16 India

16.1 Summary of Coal Industry

16.1.1 Role of Coal in India

In 2011, coal represented 41 percent of India's total primary energy supply (EIA, 2013a). The International Energy Agency (IEA) reported that in 2011, 71 percent of the coal produced and imported was used for electric power generation (IEA, 2014). About 57 percent of the installed power capacity, as of 2011, is generated from coal-fired plants. Steel, cement, fertilizer, chemical, paper, and industrial plants are also major coal users, while coal has largely been phased out from the rail transport sector. India's total primary coal production was 589 million tonnes (Mmt) in 2012. Even with high domestic production, India imported 12.7 percent (86 Mmt) of its total primary coal consumption of 675 Mmt (EIA, 2013b). According to the Ministry of Coal's (MOC) 2012 projections, coking coal would represent one-third of the total imports.

The Geological Survey of India estimates the country to possess 293 billion tonnes of total coal resources (MOC, 2012). Of this total resource, BP estimates proved recoverable reserves of 66.8 billion tonnes (BP, 2012). Table 16-1 provides statistics on India's coal reserves and production.

Table 16-1. India's Coal Reserves and Production

Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2011)	61,840	4,960	66,800	5 (7.0%)
Annual Coal Production (2012)	545.8	43.4	589.3	3 (7.47%)

Source: EIA (2013b)

India's coal demand has grown by more than 7 percent per year over the past decade and production shortfalls have driven the increase of imported coal by more than 13 percent per year since 2001 (EIA, 2013a). Despite this increased consumption, the expanding demand for power has reduced the fraction of energy consumption provided by coal from approximately 68 percent in 2002, to 41 percent in 2011 (EIA, 2013a).

The coal-bearing formations of India occur in two geological horizons, the Lower Gondwana (Permian) and the Tertiary sediments (Eocene-Oligocene) of northeastern India, Rajasthan, Gujarat, Jammu, and Kashmir (Chand, 2001). Coal resources are found in 17 major coalfields in India (GSI, 2010). Reserves in these coal fields are provided in Table 16-2. Figure 16-1 shows the location of major coal deposits in India.

Table 16-2. Coal Distribution in India's Major Coalfields (million tonnes)

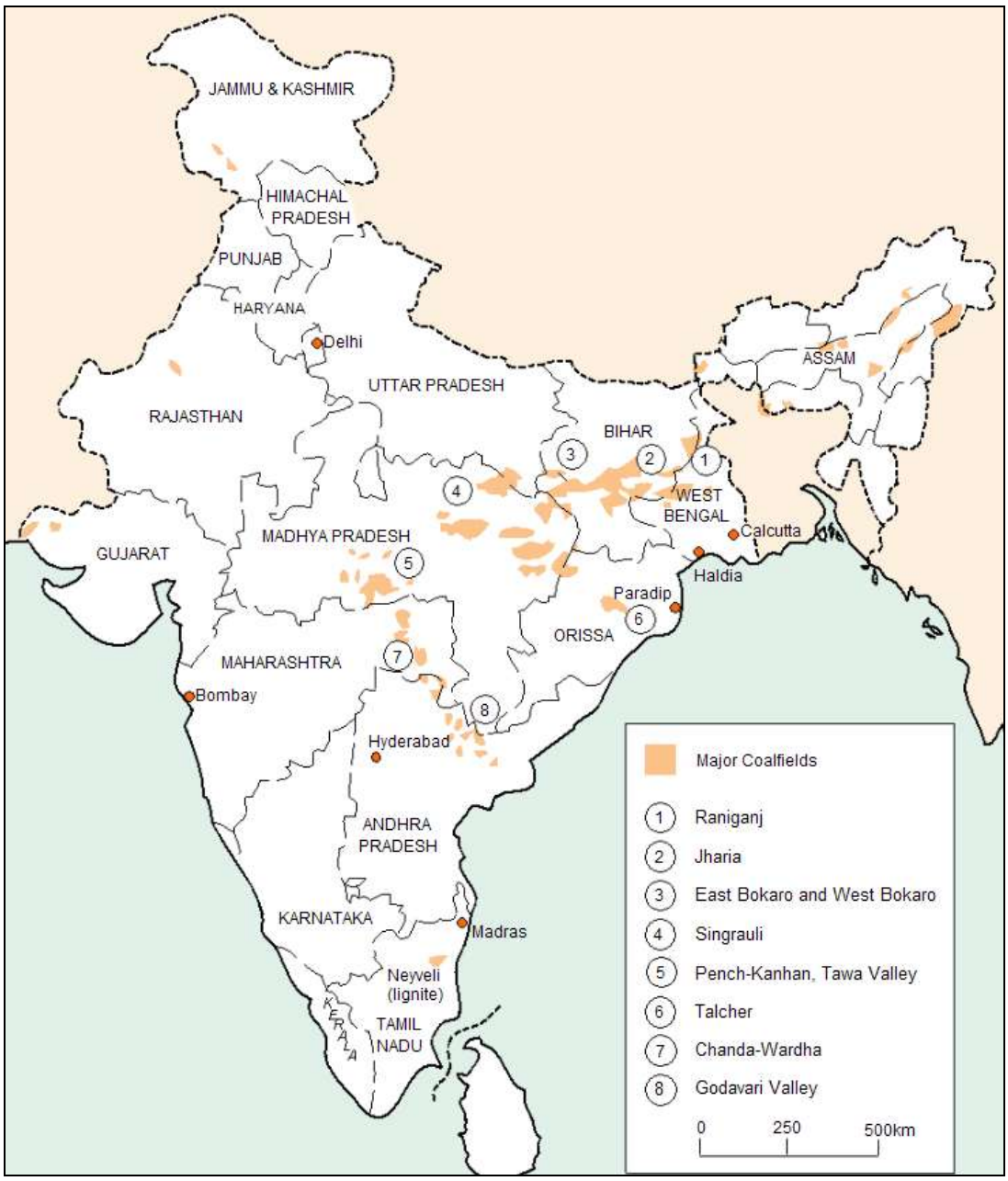
State	Coal Field	Resource	Proved Reserves
Orissa	Talcher	43858.76	14240.08
West Bengal	Raniganj	23730.81	11638.27
Orissa	Ib-river	22448.49	7266.58
Jharkhand	Jharia	19430.06	15077.57
Chattisgarh	Mand-raigarh	22177.64	3880.67
Andhra Pradesh	Godavari Valley	22016.24	9256.51
Jharkhand	N. Karanpura	17073.24	9499.42
Jharkhand	Rajmahal	14338.00	2655.52
Madhya Pradesh	Singrauli	12416.51	4795.00
Chattisgarh	Korba	11704.83	4980.58
Jharkhand	E. Bokaro	8083.29	3351.87
Jharkhand	S. Karanpura	6150.11	2620.41
Maharashtra	Wardha Valley	6044.24	3297.19
Jharkhand	W. Bokaro	5012.49	3629.03
Chattisgarh	Hasdo-arand	4993.70	1369.84
West Bengal	Birbhum	5992.76	0
Madhya Pradesh	Sohagpur	6128.74	1643.20

Note: Where coalfields overlap state borders, the state with the dominant share of resources is shown.
Source: GSI (2010)

Hard coals (anthracite and bituminous) account for approximately 92 percent of the country's proved reserves (EIA, 2013b). The principal deposits of hard coal are in the eastern half of the country, ranging from Andhra Pradesh, bordering the Indian Ocean, to Arunachal Pradesh in the extreme northeast. The States of Jharkhand, Orissa, West Bengal, and Chattisgarh, together account for about 70 percent of reserves (EIA, 2014). The Damodar Valley basins include the significant Jharia and Raniganj coalfields in the east and the Bokaro, Ramgarh, and North and South Karanpura fields in the west.

The high-rank coal seams in deeper coalfields represent a significant target for coal mine methane (CMM) and coal bed methane (CBM) development. In some of the coalfields of the Damodar Valley, there can be up to 25 coal seams, and even in excess of 40 in some areas, with a cumulative thickness of over 100 meters (M2M Profile – India, 2005).

Figure 16-1. India's Coal Fields



Source: Walker (2000)

16.1.2 STAKEHOLDERS

Table 16-3 identifies potential stakeholders in Indian CMM development.

Table 16-3. Key Stakeholders in India's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Coal India, Ltd. (CIL) and its eight regional subsidiaries ▪ Electrosteel Casting Ltd	▪ Project hosts
Engineering, Consultancy and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	▪ Technical assistance
Developers	▪ Reliance Industries ▪ Deep Industries ▪ Great Eastern Energy ▪ Reliance ADA ▪ Essar Oil Ltd. ▪ Oil and Natural Gas Corporation (ONGC)	▪ Project developers
Universities, Research Establishments	▪ Central Institute of Mining and Fuel Research ▪ Central Mine Planning and Design Institute ▪ Indian School of Mines ▪ IIT Madras	▪ Technical assistance
Government Groups	▪ Ministry of Petroleum and Natural Gas (For CBM only) ▪ Directorate General of Hydrocarbons ▪ Ministry of Coal (For CBM/CMM)	▪ Oversight of resources, licensing

16.1.3 Status of Coal and the Coal Mining Industry

In 2000, 27 percent of coal production in India came from underground mines and by 2012 that number was estimated to decline to fewer than 10 percent (MOC, 2012). Deep mines continue to be developed, but more surface mines are also being developed due to the country's vast resource of shallow, low-rank coal deposits. Table 16-4 summarizes the available statistics on coal production by mine type.

Table 16-4. India's Hard Coal Production by Mine Type

Type of mine	Production (million tonnes)	Number of mines (as of 31 March 2008)
Underground (active) mines	51.832	337
Surface (active) mines	488.108	186
Mixed	-	36
Total Active Mines	**539.94**	**559**

Source: MOC (2012)

There is a 3-tier classification system for underground mines in India based on the amount of methane emissions, as shown in Table 16-5.

Table 16-5. India's Classification System and Estimates of Mine Gassiness

Class	Specific Emissions (volume of flammable gas/ tonne of coal produced)	Number of Mines (as of 2007)
Degree I	>0.01 and < 1 m^3	222
Degree II	> 1 and < 10 m^3	102
Degree III	> 10 m^3	18

Source: M2M (2008)

India's coal production faces multiple challenges, including low productivity, distribution problems, and an increased loss of domestic market share to higher-quality, less-expensive imports. India's government embarked on a series of economic reforms in the 1990s, including relaxation of restrictions on foreign ownership and privatization of some industrial enterprises. In 2004, some of these economic reforms were curtailed and continued at a slower pace. In April 2004, 470 of India's 576 mines were under the control of Coal India, Ltd. (CIL), a state-owned entity. Private mines, or investments in mines owned by Indian companies, are allowed only if "captive" to a power plant or factory (MOC, 2004); that is, the captive coal is used for power generation, steel, or cement. Private companies were allocated 60 blocks for exploration and mining in 2006-2007. Further coal-sector liberalization has been attempted, in the form of the Coal Mines Nationalisation Amendment Bill, introduced in 2000, but under pressure from labor unions the bill has stalled and is still under consideration a decade later (MOC, 2010b).

At the end of 2009, a total of 208 coal blocks with reserves of 49 billion tonnes had been allocated for exploration and mining to eligible companies. The government is in the process of amending the Mines and Mineral (Development and Regulation) Act of 1957 to introduce an auction system of competitive bidding on future allocations of coal blocks. This is intended to be a more transparent system of awarding a decreasing number of available coal blocks to an increasing number of applicant companies (MOC, 2010a).

16.2 Overview of CMM Emissions and Development Potential

India's carbon emissions increased by 61 percent between 1990 and 2001, a rate surpassed only by China. In 2005, annual emissions were 1,181.4 tonnes carbon dioxide equivalent ($mtCO_2e$) and as of 2011, emissions had risen to 1,725.8 $mtCO_2e$ (EIA, 2013b). Large increases in emissions from the electricity, cement and waste sectors, along with rises in the transport and residential sectors, have made India the world's fifth largest emitter after China, the U.S., Europe and Russia. More than a third of India's emissions come from low efficiency coal fired power plants. High capital costs for replacing existing plants, a scarcity of capital, and the long lead time required to introduce advanced coal technologies point to the likelihood that most of India's highly polluting coal-fired power plants will remain in operation for the next couple of decades (EIA, 2004b). In 2010, methane emissions from coal mining were calculated at 18.88 $mtCO_2e$ (USEPA, 2012).

16.2.1 CMM Emissions from Operating Mines

Table 16-6 summarizes India's CMM emissions.

Table 16-6. India's CMM Emissions (million cubic meters)

Emission Source	2000	2005	2010	2015 (projected)
CMM emissions (no utilization)*	1,007	1,077	1,275	1,397

**Actual emissions reductions are unknown.*
Source: USEPA (2012)

While there is some drainage of CMM, there are currently no commercial projects for its recovery or use in India. A USD 14.9 million project of the United Nations Development Programme (UNDP), the Global Environmental Facility (GEF), and the Indian Ministry of Coal called "Coalbed Methane Recovery & Commercial Utilisation" demonstrated the feasibility of utilizing methane gas recovered before, during, and after coal extraction. The lack of commercial CMM projects in India is in part due to the lack of a legal or regulatory framework governing CMM production. Although the Ministry of Coal and the Ministry of Petroleum have been discussing a comprehensive CMM policy in recent years, a resolution to the issue does not appear imminent.

In 2008, the U.S. EPA and the U.S. Trade and Development Association assisted in the establishment of the CMM/CBM Clearinghouse located at the Central Mine Planning and Design Institute's (CMPDI) campus in Ranchi (www.cmmclearinghouse.cmpdi.co.in). The Clearinghouse seeks to promote the deployment of CMM recovery and end-use technologies in India to reduce methane emissions.

The Global Methane Initiative (GMI) International CMM Projects Database currently identifies 21 potential CMM recovery projects in India. However, the majority of these are at the "initial idea" stage and most of them have since been dropped due to the inability to receive a concession to develop the project. Through GMI, U.S. EPA awarded a grant to the Central Institute of Mining and Fuel Research to conduct a feasibility study on CMM recovery and utilization in the Jharia, Bokaro, and Raniganj coalfields. The project provided data on CMM/VAM/AMM emissions in key gassy coal regions of India. VAM data was collected from 10 working mines. More recently, EPA's CMOP program funded a pre-feasibility study for pre-mine drainage at the Sawang Mine located in the Bokaro coalfield. The study will examine the economics of utilizing long, in-seam boreholes to drain gas from the deeper, un-mined portions of the mine.

16.2.2 CMM Emissions from Abandoned Coal Mines

About 5 percent of abandoned mines in India are considered gassy, assuming the same percentage as active mines reported in the First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). No additional information is available on abandoned mine methane (AMM) in India at this time, although several studies are proposed to gain more information on AMM emissions volumes in India's major coalfields (GMI Projects Database, 2010).

16.2.3 CBM from Virgin Coal Seams

Estimates of India's CBM potential vary. The Directorate General of Hydrocarbons estimates that deposits in 44 major coal and lignite fields in 12 states of India, covering an area of 35,330 km^2, contain 3.4 trillion cubic meters (m^3) of CBM depending on the rank of the coal, depth of burial, and geotectonic settings of the basins as estimated by CMPDI.

In the Jharia Coalfield, the gas content is estimated to be between 7.3 and 23.8 m^3 per tonne of coal within the depth range of 150 to 1200 m. Analysis indicates every 100-m increase in depth is generally associated with a 1.3 m^3 increase of methane content (M2M Profile – India, 2005).

In 1997, the government formed a CBM policy that established the Ministry of Petroleum and Natural Gas as the CBM administrative agency and offered several incentives (see section 16.3.1).

In May 2001, the Indian government for the first time offered blocks for exploration and production of CBM through an international bidding process. Reliance Industries, Essar Oil Ltd., and Oil and Natural Gas Corporation (ONGC) won the bids for the blocks. The government launched a second round of bidding on nine CBM blocks in May 2003, and eight blocks were awarded to Reliance and ONGC. The Directorate General of Hydrocarbons offered an additional 10 CBM blocks during a third round of open international competitive bidding that closed in June 2006. Contracts for this third round of bidding were signed in November 2006. These 26 prospective CBM blocks in the first three rounds of bidding cover an area of around 13,590 km^2 and are estimated to contain 1.45 trillion m^3 of CBM resources (Table 16-7). Expected total production from these blocks is estimated at 39.7 million m^3 per day at their peak production level (DGH, 2010).

More than 200 exploratory (test) and nearly 300 production wells have been drilled in the awarded blocks. Commercial production began in the Raniganj (South) CBM block in July 2007, followed by commercial production from the Raniganj East Block. Current gas production from these three blocks is 0.6 million m^3 per day and by 2015 production is projected to increase to 1.0 million m^3 per day. The fourth round of bidding on 10 new CBM blocks took place in the fall of 2009. The blocks cover an area of approximately 5000 km^2 and are spread over seven states. During the fourth round of bidding, 26 bids were received for eight of the blocks on offer while 2 of the blocks located in the Wardha Coalfield of Maharashtra received no bids. Essar Oil Limited, Arrow Energy and Great Eastern Energy Corporation Ltd. were the successful bidders (DGH, 2010).

Table 16-7. CBM Project Blocks Offered for Lease

Bidding Round for CBM Blocks	Blocks Offered	Area (km^2)	CBM Resource (Bcm)	Expected Production (MMcmd)
First	5	1,930	235	9
Nomination Basis	3	643	163	5
Second	8	5,234	427	10.5
Third	10	5,784	624	15.2
Fourth	10	5,000	NA	NA
Total	**36**	**18,591**	**1,449+**	**39.7+**

Source: DGH (2010)

Table 16-8 contains a list of some of the CBM activity by private companies currently taking place in India.

Table 16-8. CBM Projects Proposed or in Development

Company	Coalfield	Status	Notes
Great Eastern Energy Corporation Ltd (GEECL)	Raniganj	Approx. 100 wells on line and selling about 0.3 MMcmd	GIP estimated at 56.6 billion m^3 (Bcm)
	Mannargudi Block	Block awarded to GEECL in 4th bidding round.	Estimated GIP is 28 Bcm
Reliance Industries	Sohagpur	In development phase. Approx. 30 exploratory wells drilled. Plan to commercialize the field starting 2015	USTDA grant for technical assistance on commercial development of CBM
Essar Oil Ltd.	Raniganj	150 CBM production wells drilled – CBM production currently 0/2 MMcmd	Project scope is 500 wells. GIP is estimated to be 130 Bcm with recoverable reserves of 28 Bcm
Oil & Natural Gas Corp. (ONGC)	Parbatpur, Jharkhand	8 exploratory wells drilled. Currently producing 15,000 cubic meters of CBM gas, but ONGC is looking to expand.	Holds 5 CBM blocks in Jharkhand and 1 in Raniganj – all in exploration stage
BP, Deep Industries Arrow, Geopetrol and more		Various stages of CBM exploration	

Source: M2M Expo (2010)

16.3 Opportunities and Challenges to Greater CMM Recovery and Use

India is a non-Annex 1 country under the UNFCCC and it is not obligated to reduce carbon and greenhouse gas (GHG) emissions. In 2012, its second national communication provided emissions estimates for 2000. The emissions are projected to continue to grow as the economy expands (EIA, 2004a). India accepted the Kyoto Protocol in 2002 (see Table 16-9). As a non-Annex 1 party, India is eligible to receive financing for GHG mitigation projects such as CMM projects under the Clean Development Mechanism. However, note that the Kyoto Protocol expired in 2012 and there is currently no follow-on agreement.

Table 16-9. India's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 10, 1992	November 1, 1993
Kyoto Protocol	---	August 26, 2002 (Acceptance)

Sources: UNFCCC (2014)

16.3.1 Market and Infrastructure Factors

Gas demand is rising sharply in India, with consumption rising from 36 Bcm in 2005 to 58 Bcm in 2012 (EIA, 2013b). Gas production rates (29.9 Bcm to 41.3 Bcm over the same time frame) are increasingly lagging consumption rates and the shortfall is made up with imported natural gas and liquefied natural gas (LNG). 12.6 Bcm of natural gas (dry) and 12.3 Bcm of LNG were imported in 2009. In 2011, India became the world's sixth largest LNG importer, with 5.3 percent of global

imports (EIA, 2013a; PFC Energy, 2012). No data is currently available for LNG imports as of 2012, but dry gas imports increased to 16.9 Bcm. Gas consumption has grown at an approximate annual rate of 10 percent from 2001-2011 and the Indian Oil and Natural Gas Ministry projects consumption to more than double over the next 5 years (EIA, 2013b).

Current prices for imported coal, gas and LNG make CMM and CBM an economically attractive alternative energy source, provided the pipeline infrastructure is developed (Dube, 2010). Investments in coal and gas transportation infrastructure, including gas gathering, transportation and distribution, are necessary to move CMM and CBM from coal fields to local and more distant end-use markets. One such project is in development by GAIL (India) Limited, India's principal gas transmission and marketing company, which is building a natural gas pipeline in north-east India running through many of the major coal regions. End-use markets for CMM/CBM include rural power generation, commercial power generation, and transportation fuels.

Limitations in cost and investment capital, however, remain significant barriers to technology development, application, and CMM and CBM project development in India.

The following actions were identified as necessary in order to fully develop India's CBM/CMM potential (M2M Workshop – India, 2005), and these are the areas that the CMM Clearinghouse addresses:

- Delineation of prospective CBM/CMM blocks,
- Development of coal field-specific databases,
- Provision of technical and other training,
- Promotion of CBM/CMM research and development,
- Transfer of CBM/CMM development technologies,
- Provision of substantive measures to encourage CBM/CMM development entrepreneurs and maintain constant interaction with and among CBM/CMM developers, and
- Establishment of a clear policy regarding CMM development.

16.3.2 REGULATORY INFORMATION

A memorandum of understanding between the Ministry of Coal and Ministry of Petroleum & Natural Gas governs the procedures for allotment of blocks for CBM exploration and exploitation. CBM blocks are allocated after mutual consultations between the two ministries (Prasad, 2006). The Ministry of Coal oversees coal resources while the Ministry of Petroleum and Natural Gas oversees CBM resources.

India's heavy reliance on coal, much of it low-quality, is a major cause of the country's relatively high carbon intensity level. However, environmental standards for limiting gas emissions from surface or underground coal mining operations, as well as emissions from coal and gas combustion, are largely lacking. Current guidelines governing CMM emissions apply only to methane concentrations, and not on volume released. Other issues affecting CMM/CBM drainage and use include clarifying gas ownership, expediting private participation and possible government mandates for pre-mining degasification (Dube, 2010). A regulatory framework for CMM is under formation by the Government of India (M2M, 2008).

India has offered several incentives to attract foreign investment for CBM development. The Indian government formed a CBM policy in 1997 that established the Ministry of Petroleum and Natural Gas as the CBM administrative agency and offered following key benefits:

- No upfront payment
- No signature bonus
- No participating interest of the Government of India
- CBM development blocks allotted through a competitive bidding process
- A 7-year tax holiday, beginning with the date of commercial CBM production
- Freedom to market in domestic market at market determined prices
- Imported equipment for CBM development exempted from customs duties
- Walkout option at the end of Phases I & II

Incentives also allow no limitation on cost recovery, unincorporated joint ventures, accelerated depreciation and securitization of interest. India has implemented policy changes to encourage foreign investment, including lowering or eliminating tariffs on capital goods, such as electric power generation equipment (EIA, 2004a).

16.4 Profiles of Individual Mines

Moonidih Mine, Jharkhand			
Mine Status	Active	**Mine Owner**	Bharat Coking Coal Limited (BCCL)
Mining Method	Longwall	**Parent Company**	Coal India Limited (CIL)
Depth of seams	To 500 m	**Location**	Jharia Coalfield, Dhanbad District
		2008 Utilized CH_4 volume	Minimal usage by GEF project

Musilia Unit, Ghusick Colliery, West Bengal			
Mine Status	Active	**Mine Owner**	Eastern Coalfields Limited (ECL)
Mining Method	Room-and-Pillar	**Parent Company**	Coal India Limited (CIL)
Depth of seams	50-65 m	**Location**	Burdwan District
No. of seams	2 (additional 4 to be mined)	**2008 VAM volume**	1.899 Mm^3

Jarangdih U/G Mine, East Bokaro Coalfield, Jharkhand			
Mine Status	Active	**Mine Owner**	Central Coalfields Ltd
Mining Method	Bord & Pillar	**Parent Company**	Coal India Limited (CIL)
No. of seams	22	**2011 CH_4 Emissions**	0.521Mm^3

Mohuda Top U/G Mine, Jharia Coalfield, Jharkhand			
Mine Status	Active	**Mine Owner**	Bharat Coking Coals Ltd
Mining Method	Bord &Pillar	**Parent Company**	Coal India Limited (CIL)

Mohuda Top U/G Mine, Jharia Coalfield, Jharkhand			
No. of seams	8	**Location**	Dhanbad District
		2011 CH_4 Emissions	0.504 Mm^3

Pootkee-Bulliary U/G Mine, Jharia Coalfield, Jharkhand			
Mine Status	Active	**Mine Owner**	Bharat Coking Coals Ltd
Mining Method	Bord & Pillar	**Parent Company**	Coal India Limited (CIL)
No. of seams	18	**Location**	Dhanbad District
		2011 CH_4 Emissions	0.389 Mm^3

Other mine profiles are located at https://www.globalmethane.org/activities/indexact2.aspx?geoFocus=india&sector=coal and https://www.globalmethane.org/expo/posters.html.

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