Renewable Energy for Mines

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ABSTRACT

Mining operations require a secure energy sources(s) to maintain their operation and many around the world typically resort to expensive diesel generated power, with fuel operating costs alone varying from $300/MWh in West Africa to over $800/MWh in the Canadian Arctic. Renewable energy solutions such as small hydro, wind and solar offer significant cost saving opportunities for these mines, and in addition help the miners attain their "Social License" to operate. If these mines have a shorter operating life (i.e. 10-15 years), the renewable energy infrastructure can provide a "Legacy Asset" for the local community and/or a longer-term revenue stream for the mine that typically needs to monitor the decommissioned mine and waste management facilities for decades after production has ceased. With a short pay-back term, renewables also offer opportunities to lower operating costs, mine lower grade material and extend the life of mine. This presentation is a practical view on renewables for two mine case histories located in Africa and in the South of the United States of America.

Introduction

Mining operations require reliable, secure and constant source(s) of power to maintain their operation. Many around the world resort to expensive diesel generated power with high fuel operating costs and logistic risks associated with transportation of fuel to site. Others rely on expensive grid tariffs and/or have to deal with potential interruption of supply requiring a diesel generated back up system. Power interruptions lead to potential plant operation delays and complications.

This paper presents a general overview of renewables for mines in Africa and has a closer look at four case histories where renewables offer an alternative to traditional forms of energy with benefits to the mines and surrounding communities.

Renewable Energy for Mines

Renewable energy represents a great opportunity for mines in remote locations or in locations where grid electricity generation is not sustainable. This section presents a rapid glance at renewable power potential in Africa, power requirements for mines and for communities, economics of renewables and legacy asset opportunities.

Power Potential in Africa

Africa remains the most underdeveloped continent with respect to limited electricity supply and is hampering current and future development of mines and other industries.

The African continent has a huge underdeveloped renewable energy potential in terms of hydro, solar, wind, geothermal and other forms of renewables. Looking locally Namibia has recently been shown in the Namibian Energy Institute researches to have one of the best solar direct radiation ratings in the world ranging 2000 kilowatt-hour per square meter (kWh/m^2) to 3000 kWh/m^2 from, closely below the Chilean Atacama desert[1]. Wind power potential is also promising in the southern region and further hydro developments are envisaged in the northern Kunene region of Namibia.

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[1] Namibian Energy Institute, the CTT project, pre-feasibility report presentation at the Concentrated Solar Power (CSP) workshop for the consulting stakeholders in Windhoek, Namibia.

Yet, Namibia remains a net importer of energy, some of its own generation and importation being from costly non-renewable sources such as coal.

Power Requirements for Mines

Power requirements for mines differ considerably depending on the type and size of operation. Hard rock mines for example would have much higher power demand than typical heap leaching operation using softer oxide material. The major load of a mine is produced by its crushing and grinding circuits and the total load can be roughly estimated at 1.5 Mega Watts (MW)per 1,000 tonnes per day (tpd) for open pit operations. Underground mines would require additional power for ventilation, lighting, etc. A typical small gold mine running at 6,000 tpd would have an overall mine load of approximately 9 MW. A large copper mine would typically have an overall mine load of approximately 180 MW. A heap leach operation typically has lower power requirements in the order of 3 to 5 MW, depending on the size of the operation. For remote precious metals mines, power typically accounts for more than 20% of the operating cost of the mine.

A mine has a typical operational life of 10 to 15 years, sometimes extended when further deposits are discovered or lower grade ore becomes viable. A source of lower cost energy source such as renewable energy can extend the mine life and allow mining of lower grade ore. In most cases where a renewable energy source is exploited, a mine in a remote location will need a base load power source (such as diesel), since solar, wind and hydro power are variable sources and storage is expensive. The advantage of the renewable option is that it allows a more expensive system to be switched off when not required. Renewable power can substantially lower operating costs of Diesel or Grid powered mines.

Household consumption in communities

Typical household consumption in USA can be estimated at 15 Megawatt-hour per year (MWh/yr.). In developing countries such as Sierra Leone in West Africa, household consumption in rural communities is estimated at 0.04 MWh/yr. Namibian medium income consumption is estimated at 5 to 8 MWh/yr. Many people living in rural areas or in periphery of the main cities still don't have access to grid power. To electrify a small village with a health clinic and a school, approximately 100 to 200 kW is required with an annual power consumption of 90-180Mwh/yr.

Community electricity requirements are very small in relation to a mine, but diesel is expensive (i.e. small power contributions from a neighbouring mine can make a huge difference to the local community). This represents an opportunity to sustain a "social license". Building up legacy assets for a community can empower generations and assist with transitioning from a mining economy to an industrial economy once the mine life is terminated. It also comes with its set of challenges and community relationships and agreements must be appropriately put in place at the start of the project to lead to its success. People and utilities depending on the context must engage themselves to sustain the project.

Economics of Renewables

Projects in a remote location will most likely find multiple advantages in renewables in terms of costs, reliability, logistics (reduced or no fuel transportation), social license, and risk management.

When compared with non-renewable forms of grid power such as coal or a gas fired power plant, hydro, solar and wind are competitive forms of power generation using the Levelized Cost of Electricity (LCOE) and may even be cheaper according to the Bloomberg New Energy Finance's (BNEF) most recent studies based on LCOE analysis.

Connecting mines and communities to a power generation facility represents a huge benefit for communities that don't have access to power to use power but also to use this legacy after mine closure to develop another form of economy. Power generation from renewable source is an opportunity to sustain the community long after the mine has closed with a low cost power supply. This can offer an affordable transfer of economy from mining to agricultural or industrial developments. Power generation streams can also be used to fund closure, long term monitoring and socio-economic transition plans.

Case History

24 MW Hydro for a Gold Mine in the DRC

A confidential Mining Client is looking at developing 4 mines within a mining Gold Belt in the Democratic Republic of Congo to extract a resource estimated at 5 million oz of gold in this area. The initial power requirement for the first operational mine is approximately 6 MW for an estimated mine production rate of 16,000 tpd. The mine site is located approximately 90 km south of the nearest point on the national grid which has no spare capacity at this time. Therefore the client is looking at hydropower supply to offset reliance on diesel generation. The proposed 6.5 MW run-of-river hydroelectric facility will replace 96% of the 20 million USD (based on an energy charge of $380USD per MWh) currently spent on Diesel each year. The proposed hydroelectric facility has been sized to accommodate the maximum mine load and account for transmission line losses of approximately 0.2 MW as well as supply local communities with approximately 0.3 MW. The estimated payback period for this hydroelectric project is approximately 2 years when considering the savings on diesel generation.

Throughout the development of their mine projects the mine has also established a Foundation to support local health clinics, schools, community centre and water supply, and the hydropower facilities will also provide a legacy asset for these communities long after the mining operations have ceased. In addition the local communities that are to be connected to the local grid built by the mine, there is a initiative to join this grid to the regional grid after mine closure. Two development options are currently being considered by the mine to advance these hydropower developments including building and operating the hydro facilties themselves or partnering with an Independent Power Producer (IPP) through an IPP Power Purchase Agreement (PPA).

16 MW Hydro for Gold Mine in Sierra Leone

The Sierra Rutile Mine in Sierra Leone has been operating for 30 years and has an estimated remaining mine life over 20 years. Its operation requires approximately 12 MW to 15 MW of power currently supplied by burning fossil fuels (HFO and Diesel). An independent power producer called Smol Pawa has signed an Memorandum of Understanding (MOU) with the Sierra Rutile mine to develop a 15 MW run of river hydro facility combined with solar power to displace their reliance on fossil fuels and source their electrical needs from more cost competitive and reliable hydropower and solar facilities to be built by Smol Pawa. This project has a payback period estimated at less than 5 years with an Internal Rate of Revenue (IRR) greater than 25% when compared to electricity from Heavy Fuel Oil (HFO) source priced at 0.23 USD/kWh. The run-of-river hydro facility has a capacity factor of 45%, which means that it could supply 45% of the mine’s electricity requirements. The IPP developer (Smol Pawa) partnering in the project is also looking at solar power to fill the gap during the dry season when limited water is available. The project is to be developed as one of Sierra Leone first IPP projects and will also provide a long term legacy asset for the local community and Sierra Leone.

Concentrated Solar Power Plant for a Copper and Gold Mine in Southern USA

As a strategy to reduce overall electricity consumption a Copper and Gold Mine Client is looking at developing a Concentrated Solar Thermal Power plant to supply 16,000 MWh/yr. to its mine located in the South of the United States. The Concentrated Solar Power (CSP) plant is designed to interface with an existing steam generation and distribution system. The CSP plant is developed using trough mirrors, heat exchangers, and connections to the existing system. An additional wind farm is also considered to reduce the overall gas usage.

Conclusions

Remote hydro, wind and solar projects are proving to be cost competitive, environmentally sustainable and provide an extremely attractive alternative to diesel generated power. In many cases, two sources of power are required, a base load generation system, and a renewable system that can offset significant power demands. This may increase the initial capital costs, but once the renewable energy asset is paid off, it allows the mine to operate at a much lower cost, thereby potentially extending the life of the mine. This is also a long term asset and revenue stream to fund closure costs. The asset can become a “Legacy Asset” power supply for on-going development of the local area post mine closure.

A renewable energy project, developed in partnership with the local communities, can help the mine with its “Social License” to operate. Miners are passionate about mining, not power generation or developing renewable power projects. This provides a huge opportunity for Renewable Energy Developers to export their know-how and develop profitable “Legacy” renewable energy developments around the world.