

# Challenges in Large Open Cast Mine in respect of Renewable Energy Initiatives for Production and Safety: Review

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**Abstract:** An increased global supply of minerals is essential to meet the needs and expectations of a rapidly rising world population, with the increase in demand of coal in India in power sector and other industries, open cast mining of deep seated coal deposits has increased. It emphasizes on safety and production of the open cast mining. There is a need to adopt easy and cost-effective options to meet the demand supply gap of coal in India. Numerous problems like safety, production, skilled work force, intelligent machinery, green initiatives by using renewable power supply etc., and their possible solutions have been dealt in brief which are likely to be encountered while extraction of deep seated coal deposits through open cast mining.

**Keywords –** open cast mining; renewable energy; Solar PV; Wind energy; battery storage.

## I. INTRODUCTION

The mining industry is a fundamental instrument of the global economy. It is also notoriously energy intensive. The International Energy Agency (IEA) estimates that approximately 11% of total final energy consumption can be attributed to the mining sector. Such intensity makes power generation decisions even more important. While the industry is predominantly powered by traditional fossil fuels, there has been a notable willingness to incorporate renewable, namely solar PV and wind, into mining operations.

The extraction of minerals from the earth has been an essential element in the development of human society since the dawn of civilization<sup>1</sup>. Considering the many remarkable technologies available today, it is easy to overlook the fact that almost all of these technologies are founded on, and would not exist without, minerals and the process of extracting them from the earth—that is, mining<sup>[1]</sup>.

Coal remains the primary source of commercial energy in India on economic consideration over the last two decades. The Coal vision 2025 estimates that the total domestic coal production is projected to increase to 1086 MT in 2025, of which the opencast production will be 902 MT (83%). Coal extraction through opencast mining method is the most efficient and economic method of coal mining in India because of high production and extraction rate, low cost of production, lower gestation period, potential of full scale mechanization and lower safety hazards. In India, around 92% of the coal is produced by opencast mining method.

If domestic coal production continues at 5% increasing rate, the extractable reserve will last for 45 years. Opencast

mining has been proved very economical for low grade coal lying at shallow depth and there are lots of scopes to increase the production. This factor alone has attracted coal companies to opt for opencast mining. In view of the future planning and taking into account the limitations of underground mining, it may be essential to have more number of opencast coal mines. But, in last few years, environmental issues have surfaced up posing threats to growth of opencast mining sector. The opencast mining project requires a huge area of land whose acquisition has become very difficult task in now-a-days [2].

Several renewable projects for mines were commissioned over the last decade. Navigant Research expects this trend to continue as renewable costs decrease and emphasis on decarbonization increases. Significant growth of renewables in mining operations is anticipated, resulting in global capacity nearly tripling through 2027. Growth is expected to be led by Asia Pacific, which is home to some of the world's largest mining economies such as China, India, and Australia. Latin America will also drive growth as economies like Chile seek to diversify generation sources due to dependence on fuel imports.

New mining technologies and regulations have significantly improved mining efficiency and reduced environmental impact in recent years. In general, mining techniques become much more environmentally sensitive when efficiency is improved because less waste is produced. The plan for improving efficiency and decreasing the environmental impact of mining is broken up into the following categories:

Shutting down illegal and unregulated mines

- Choosing environmentally friendly general mining processes
- Implementing recently discovered green mining technologies
- Cleaning up the sites of shut-down mines
- Reevaluating Cut-off Grades
- Research and Development of Green Mining Technology

### 1. Challenges in Productivity:

One of the main challenges is to get the trained and experienced labour. Primarily the productivity is depends on the efficiency of the labour and their efforts in the production. During the boom, a focus on growth at any cost forced many mining companies to accelerate recruitment. Normally the workers will demand the higher salaries to work in remote locations. Induction program and proper training is required the operators to work on machinery. There is a need to focus on building talent from within the organization by giving the training and refresh the knowledge. Managers and supervisors to guide their technicians/work force in a planned manner to get the maximum production with less number. The mining sector also suffers from an aging workforce, and retirement rates are anticipated to increase over the next decade.

The retirement to be the most significant contributor to the Indian mining sector's future hiring needs. These retirements impact operational continuity and lead to a great loss of organizational know-how and operational experience for mining companies. Many of the survey participants said that they have regretted loss of good talent, which has caused inefficiencies to creep into their operations. A further concern cited by executives was the lack of understanding of the business model throughout their organization, and as a result definitions of good performance were not uniform across the organization.

Capital: Productivity has been impacted by long lead times between investment and production, over-investment in capital, as well as the lack of innovation. The mining sector used to pride itself on innovation, with new exploration, mining and mineral processing techniques being a common feature of the sector.

## II. RENEWABLE ENERGY AND MINING

Many mines are located in remote sites that are not grid-connected. Electricity is often produced by Diesel Generating sets. Driven by high fuel-transportation costs, the price for electricity generation is normally high. Renewable energy is an optimal add-on to Diesel-gen-sets and can generated considerable fuel and total energy cost-savings.

### 1) Better fit for mining and renewable energy

This is quite a number of factors on both sides that have lead in the last years to a better fit of renewable energy and

the mining industry as shown in the figure 1. Many experts expect a boom of renewable energy applications at remote mines in the near future.

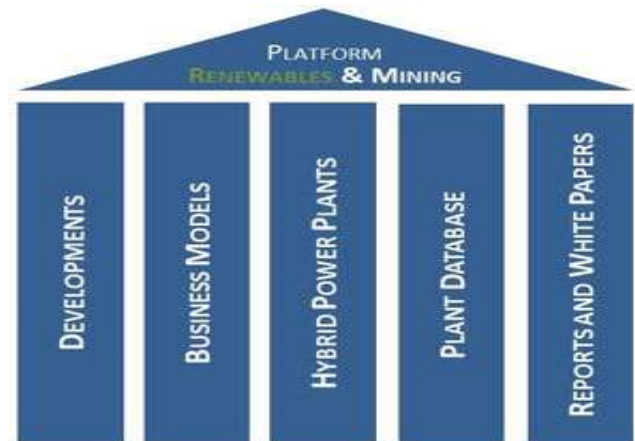


Fig.1.Platform: Renewable & mining

### 2) Overview platform Renewable & Mining

#### 2.1) Business Models for renewable energy applications in the mining sector

Mining companies can get involved to different degree into renewable energies. They can invest or co-invest into wind or solar power plants. There are several providers who offer leasing contracts for solar power plants. Finally, mines can buy electricity through PPAs from renewable plants.

#### 2.2) Plant database for solar and wind applications in the mining industry

Plant database contains power plants such as Solar power plants: PV, CPV, CSP, Solar thermal, Wind power plants:

There are different applications: Wind or solar-diesel-hybrid-power plants (for diesel reduction), Renewable energy power plants with PPAs from nearby mines, Renewable that deliver process heat (solar thermal), and Renewable energy plants on reclaimed mine sites

Recent developments in mining: i) Higher electricity needs as raw material quality normally deteriorates during the life-time of the mine ii) Price pressure on key mining products such as gold, iii) Openness for alternative energy solutions. iv) Renewable energy plays an important role in the corporate sustainability strategy.

Recent developments in the renewable energy sector: i) Falling prices in both solar and wind (solar panel price decrease by 75% during last 3 years. ii) Proven track record and excellent reliability (big renewable energy plants are technically considered as low-risk by institutional investors). Iii) Development of technical solutions for the integration of diesel and renewable energy. iv) Considerable number of solar and wind pilot projects in the mining industry.

Various factors are influencing the optimal electricity generation at mining sites. Some of these are external

factors such as sun and wind conditions, grid-availability or grid stability. Some are directly related to the mining company, e.g., environmental sustainability policies, availability policies, availability of capital or whether or not energy is considered as a core competence. Other factors are rather related with the mining site. Almost these are the remaining lifetime of the mine, the load-profile or the need of process-heat.



Fig.2. Factors influencing the renewable energy application at mining sites

Chart 1-1. Annual Capacity of Renewables and Storage at Mining Sites by Region, World Markets: 2018-2027

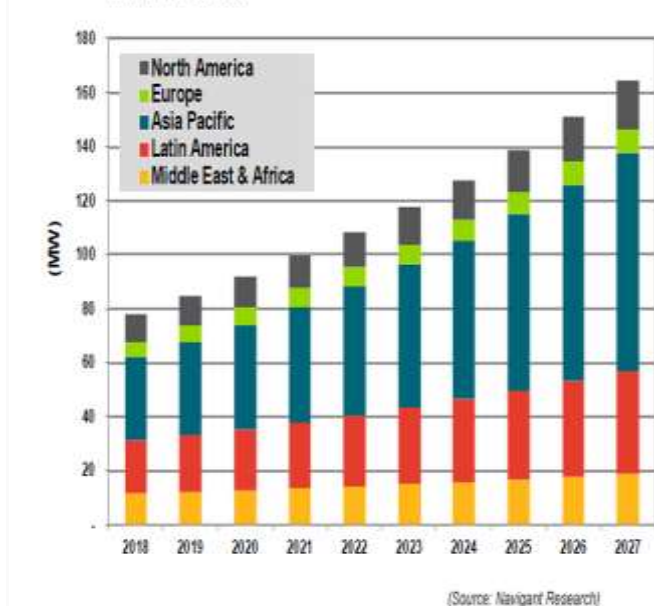


Fig.3. Navigant Research, Renewable Energy in the Mining Industry

Navigant Research expects significant growth in the industry sector from this year on out to 2027, with mining companies' investments in and use of digitally networked, low- or zero-emissions energy resources and technologies-

solar PV, wind and battery energy storage-nearly tripling over the period. Growth will be fastest in the Asia-Pacific region, which is home to some of the world's largest mining sectors, such as China, India and Australia, according to Navigant's Renewable Energy in the Mining Industry.

### III. CHALLENGES IN OPEN CAST MINES SAFETY

#### a. Stability of high benches

Safety scope is one of the major tasks in the open cast mining. Safe geotechnical designs of slope using some stabilization techniques for permanent slopes and installation of slope monitoring devices for these slopes are some of the ways to reduce the chances of slope failures. Stringent slope stability analysis and monitoring is must for a deep opencast mine involving high benches.

#### b. Transport of material from pit

There is a need of selection of suitable size and type of equipment can result in greater energy efficiency and productivity. Haul road optimization, dump configuration and optimization can minimize the overall transport cost.

Old shovel dumpers, in-pit crushers; conveyors are purely maintained through Preventive maintenance/ Predictive maintenance to avoid the accidents. Shovel with in-pit crushing and conveying technology using mobile/ semi-mobile crushers and conveyor combination can be more efficiently and economically used where production requirements are high and mine depth is large. With this system, the materials transportation from the pit is continuous.

#### 3.1) Recommendations:

- The safety of the rescue team should remain the first priority. On any emergency event, a team should not be deployed underground unless and until existing conditions, risk, and threats to the team's safety are assessed.
- Any time a team is in harm's way—even if there is no rescue requirement—adequate support must be available for that team. To this end, back-up teams should be available underground and outside whenever anybody is underground during an emergency (miners or another team), whether they are engaged in rescue or property recovery.
- In cases where miners are trapped, mine operators should act proactively to understand the situation so that their teams can be briefed and deployed expeditiously. Operators should be afforded discretion and authority to deploy their teams as is warranted by a careful assessment of conditions, risk, and potential to save lives.
- Mine operators should be afforded the flexibility and discretion to relax conservative safety standards in accordance with the conditions they face [3].

#### IV. GREEN MINING

Access to reliable and cost-effective forms of energy is a strategic priority for the global mining sector. The mining industry has traditionally relied on conventional fossil-based fuel sources-diesel, oil, coal and natural gas to meet its growing energy demand. The industry is now tasked with responding to the challenges of increasing fuel prices while commodity prices tighten, resulting in ever-narrowing operating margins and increased opposition from communities to new conventional energy sources. The environmental risk associated with traditional mining processes includes the release of harmful substances and by-products into the soil, air and water, all of which depend upon the specific type of mining being conducted.

Green mining is described as the implementation of technologies and mining processes that are aimed at reducing any possible environmental impacts that can occur following the extraction and processing of metals and minerals within a mine. The mining sector is expanding into new and often remote locations as a response to increasing demand from growing emerging markets. This often means having to deal with unreliable power supply from the grid and uncertain power prices. In most instances, grid-connected electricity needs to be supplemented with on-site generation, typically large-scale diesel generation, resulting in a dependency on diesel fuel. The more remote the mine, the more likely off-grid power solutions are required.

##### 4.1) Energy-related business risks

- Energy price volatility
- Reputation and brand
- Increase in fossil fuel costs
- Energy security
- Environmental regulation

Renewable energy to play a strategic role Site-appropriate renewable energy solutions, provide cost-competitive energy while delivering greater energy supply reliability and consistency. Reliable access to cost-efficient energy sources is a strategic imperative for mining companies. The transformation of the mining sector is driven by a number of strong converging trends, including energy security concerns.

TABLE I Renewable energy investment in the mining industry (base case, US\$m), world markets: 2013-22.

Year	2013	2018	2022
North America	38	262	445
Europe	39	174	379
Asia-Pacific	51	688	1343
Latin America	37	532	1047
Middle East and Africa	44	312	729

#### V. RECOMMENDATIONS

The most urgent necessity is to ensure effective, efficient and purposive administration of the existing mining and environmental laws. The procedures for various approvals and monitoring including those for environmental and forest clearances should be streamlined in order to improve the efficiency and effectiveness of the system and to reduce the time taken to clear a proposal.

Preparation of a socio-economic assessment report for a mining project to be followed by the formulation and implementation of long-term and short-term development projects should be made a part of the permitting process for the grant and administration of mineral concession to a mining enterprise. Local socio-economic development works should preferably be executed by mining enterprises rather than government and semi-government agencies. In order to alleviate the limitations of small mines in carrying out sustainable development activities, consortia of small mining enterprises in a region should be promoted. Technical advisory services should be made available to them in the relevant areas.

The following major elements best capture/may defines the essence of a suitable sustainable development framework (SDF) for the country’s mineral sector:

- (i) Scientific mining; (ii) Environment protection and mitigation including minimization of the impacts of mining practices on biodiversity; (iii)Community stakeholder engagement; (iv)Local socio-economic development in mining project areas; and (v) Transparency and accountability.

The government’s responsibility is to ensure that these legal provisions are enforced faithfully and objectively. Its research and development agencies (such as the Indian Bureau of Mines) can assist the industry by technical advice and by bringing out publications on international best practices.

A few thrust areas in each of these elements have been suggested below. Possible sustainability indicators can be linked to these (thrust) areas in order to present a holistic account of a mining enterprise’s sustainability performance.

- Scientific Mining: Mine planning, Methods of mining, Level of mechanization, Technology up gradation, Availability, depletion and conservation of mineral resources, Mine closure planning and target-setting, Progressive implementation of mine closure plan and commitment to rehabilitation
- Environmental protection and mitigation, Land use, Water use and efficiency, Energy use and efficiency. Waste minimization. Tailings management, Air pollution, liquid effluents and solid wastes, Dust management, Noise and vibration control, Biodiversity loss and mitigation Environmental compliance and

voluntary activities, Conformity to environmental management standards (eg. ISO-14001)

- Community stakeholder engagement, Policy on and extent of stakeholder involvement in mining operations, Mechanisms of stakeholder participation/consultations in decision-making, Procedures for attending to stakeholder grievances and concerns, Engagement procedures and principles in respect of indigenous people, Policy on business ethics, Approach to bribery and competition, Resettlement of communities affected by mining project.
- Local socio-economic development in mining project areas, Policy on and procedure for assessing socio-economic impact of mining operations in a project area, Mechanisms and procedures for preparing and implementing area development plans and projects, Plans for generating local community income, Investments in community and mineral wealth distribution, Contribution to local employment, Level of commitment to education, training and skill development, Contribution to the development of physical infrastructure in mining area.

## VI. CONCLUSIONS

Coal will continue to dominate other fossil fuels for energy generation in Indian scenario. The huge gap between demand and supply can only be filled up by extraction of deep seated coal deposit by opencast mining. Obviously, it has so many constraints which must be taken care of. The production, safety, green mining initiatives are explained and economical solutions have been discussed in the paper to provide a basic know how for the investors while exploiting deep seated coal deposit [4]. Renewable have reached a position where they should be in the consideration set, at least for new mines. But, in analysing energy options, it is short-sighted to evaluate renewable purely as a cost play [5]. The dramatic reduction in solar and wind energy costs in recent years means renewable energy is an increasingly attractive alternative to fossil fuelled power, for remote mines not connected to the electricity grid. However, while energy management practices are becoming more prevalent in the sector, some have yet to integrate renewable energy sources and enabling technologies, such as solar and wind power and smart storage.

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