cmpdi
A Mini Ratna Company

WORKSHOP ON

COAL MINE METHANE & ABANDONED MINE METHANE

IN THE CONTEXT OF SUSTAINABLE ENERGY

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APPLICATION OF UNFC FOR MANAGEMENT OF CBM/CMM/AMM/VAM RESOURCES IN INDIA

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CMPDI

CMPDI: An Introduction

- ✓ CMPDI is a Government of India public sector undertaking
  (Fully owned subsidiary of Coal India Limited (CIL), established in 1975)
- ✓ Corporate headquarters at Ranchi (Jharkhand) India;
- ✓ A Mini-Ratna Company providing consultancy services to various government & private organizations in exploration, mine planning and allied engineering services;
- ✓ Accredited with ISO-27001 Certificate by Certification International (UK);
- ✓ Environmental and Chemical Laboratories are accredited to National Accreditation Board for Testing and Calibration Laboratory (NABL) - ISO/IEC 17025:2005;
- ✓ Certified to Operate "Health and Safety Management System" from OHSAS-ISO 18001:2007.

CMPDI: An Introduction …

- **In-house consultant to CIL & its subsidiary companies** in Exploration, Mine Planning, Environmental Management and allied Engineering Services
- **Imparts technical support to Ministry of Coal (MoC)**
  - •In Promotional Exploration & Detailed Exploration in Non - CIL blocks;
  - •Identification of Captive Coal blocks;
  - •For auction/allocation of captive coal blocks;
  - •Coal based Non-conventional energy resources like CBM/CMM, UCG etc
- **Nodal agency** for
  - •Research Projects under S&T scheme of MoC;
  - •CIL R&D Projects;
  - •Development of CMM in India;
  - •Development of UCG in India;
- India CMM/CBM Clearinghouse is functioning in CMPDI, Ranchi (Jh) since November 2008 at the instance of CIL under the aegis of MoC and US EPA.

CMPDI: SPECIAL ACHIEVEMENTS

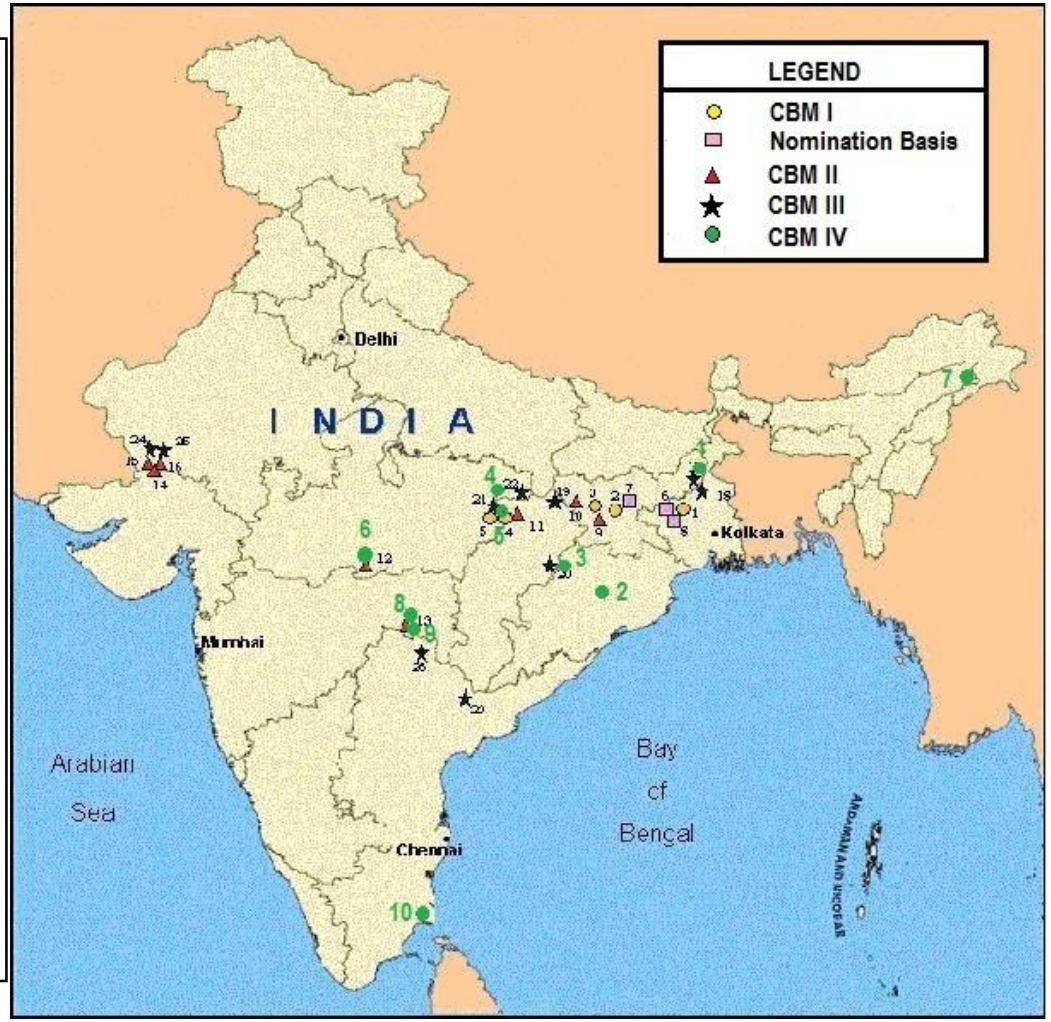
- Adjudged the **Best performing Subsidiary Company** of **CIL** for the year 2008-09 as per MoU rating;
- Awarded the Commendation Certificate of **SCOPE Meritorious Award for R&D**, **Technology Development & Innovation** for the year 2009-10;
- Successfully implemented the **UNDP/GEF-GoI** funded demonstration project on “CBM Recovery and its Commercial Utilization” at Moonidih mine of BCCL (a subsidiary of CIL).
- Established state-of-the-art CBM Lab in 2008, conducting CBM/CMM and Shale Gas related studies;
- Received **Geospatial World Excellence Award 2012** in recognition of excellent usage of Geospatial technology for Land Reclamation Monitoring of Coal Mines;

CBM/CMM Development

- CBM related studies by CMPDI started in early 1990s;
- Thrust for CBM development came with pronouncement of CBM Policy in 1997 by the Govt of India;
- MoP&NG was made administrative Ministry and DGH the Nodal agency for development of CBM in India;
- Policy outlined attractive fiscal incentives & mode of CBM blocks allotment for commercial development through global bidding;
- CMPDI played key role in identification and carving of the prospective CBM coal blocks;
- Being repository of massive exploration and mine related data, CMPDI was assigned responsibility of identification of prospective CBM blocks and preparation of Data Dossiers for DGH;
- CMPDI prepared most of the Data Dossiers of the awarded 33 CBM blocks in 4-rounds of bidding by the MoP&NG between 2001 to 2009.

CBM Development in India: Present Status

- 33 CBM blocks awarded: Area 16613 Sq. Km;
- Prognosticated Resource: 1.7 TCM (62.4 TCF);
- Established GIP: 280 BCM (9.9 TCF);
- Commercial Production since July 2007;
- CBM Wells drilled: 926;
- Blocks in Development/Exploration Phase: 9;
- Many allotted blocks are under relinquishment or relinquished;
- Current Production: 1.7 MMSCMD from 4 CBM blocks.



CBM/CMM Development: CMPDI's Endeavour

- **CIL/CMPDI** is pursuing commercial development of CBM in collaboration with ONGC in two CBM blocks namely Jharia and Raniganj North, both of which are in Development Phase;
- These blocks were awarded to the consortium of CIL & ONGC on nomination basis in 2003. ONGC is the Operator for both the blocks;
- The Field Development Plan (FDP) of both CBM block was approved in 2013;
- PML for the Jharia CBM block granted in 2015 by Govt of Jharkhand. Incidental production is going on and full scale commercial production will start soon after resolving overlap / co-development issues.

Opportunities in CBM/CMM Development by CIL

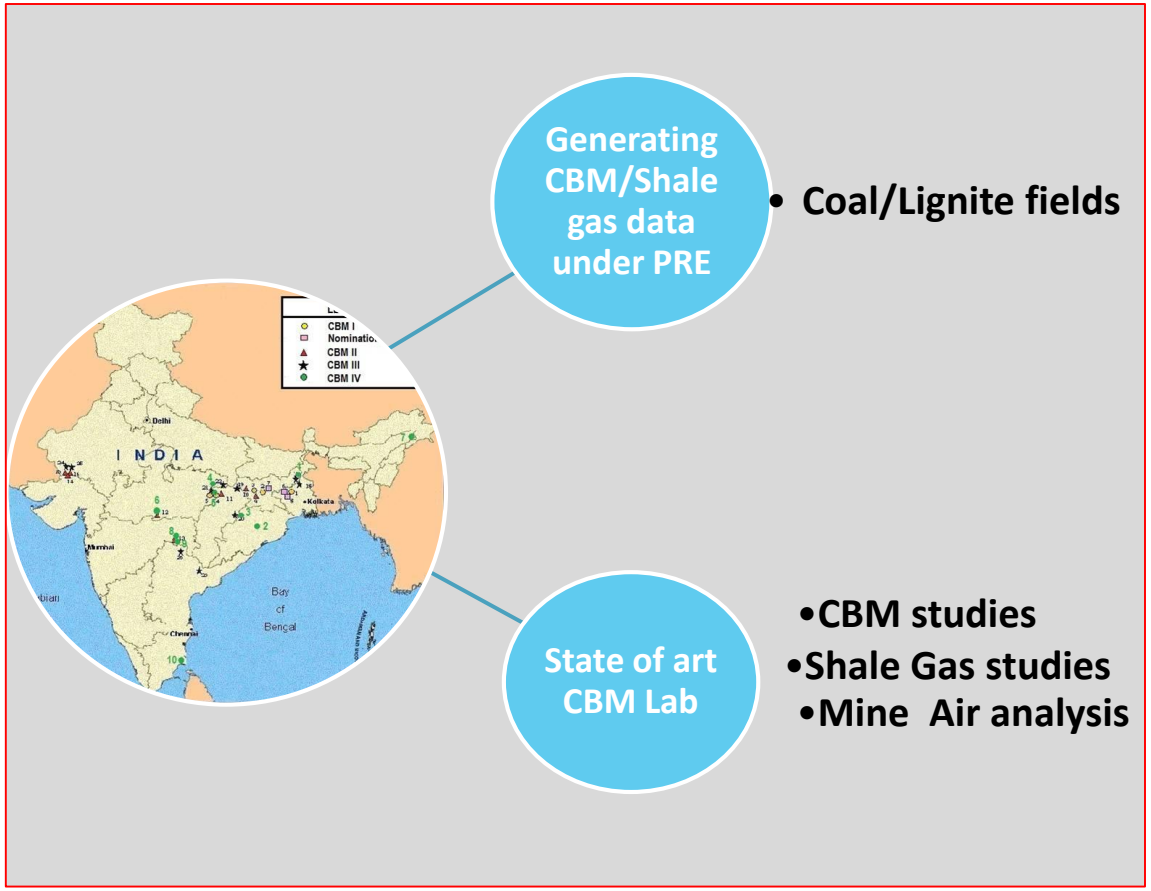
- India is bestowed with substantial reserves of coal (315 BT)
- India is the 3rd largest producer of coal in the World;
- CIL produced 554 MT of coal during FY 2016-17 contributing 84% of India's total coal production of 659 MT;
- Many Coalfields in India store high rank and gassy coal seams, posing challenges in coal mining;
- CMPDI plays proactive and important role to facilitate CBM/CMM development in the country.

CBM/CMM Development: CMPDI's Endeavour

- Successful Implementation of UNDP/GEF-GoI funded demonstration project on CBM/CMM by CMPDI & BCCL in Jharia coalfield proved the efficacy of CBM Technology in Indian Geo-mining conditions;
- CMPDI also successfully implemented CIL R&D Project on Development of CMPDI Capacity for delineation of viable CMM/AMM blocks in the existing and would be mining areas in partly de-stressed coal and virgin coal seam;
- Potential CMM/CBM blocks are identified in CIL command area Data dossiers are under finalization for commercialization initially in Jharia Cf;
- Towards capacity building and to acquaint with the processes of concurrent exploitation of coal and CMM/AMM, officials from CMPDI and CIL coal producing subsidiaries companies visited operational sites of CBM, CMM/AMM and VAM projects in USA, Australia, Poland, China & Indian mines

CBM/CMM Development: CMPDI's Endeavour

- Generating CBM specific data during exploration stages in Indian coalfields;
- CBM Lab Services: State–of–Art Laboratory established for CBM & Shale Gas parametric studies and Mine air analysis.



R&D Efforts for Development of CBM/CMM

R&D Projects on CBM/CMM in progress under Coal S&T Grant of MoC :

- S&T Project on “Capacity Building for Extraction of CMM Resource within CIL Command Areas”; Implementing Agency - CMPDI and Sub Implementing Agency - CSIRO, Australia;
- S&T Project on “CBM Reserve Estimation for Indian coalfields”: Principal Implementing Agency – IIEST Shibpur; Sub Implementing agencies: NGRI Hyderabad, TCE Kolkata & CMPDI;

Development of CBM/CMM: Recent Initiatives by CIL - CMPDI

- Primafacie, Damodar Valley Coalfield appears promising for CBM/CMM development;
- Initial steps have been taken up for commercial exploitation of CMM/CBM from Jharia Cf (Bharat Coking Coal Limited), Raniganj Cf (Eastern Coalfields Ltd.);
- Initiatives for Pre-drainage of methane from working seam in Moonidih mine has been taken up as a Pilot project.

A CASE STUDY OF CBM EXTRACTION IN INDIA

MOONIDIH CBM PROJECT

- Total Area: 6.5 Sq. Km
- Borehole density: 6 Bhs/Km^2
- CBM Quantity assessed: 5.5BCM
- Category of CBM Resource: Gas Initial In Place
- Method used for assessment: Generalized and GRI
- Extraction method: Vertical Well
- Average rate of CBM extraction achieved: 1800 M^3 per day

Opportunities in CMM Development by CIL

Degree of gassiness	Number of mines
Degree I(Methane < 1m^3/te)	136
Degree II(Methane > 1m^3/te;< 10 m^3/te)	81
Degree III(Methane > 10 m^3/te)	9
Total	226

- Mining operation in CIL areas is very old, most of geo-mining conditions are known;
- Target seams for CMM development are Virgin Coal seams lying below the active mining/ worked out / goaved / abandoned areas;
- CIL is putting thrust on Mining of Deeper Coal deposits in near future;
- Considering safety of mine personnel and enhance mine production safely, Pre-drainage of methane is being taken up initially in gassy seams i.e; Jharia Cf;
- Further, the Corporate Objective of CIL is Green mining, harnessing and utilization of Methane is on priority.

CMM Opportunities

De- gasification systems to drain methane to:

- Improve mine worker's safety;
- Enhance methane recovery to prevent gas from escaping into the mine atmosphere;
- Reduce ventilation cost;
- Reduce ventilation related mining operation delays to increase productivity

CMM Opportunities

CMM extracted from the mine may be used:

- For pipeline injection (gas grid laying is proposed in the eastern India);
- To meet the fuel needs of local industries;
- For power generation (for on-site use or sale to the power grid) – on-site use of power thus generated will cut-down power bills;
- For other on-site uses such as, drying coal, for even fuelling mine vehicles after being compressed, etc;
- Feed for fertilizer plant.

VENTILATION AIR METHANE EMISSIONS:

Mitigation and utilization under Indian mining scenario

A VAM project for abatement/utilization in a degree-III UG mine (Moonidih) is under formulation in association with CSIRO, Australia.

VENTILATION AIR METHANE EMISSIONS:

Mitigation and utilization under Indian mining scenario

Challenge of technology in present UG mining scenario in India is to utilize very low methane concentration in ventilation air

Ventilation air analysis of few UG mines of BCCL

Sl #	Mines	Site of sample collection	Coal Production (TPD)	Volume of return air (m^3/hr)	Average methane %
1	Moonidih	Main return	1800	726000	0.3299
2	Sudamdih	Main return	110-120	420000	0.1461
3	Amlabad	Main return	120	348000	0.004
4	Begunia	Main return	100-150	150600	0.2343

VENTILATION AIR METHANE EMISSIONS:

Mitigation and utilization under Indian mining scenario

Ventilation air analysis of few UG mines, ECL

Sl No.	Mine	Site of sample collection	Coal Production (TPD)	Volume of return air (m^3/hr)	Average methane %
1	New Ghusick Mushilia	Main Return Main Return	30 90	91980 182640	0.0128 0.2835
2	Tirat	Main Return	90	183600	0.0104
3	Kalidaspur	Main Return	400-450	343200	0.0416
4	Narsamunda	Main Return	280	293040	0.0008
5	Sodepur (R)	Main Return	150	96500	0.0123

Abandoned Mine Methane (AMM)

Emissions in the Indian mining scenario

Approach for creating AMM national inventory:

- Creating a database of gassy abandoned coal mines;
- Identifying key factors affecting methane emissions (e.g., permeability, sealed or flooded status of mine or time elapsed since abandonment) and develop coal basin - specific emission rate decline curves;
- Validating mathematical models (decline curves) through a field measurement program;
- Preparation of national emissions inventory for each year;
- Adjustment for methane recovery and determining the net total emissions.

United Nation Framework Classification (UNFC)

The three axes used in the UNFC resource classification system are:

- Economic Axis (E) : Represented by first digit;
- Feasibility Axis (F) : Represented by second digit;
- Geological Axis (G) : Represented by third digit;

UNFC SYSTEM: BASIC CATEGORIES

E = Economic Viability

E1-Extraction and sale has been confirmed to be economically viable.

E2-Extraction and sale is expected to become economically viable in the foreseeable future.

E3-Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability.

UNFC SYSTEM: BASIC CATEGORIES

F = Feasibility Study

F1- Feasibility of extraction by a defined development project or mining operation has been confirmed;

F2 - Feasibility of extraction by a defined development project or mining operation is subject to further evaluation;

F3 - Feasibility of extraction by a defined development project or mining operation cannot be evaluated due to limited technical data;

F4 - No development project or mining operation has been identified.

UNFC SYSTEM: BASIC CATEGORIES

G = Geological Assessment

- G1-Quantities associated with a known deposit that can be estimated with a high level of confidence;
- G2-Quantities associated with a known deposit that can be estimated with a moderate level of confidence;
- G3- Quantities associated with a known deposit that can be estimated with a low level of confidence;
- G4- Estimated quantities associated with a potential deposit, based primarily on indirect evidence.

Sub-categories also exist for some of these basic categories E, F and G.

UNFC APPLICATION TO CBM/CMM/AMM RESOURCES

CBM, CMM and AMM resource studies generally may involve:

- Desorption studies – Estimation of Gas content and Resource assessment vis-à-vis Coal volume using borehole core samples (i.e. Resource Modeling);
- Geo-engineering studies – Reservoir characteristics;
- Adsorption studies – Adsorption Isotherm parameters for Reservoir modeling;
- Feasibility studies – Extractability, economics etc.

UNFC APPLICATION TO CBM/CMM/AMM RESOURCES

- Applying UNFC system to these resources would help clarify the extractability and business potential of these methane gas deposits;
- But for this, specific criteria has to be developed for each category and sub-category of UNFC system;
- Considering co-existence of methane gas with coal in-situ, the criteria for applying UNFC to CBM, CMM and AMM resources would be similar to those for coal;
- The criteria for E and F categories in coal system can be adopted for CBM, CMM and AMM with minimal adjustment;
- But criteria for G Axes for CBM, CMM and AMM needs to be defined on the basis of the confidence level of data needed for assessing gas content, permeability etc.

UNFC APPLICATION TO CBM/CMM/AMM RESOURCES

G-Axes criteria evidently depends upon:

- Borehole density;
- Coal seam thickness;
- Gas content;
- Permeability; etc.

- Basic tenet is the desired confidence level of the information about coal seam(s) thickness, Gas content and Permeability factors;

- Based on the above, the acceptable level borehole density needs to be firmed up, i.e; the spatial spread of the sampling/observation points for gas studies and reservoir characteristics tests (may be in terms of number of boreholes per sq. km)

UNFC APPLICATION TO CBM/CMM/AMM RESOURCES

Likely scenario:

- **G4:** Prognosticates estimate through indirect methods based on empirical studies and theoretical methods deployed to compute the gas volume;
- **G3:** Estimates through experimental methods using Adsorption Isotherm analyses;
- **G2:** Estimates through direct methods involving boreholes say 2-3 km apart with proximate analyses;
- **G1:** Reasonably firm estimates through direct methods involving borehole density of 150-650 Sq. m per borehole, with coal characterizations and its analysis;

- For each of these categories, the criteria depends upon borehole density, coal characteristics, gas content, permeability etc.
- To enhance confidence level in case of seams having lower gas content we may require higher borehole density for reservoir characterization, reservoir modeling and feasibility studies.

UNFC - INTEGRATING CBM, CMM, AMM AND COAL RESOURCES

Integrating UNFC classification of Coal and CBM/CMM/AMM Resources would require correlation between at least one factor common to both – may be the borehole density;

However, variations in G category for gas resources depend not only on borehole density but also upon gas content, permeability, etc.;

Linking coal and gas through E and F axes appears unlikely due to variability in extraction-feasibility, technology, commercial considerations, market availability, economics, etc.;

Therefore, it need to link the G-axes criteria for coal with those for CBM/ CMM/ AMM through at least one factor, for unified reporting of these two resources; Apparently, borehole density appears to be linkable factor.

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Thank You