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Uranium Mining Towards Sustainable Clean Energy: Indian Scenario

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INTRODUCTION

Energy plays a key role in the development and functioning of the world's economy. However, increased energy use and mechanization to support ever growing industrialization brings with it the burdens of environmental pollution adversely affecting health, safety, lifestyle, etc. Ideally, a matured society should find ways to keep a balance between socially desirable, economically workable and ecologically sustainable measures through an adaptive process of integration. Sustainable clean energy supply to the mankind is an essential factor for sustainable development. Global energy sector is characterised by definite sources of energy like coal, oil & gas, atomic minerals, hydro power, solar etc. However, the challenge lies in finding ways to reconcile the necessity and demand for energy resource with acceptable impact on the environment within available natural resource base.

India, with a population of more than one billion has been facing formidable challenges in addressing its energy needs. Though fossil fuels and hydro power dominate the country's energy production scenario, recognition of nuclear power as a clean, reliable and abundant source of energy with no greenhouse gas emissions in the country is a giant step towards sustainable development process. It has a great potential to protect the earth from irreversible environmental damage.

URANIUM MINING IN INDIA AND SUSTAINABILITY

India's nuclear programme adopts a unique three-stage strategy based on a closed fuel cycle, where the spent fuel of one stage is reprocessed to produce fuel for the next stage. The objective is to utilize both fertile and fissile components of uranium, and utilisation of thorium. This scheme also takes into account the country' s unique atomic mineral resource base (modest uranium and abundant thorium) with a goal for clean energy security. India's PHWR programme (First stage of three-stage strategy) has reached a state of commercial maturity over the years with indigenous capability and the county is now entering into second stage of U-Pu based fuel reactors. The third stage of reactors with thorium as fuel has been developed in pilot scale and development of commercial technology is underway.

Indian uranium deposits are of low grade and moderate size. Most part of the country's uranium resources are in carbonate host rock that calls for adoption of alkaline leaching which is acknowledged as a complex and costly process. These resources do not lend themselves for development on plain commercial considerations. However, the integrated economic model of nuclear power production programme (exploration, uranium mining, fuel fabrication, power production, waste management) of the country facilitates not only to absorb the commercial disadvantage of indigenous uranium production, but also provides fiscal latitude for adoption of new technology with higher level of safety standards and environmental measures. With successful commissioning of first alkali leaching based plant at Tummalapalle, more such projects are planned to be set-up soon to extract uranium from carbonate host rock.

Uranium mining technology in India are appropriately chosen with an aim to achieve minimum generation of waste rock, use of waste rock in underground mines as fill, minimum disturbance to surface topography through continuous filling of voids created by underground mining, reuse and recycle of the liquid waste etc. Adoption of decline entry, ramps as entry into stopes, use of electro-hydraulic underground equipment

replacing diesel powered etc in underground mining help in maintaining the operations within the absorptive capacity of local sinks for wastes. Uranium mining in India is gradually absorbing globally acceptable technology of trackless mining with improved efficiency and safety features. Recently commissioned Tummalapalle underground uranium mine with three declines as entry and conveyor transport of ore from mine through central decline to the plant is a landmark development in Indian mining industry.

Uranium ore processing through acid leaching though dominate in the uranium production scenario of the country, continuous efforts are made for up-gradation with utmost consideration on maximising recovery, reduction in discharge of effluents and maximising the recovery of by-products. Recovery of by-products ensures optimum utilization of all useful materials from the ore in an integrated sequence (single flowsheet). This helps in minimising waste streams and mine-site disorders demonstrating comprehensive extraction of resources. Extraction of magnetite from ores of Singhbhum and proposed extraction of sulphides from ore of Rohil uranium deposit in the country illustrate recovering values from the waste. Adopting a shorter processing route, implementing measures to maximize the re-use of water, producing environmentally benign product like uranium peroxide etc. are some of the distinctive features which exemplify the values of sustainability.

Management and eco-restoration of uranium tailings impoundment (solid and liquid waste) facilities are the crucial part of uranium mining all over the world. In India, the technology for management of tailings has been constantly upgraded in line with the international practices. Tailing ponds have been designed with improved floor lining to prevent downward movement of effluent and robust monitoring mechanism to maintain the permissible discharge quality of water. Eco-restoration of the filled tailings pond with appropriate thick layer of soil for arresting radon emanation, planting specific varieties of non-edible grass to control soil erosion and prevent radioactive incursion into the food chain through grazing animals etc. are well acknowledged in the society. Presently, a new innovative method of tailings management –called Near Surface Trench Disposal is being developed which aims at effective utilization of land within mining area available away from public domain and ease of handling and monitoring of tailings.

Avoiding the transfer of large financial burden through time to future generations is a part of "future-proofed" sustainable development goals. Future financial liabilities and costs associated with closure of uranium mines, decommissioning of process plants and reclamation of tailings impoundment facilities are adequately set aside to ensure funds availability when needed in the future.

Displacement and disruption of settlements around mining sites is generally seen as a major cause of resentment in the communities. Hand holding for skill development and education to students in the area around uranium projects in India at early stage of project development helps creating a skilled society in the area, thus avoiding large scale influx of trained manpower from other parts of the country. It also helps in the growth of secondary industries in the neighbourhood. Local industries are encouraged to progressively develop the competency to support the need of the mining sector thereby brining in sustainability of new technologies and developing the competency to support need of critical components enhancing the skill base of the community. The uranium production facilities in the country have helped in creating self-sustainable skilled society for mining and processing industries thereby supporting other similar industries.

CONCLUSION

With limited uranium resource base, India marches ahead in its goal of multi-fold increase in uranium production and nuclear power generation by delicately balancing the sustainability of the community around the production facilities through appropriate mix of technology, environmental measures, social harmony, finance and governance. Apart from strengthening the operations in its eight mines and three process plants, efforts are on for setting up new units in different parts of the country.

Sharing of knowledge on past practices and collective wisdom of good systems is essential for sustainable uranium industry particularly to engage the countries with little or no experiences in such fields. Indian experience, assimilated over time of working with low grade small to medium size deposits and organisational structure of nuclear power sector may become a model for new practitioners in the field of uranium production and nuclear power in the world.

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