelectric and renewable energy on the Southern grid.¹³³ It could bring energy costs down by 4.1% on average throughout the SIC and SING, and offer an important solution to the power needs of the mining sector. Until now, the IPR-GDF Suez is the only firm to have offered proposals on the interconnection. The project is a 570km double circuit transmission line and would cost about US\$ 600 million. Whether the project will be financially viable, depends on the energy demand from mining companies but in any event the Chilean government is not interested in financially contributing to the cost for now.¹³⁴

In Pilbara, Australia, the lack of coordination between companies in addition to the lack of government involvement in the interconnection of the grids prevents the industry from gaining massive cost savings (see box 29).

Box 29: Pilbara, Australia – Missed opportunity

According to recent studies, 3,000 MW of new capacity will be required by 2020 to meet the demand of new mining projects in Pilbara, mainly related to iron ore. Iron ore miners have been historically responsible for the provision of their entire infrastructure.¹³⁵ In addition because of the long distances between loads and high management and operation costs due to frequent cyclonic activity and high ambient temperatures, Pilbara has never benefited from an interconnected network. This explains why some transmission lines run on parallel routes, not connected and with different voltages. Without central coordination, some sections of the network have excess capacity, while other sections are heavily constrained.¹³⁶

Nevertheless, as the number and scale of loads increase, the case to develop a coordinated network grows stronger and the relative costs drop significantly. Studies suggest that “an integrated transmission system with large-scale efficient generation, compared to a gas pipeline with isolated generation, could reduce daily gas consumption in the Pilbara by 186-573 TJ as of 2019”. In addition, it would provide electricity more economically and with greater reliability. Having multiple generators with different cost characteristics supplying electricity into an open access and common-user network would allow for the optimal cost generation to be selected at any time. It would

¹³² B. O'Donovan, “Codelco reports NA copper growth,” 119(16-3), *American Metal Market* (2012), p. 9, available at: <http://supremacycapitalgroup.com/amm/2012/04/18/Daily.pdf>.

¹³³ J. Fowler, “Transelec chief backs “economically viable” SING-SIC interconnection,” *Business News Americas* (June 12, 2012), available at: <http://www.bnamericas.com/news/electricpower/transelec-chief-backs-economically-viable-sing-sic-interconnection>

¹³⁴ “Chile Could Save \$1.6 Billion By Connecting SIC, SING Power Grids,” *Dow Jones Newswires* (November 28, 2011), available at: <http://www.epcengineer.com/news/post/6728/chile-could-save-16-billion-by-connecting-sic-sing-power-grids-government>

¹³⁵ Evans and Peck, “Assessment of the potential for renewable energy projects and systems in the Pilbara,” Evans and Peck, October 2011, available at: <http://www.ret.gov.au/energy/Documents/cei/acre/studies/WARREA-Pilbara.pdf>; See also Energy Supply Association of Australia (ESAA), “Draft Energy White Paper,” March 16, 2012.

¹³⁶ ESAA, Draft Energy White Paper, op. cit.

also enable small to medium-sized mining projects that could not otherwise economically justify individual power generation.¹³⁷

The government of Western Australia has not excluded the option of an integrated electrical grid, but contends that the private sector should pay for it. All earlier attempts to develop a bigger network have failed because of the lack of a suitable third party facilitator¹³⁸ as well as different time horizons for new projects, which diminishes the opportunity for some multi-user facilities. This is exacerbated by the competitive nature of the mining industry, as they compete to have their respective projects developed earlier and thus gain market share.¹³⁹

Even when the government is willing to coordinate and plan with the industry, the mining projects are so time-sensitive that waiting for government plans often present a substantive loss from delays, acting as a disincentive to coordinate. The desire to avoid this wait was what encouraged Karara mining (see box 30) to quickly engage in the financing of power infrastructure for the Mid-West project. The company did not try to set up a joint-financing project with the public utility, but rather relied on the creditworthiness of the utility to be reimbursed later on.

Box 30: Western Australia – Karara Mining participates in the Mid-West Energy project to accelerate the process

The Mid-West Energy Project (MWEP)¹⁴⁰ is one of the largest transmission line projects ever undertaken in Western Australia. The goal is to build transmission lines to overcome the current capacity constraints on the existing lines, connect the different power generators of the region, and link them to the new mining operations. The lines are funded jointly by the Western Australian State Government and Karara Mining Limited (KML) through different arrangements. KML developed the \$1.2 bn Karara Iron Ore Project and financed, built and owns the 105 km 330 kV high voltage line from its mining operations to the town of Three Springs. On behalf of Western Power, KML also financed and built the Terminal Substation at Three Springs and extended the 330 kV line from this Substation to the town of Eneabba, where the line connects to the public network operated by the public utility Western Power. KML will be reimbursed later on by Western Power. Thus, KML will be supplied in electricity by Western Power that will use its State electricity grid to transmit power to Three Springs and then to the mine via KML's 330kV line.

To explain its participation, KML said: “By building and funding the line itself, Karara ensured its power supply would be in place well before it was needed, removing risks associated with relying on third parties to provide crucial infrastructure. This is also another excellent example of the flow-on benefits that come from the development of major resource projects such as Karara, with the construction of this new 330kV

¹³⁷ G. Forrest and F. Tudor, “Energy White Paper” (Department of Resources, Energy and Tourism of Australian Government, June 12, 2009), available at:

<http://www.ret.gov.au/energy/Documents/ewp/pdf/EWP%20103%20DP%20Submission%20-%20Western%20Power%20and%20Horizon%20Power.pdf>.

¹³⁸ K. Chinnery and P. Kerr, “Battle to power up the Pilbara,” *Financial Review* (September 19, 2011)

¹³⁹ Evans and Peck, “Assessment of the potential for renewable energy projects and systems in the Pilbara,” 2011, op. cit.

¹⁴⁰ Western Power, “Mid West Energy Project,” available at:

http://www.westernpower.com.au/networkprojects/substationPowerlineProjects/Mid_West_Energy_Project.html.

transmission line acting as a key catalyst for the first stage of Western Power's MWEF, which will ultimately benefit communities across the Midwest region with greater security and reliability of supply."¹⁴¹

In Western Australia, in an attempt to accelerate the planning process and optimize coordination with companies, the government has introduced Development Assessment Panels. These panels consist of two local government counselors and three independent experts with technical knowledge. These DAPs help improve the planning system by providing more transparency, consistency and reliability in decision-making. In terms of power generation, projects that cost more than US\$ 7 million, outside Perth, must be assessed by the Panel, but is optional for smaller projects.¹⁴²

Another interesting initiative to ensure multilevel coordination both within government agencies and between government agencies, the mining industry, and civil society is in Mongolia, where the government together with the World Bank, proposed the creation of specialized institutions to oversee the national infrastructure development process (see box 31).

Box 31: Mongolia – An institutional framework for more efficient planning¹⁴³

In Mongolia, the government is organizing negotiation forums with the mining industry to oversee infrastructure developments and define priorities, with plans to create new institutions to further this goal as described below. One body will be granted with the right to take the lead with regards to infrastructure development decisions, and implement the overall integrated development plan that each of the following agencies would then be charged to implement according to its particular specialization:

Southern Mongolia Infrastructure Council. The Council would consist of representatives from the national government, local governments, mining companies, and NGOs. Its goal would be to serve as a forum for public consultation and exchange of information. It would be developed either as an advisory committee or as an entity that makes decisions and finances infrastructure developments.

Southern Mongolia Infrastructure Coordination Unit. This entity would serve as an information forum to coordinate the multiple levels of local government, and would be entitled to step in the decision-making process to accelerate it,

PPP Unit. This unit would have expertise in PPP developments to compensate for the lack of expertise of Mongolia in this field.

Risk Management Unit. Since investors in PPP transactions typically request government guarantees, this unit would specialize in the negotiation of government guarantees for PPPs, and it would set caps on governmental risk exposure. In particular, this unit would report to the government, annually on the extent and probability of its liabilities.

¹⁴¹"Karara finalises transmission access agreements," *Mining Weekly* (April 30, 2012), available at: <http://www.miningweekly.com/article/company-announcement-karara-finalises-transmission-access-agreements-2012-04-30>

¹⁴² Evans and Peck "Assessment of the potential for renewable energy projects and systems in the Pilbara" 2011, op. cit.

¹⁴³ IBRD/World Bank, "Southern Mongolia Infrastructure Strategy", 2009, op. cit.

International Infrastructure Expert Advisory Panel. To make sure that the government is negotiating the best deals, it might call on a panel of international experts to review cases on a case-by-case basis.

Economic Regulation Agency. This agency would have an expertise in tariff setting in the railway and electricity sectors.

Southern Mongolia Groundwater Management and Information Center. This agency would be charged with gathering information on groundwater from all the other government agencies.

Further research

This Policy Paper has set out preliminary findings on appropriate commercial, financial, technical and regulatory models to leverage the mining industry's energy demand either to improve the availability and reliability of the grid or expand electricity access solutions for the community. Further research¹⁴⁴ will include examining more closely the scope for cost savings for the country and the company of the different institutional arrangements, laying the emphasis on a quantitative analysis of the different situations.

The Columbia Center on Sustainable Investment (CCSI), a joint center of Columbia Law School and the Earth Institute at Columbia University, is a leading research center and forum dedicated exclusively to the study, practice and discussion of sustainable international investment (SII) worldwide. Through research, advisory projects, multi-stakeholder dialogue and educational programs, CCSI constructs and implements an investment framework that promotes sustainable development, builds trusting relationships for long-term investments, and is easily adopted by governments, companies and civil society.

¹⁴⁴ This research is currently undertaken with the World Bank.