

**THRUST AREAS OF RESEARCH ON COAL MINING
AND OTHER ALLIED ACTIVITIES
FOR MINISTRY OF COAL**

1. Advanced technology/methodology for improvement of production & productivity from underground mining and open cast Mining

a) Mass production technology to extract the coal seams from the higher depth of cover (>300m)

Design guidelines for suitable method (Wongawilli/Longwall/CM) including design of panel orientation, support systems, size of rib/remnants, etc for better safety, conservation and productivity.

b) Extraction of thick coal seam / thin seam / Inclined /geologically disturbed seam/ locked-up standing coal pillars

Suitable mining method is to be developed for exploitation of thick seam (> 6.0 m), thin coal seam (<2.0m), Inclined seam & geologically disturbed coal seam, locked-up standing coal pillars so as to overcome the severe geotechnical problems.

c) Longwall/mechanized mining under surface structures with high speed stowing in Indian geo- mining conditions

Study of techno-economic feasibility for the exploitation of coal seams under surface structures with high-speed stowing. Pilot-scale application and validation of the model for standardization.

d) First mile connectivity in opencast mines

Study should be undertaken to assess the techno-economic feasibility of alternative means of surface coal transportation from the coal mines to the user agencies like cross-country conveying, coal slurry transportation through pipelines, etc.

e) Haul Road design construction to improve productivity

Proper designing of haul road construction is a grey area which can reduce accident due to movement of mobile equipment and vehicle which in turn improve productivity.

f) Highwall mining or any other mining technology

Research is need for Advanced Opencast mining technologies like Highwall mining etc., High speed and angle conveyors and other related technologies.

2. Improvement of safety, health and environment

a) Prevention of bench and dump failure

Methodology of dump stabilization, design of dump in hilly terrain and constrained place design guidelines for bench width, bench height, and overall slope angle are the prominent research areas.

b) Ground/strata control /Hard roof management in underground mining

Development of real-time monitoring of the health condition of the support system and prediction of failure of the support system along with activating alarm for immediate withdrawal of persons. Assessment and mitigation of coal bump/rock burst during the extraction of deep-seated coal seams and Monitoring behaviour of goaf using cavity scanner or similar other instruments, analysing data using AI.

Application of hydro-fracturing technique and use of slow-acting expansion chemicals in drill holes into the roof strata to induce fractures for hard roof management.

c) Prevention and control of spontaneous combustion & fire in highly gassy coal seams

Development of an integrated system & wearable portable sensors for continuous monitoring of indicators for spontaneous heating by detection of hotspot and analysis of indices using artificial intelligence (AI) based analytical software and activation of control measures including Mass inertization (N_2 or CO_2), withdrawal of persons, equipment etc. Technology development for Pre-drainage of coal seam methane by in-seam/surface to in-seam gas drainage system and its standardizing.

d) Surface potholing or collapse due to subsurface cavities

Identification of sub-surface unstable areas due to fire or mining-induced cavities by using geophysical methods for stabilization of such areas by remote sealing.

e) Fatigue management

Measuring and monitoring of physiological effects of the human body due to fatigue, physiological stresses due to working and task conditions, and physiological disorders due to lack of proper ergonomic design of machines. Prediction of fatigue level, to be assessed by analysing the data using AI. Also, activation of machine interlock with digital fatigue detectors is a key area.

f) Environmental impact and sustainable development

Monitoring of mine reclamation & rehabilitation using remote sensing, subsidence monitoring through advanced Geomatic tools (Radar Interferometry), application of UAV, Tree transplantation, integrated hydrological study for impact assessment of mining activities on perennial river, Biodiversity assessment & ecological study of coal mine reclamation/plantation sites as per International Union for Conservation of Nature (IUCN) and UNFCCC methodologies, minimization of Diesel Particulate Matter (DPM) etc. are the major areas of research. It is also required to develop technologies utilizing excavation without use of explosives.

g) Disaster management

Gap identification and related training is needed for principals of risk assessment based safety management system with a view to identify the structural framework in effective implementation. Also, a methodology can be developed so that dedicated rescue trained person in India can be gathered in one platform so that they can immediately swing into action in case of any emergency.

h) Mine closure & Acid Mine Drainage

Mine Closure with thrust to environment concern and future use of that excavated area is a research area which can be prioritized. Also to tackle the acid mine drainage on existing mining areas may be looked into through R&D.

i) Energy efficiency and optimization

Though Energy audit is being done regularly, still energy efficiency and optimization is a green area for research. It is required to optimize the energy input and output of the mining operation to improve efficiency and become an energy efficient industry.

3. Waste to Wealth

a) Use of overburden material

Analysis of OB materials for identification of useful minerals and its segregation and Crushing of OB for road/building construction materials.

b) Use of underground excavations for storage

Design methodology to identify the suitable storage place and Stability analysis of underground storage by laboratory experiment & simulation for implementation of the design in the field.

4. Alternative use of coal and clean coal technologies

a) Coal to activated carbon (AC)/carbon nanoparticles /carbon nanotube (CNT) / Graphene

A carbon nanotube is a seamless cylinder of rolled graphene sheet with a high length-to- diameter ratio showing mechanical & electronic properties. The use of CNT in electrical conductivity, thermal conductivity, field emission characteristics are impressive. Its application in electronics, mechanically robust composites, chemical, and biosensors, interconnects and chip cooling in integrated circuit manufacturing, field emission devices, catalyst support, fuel cells, batteries, shielding of electromagnetic interference, textile, coating, optics, smart devices, and several other areas has been increasing day by day.

Graphene is an atom-thick honeycomb two-dimensional sheet of carbon atoms. It is the building block for other graphitic materials. It is harder than diamond yet more elastic than rubber, tougher than steel yet lighter than aluminum, possess faster electron mobility than silicon, more thermal conductive compared to diamond, and better electrical conductivity than copper. Application includes mechanical, thermal, energy storage and conversion, coatings, sensors, electronics, catalysis, and bio-medical.

Process to convert coal to **activated carbon (AC)/carbon nanoparticles/CNT/ Graphene**, its Pilot-scale study& field implementation is the research area.

b) Technology for commercial production of CBM/CMM/AMM

Different technology has been established for CBM resource estimation and few technologies are available for production of CBM/CMM & AMM. It is required to have technologies for commercial production of CBM/CMM/AMM.

c) Surface & Underground Coal Gasification

Mapping of Indian Coal for Gasification& Indigenous development of Surface & underground coal gasification technology and field implementation.

d) Coal to chemicals, Fertilizer and liquid

Characterization of coal, experimental and simulation studies, Pilot-scale study &field implementation.

e) Establishment of geothermal energy power generation

Characterization of the site & development of technology to capture the geothermal heat by Simulation, pilot and field-scale study.

f) CO₂ Capture, Utilisation & Storage

Large quantities of CO₂ are released from heavy industry. CO₂ capture will be a potential means of mitigating the contribution to global warming by reducing the content of CO₂ in the atmosphere. Development of technology/method to capture CO₂ from the atmosphere, its utilization & storage is a prior area.

g) Replacement of furnace oil by coal through plasma

Coal may be a substitution of furnace oil. R&D is needed in this field for utilisation of coal as a replacement of furnace oil. Development of technology/method for replacement of furnace oil by coal through plasma.

5. Coal beneficiation and utilization

a) Substitution of imported coking coal

The country is largely dependent on imported coking coal entailing foreign exchange. Thus to reduce import, immediate attention is required for the substitution of imported coal by augmentation of all the available resources.

Development of a process for beneficiation (through oil agglomeration), blending and coke making from the alternative raw materials and additive development for coke making are research area

b) Improving the recovery of clean coal from the coking coal washeries

Most of the coking coal washeries being operated by CIL are old due to varied washability characteristics and feeding of coal from multiple sources and losing good quality coal in the middlings/rejects.

Development of technology/method to improve the recovery of clean coal from the coking coal washeries, Pilot-scale study and field implementation.

c) Dry coal beneficiation

Beneficiation of high ash Indian coal is need of the hour. A suitable technology is required to be developed to reduce the ash percentage through dry beneficiation of coal.

6. Exploration

a) Coal quality estimation

Coal quality estimation is an important parameter for predicting the future coal reserve. An indigenous method is to be developed for Geotechnical Characterization & Coal quality estimation from Borehole Logging Data. Also, a method is required to delineate the coal potential zone where it is difficult to access the area for exploration.

b) Assessment of Rare Earth Elements (REE) in Coal & Non-Coal strata

Rare earth is one of the essential material for different electronic use. India is a poor contributor of it in the world market, as on date. Assessment of rare earth is one of the prime area of research in coal & non-coal strata with special emphasis to North Eastern Coalfields.

c) Development of geophysical exploration techniques

For exploration in areas under forest cover or inaccessible areas, different state-of-the-art geophysical exploration techniques are required to be developed for quick exploration of any unexplored area.

7. Innovation and indigenization (Under Make-in-India Concept)

Indigenization of new technology: Prime Minister of India calls for Aatma Nirbhar Bharat through innovation and indigenization under Make-in-India Concept. It is the need of the hour for indigenization of different technology through Indian manufacturer for further use in the coal industry.

- a)** Indigenous development of active method of detecting buried human for opencast and underground mines
- b)** Indigenization of integrated low power wireless load monitoring, gas monitoring and tracking system using RFID technology for underground mining
- c)** Indigenous Development of IoT Enabled Technology for Monitoring, Analysis and Interpretation of Longwall Shield Pressures for Improving Safety and Productivity
- d)** Indigenous development of Self- contained Breathing apparatus (Both closed and open circuit), Escape apparatus and Reviving apparatus used for below ground and opencast mining.

- e)** Indigenous development of Drop test facility for pit bottom buffer used in underground coal mines
- f)** Development of an indigenous robotic technology for detecting firefighting in opencast mines and extinguishing the fire
- g)** Development of technique for Artificial Intelligence (AI) / Machine Learning (ML), data analytics for automated mine management system
- h)** Development of Mixed reality (Virtual reality, Augmented reality & Extended reality) for mining (UG & OC) operation & training
- i)** Development of miners Personal Protective Equipment (PPE) using nano technology
- j)** Development of a portable instrument for detecting bed separation, minor faults/ hidden slips in the roof of coal mines.

(As per MoC office order No. 34011/2/2019-CCNT dated 04.09.2020)

In order to strengthen R&D efforts of MoC and to encourage wide participation by different agencies, CMPDI, being the Nodal Agency, is inviting new research proposal on the above identified thrust areas from leading academic and research institution(s) / organization(s) including coal/lignite producing companies, who can take up research works for overall benefit of Coal Industry (including North Eastern Region).

The proposals may kindly be formulated in line with the S&T Guidelines of MoC, which are readily available in the website: <https://www.cmpdi.co.in>. For any query, feel free to contact GM(S&T), CMPDI (gmsnt.cmpdi@coalindia.in).

Proposal can be submitted throughout the year. The submitted proposal will be scrutinized by the concern experts before placing them to the concerned Committees for consideration and funding under S&T Grant of MoC.