United Nations Development Programme
GLOBAL ENVIRONMENT FACILITY (GEF)

25 March, 1998

Dear Mr. El-Ashry,

Subject: **IND/97/G34/A/1G/99 Coalbed Methane Recovery and Commercial Utilization**

I am pleased to enclose the project entitled **"India: Coalbed Methane Recovery and Commercial Utilization"** which was included in the July 1997 Intersessional Work Program approved by GEF Executive Council.

As per paragraphs 29 and 30 of the GEF Project Cycle, we are submitting this project to you for circulation to the Executive Council Members for comments and, subsequently, for your final endorsement.

Thank you in advance for expediting the review and approval of this project.

Yours sincerely,

Rafael Asenjo
Executive Coordinator

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UNITED NATIONS DEVELOPMENT PROGRAMME
Project of the Government of India
GLOBAL ENVIRONMENT FACILITY

PROJECT DOCUMENT

Project Number	:	IND/97/G34/A/1G/99
Project Title	:	Coalbed Methane Recovery and Commercial Utilization
Duration	:	Sixty Months
ACC/UNDP Sector	:	2000 Environment Policies
Government Sector	:	Environment
Sub-sector	:	Climate Change
Government Counterpart	:	Department of Economic Affairs, Ministry of Finance
Executing Agency	:	Ministry of Coal

FUNDING SUMMARY:

UNDP and Cost Sharing		
UNDP	$	1,210,000
UNDP/GEF	$	9,198,000
Government contribution (in cash)	$	4,544,000
Cost Sharing or Third Party		
UNDP and cost sharing		
Total	**$**	**14,952,000**

N.B: The above figures do not include $1,960,000 which is revenue to be generated during the Project duration.

Estimated Starting Date : June 1998

Government contribution (in kind) US$ 2,321,000

Brief Description : The purpose of this project is to demonstrate the commercial feasibility of utilizing methane recovered during coal mining activities from coal and surrounding strata before, during and after extraction of coal. Recovered methane will be used as fuel in a 1MW internal combustion generator and in 50 ton mine dump trucks that that are powered by converted bi-fuel engines.

On behalf of Signature Date Name & Title

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A. BACKGROUND

A.1 BACKGROUND

Development of methane resources has attracted attention in the recent years as an alternate clean energy source in many parts of the world..

Efforts are now being made worldwide to control the emission of greenhouse gases and thereby reduce the pressures for accelerated climate change. Methane is a powerful greenhouse gas, as its adverse impacts are felt more intensely due to its shorter residence and higher potency in the atmosphere than carbon dioxide. However, methane is a remarkable clean fuel when burnt, and its combustion produces no SO2 or particulates and only about half of the CO2 associated with coal combustion.

Emission of methane is related to various human activities like rice cultivation, livestock management, burning of bio-mass & fuels, coal mining and land-fills. Human activities account for about 60% of total methane emissions. Although the growth in emissions is loosely correlated with increase in population, presently the global concentration of methane is increasing by about l% per annum.

Coal mining is estimated to account for about l0% of all human-related methane emissions. Methane is associated with coal as a by-product of the coal formation process. It is trapped in coalbeds and released during and after mining. The methane associated with the coalbeds has caused disasters in underground coal mines all over the world. In order to reduce the hazard from methane explosions, mines are ventilated to reduce the methane content in the mines. Technologies are now available to recover the trapped methane from coal-beds prior to mining through drilling of boreholes,. These provide an additional source of energy while reducing both the escape of methane gas to the atmosphere and the mining hazard.

India is the third largest coal producer in the world and has substantial coal reserves (204 billion tonnes, plus 68 billion tonnes of prognosticated reserves). It produced about 289 million tonnes in 1996-97. Opencast production accounts for 74% of the total output and the remaining 26% is met by underground production. The share of the underground output in the total production is expected to be maintained at the current level through the Ninth and the Tenth Five Year Plans i.e. up to 2010 even as the coal production increases. The average depth of the underground mines is 150-200m with a seam thickness of 2-3m and 60m for opencast mines with average seam thickness of 3-4m. On an average, 75% of Indian coals are not highly gassy. However, the underground coking coal reserves of the eastern coal belt are highly gassy and go up to gassiness of degree three. Almost 45% of the underground coal output is met from the two coal fields in the sample sites selected in the project brief, belonging to the eastern region of the country. The coal seams of the region primarily possess superior grade coal : prime and medium coking , and some semi and weakly coking coal . Coal mining activity in this region has been and will continue to be a major industry, maintaining a dominant share in the coal sector of the country, given the demand for superior grade coal. The region has a high concentration of industrial units (steel plants, chemical, ceramic, and glass industry, all of which demand high temperature long flame coal found in the region), and high population density. As such, use of coal has been a major contributor of methane to the atmosphere. If efficiently recovered, coalbed methane associated with coal reserves could be a significant potential source of energy both in the region and for the country.

A.2 DESCRIPTION OF INDIA'S ENERGY SECTOR

The development of the energy sector has been one of the priority areas of the government policy, and has received the highest consideration of the Government of India (GoI), in view of its needs for sustaining the

growth of the economy and meeting the basic needs of the people. Integrated energy planning was recognized as an essential element of development as early as the 1960s and a strategy for energy development forms a part of the country's economic development strategy. The efficient use of energy resources and long-term sustainability of energy supply are two important objectives of energy planning.

Coal remains India's predominant source of commercial energy, accounting for 60 % to 65% of the primary energy needs of the country over the last decade. In absolute terms, the coal production has steadily increased from 72.3 million tonnes of oil equivalent (mtoe) in 1984-85 to 132 mtoe in 1995 -96. Petroleum and natural gas are the second largest energy sources to the economy, at 36.2 mtoe in 1996. To meet the increasing demand and clear the market distortions affecting the optimal use of coal by the end users, the Coal Industry has gone through a series of price deregulations in the last two years: The price of coking coal and grades A,B, and C were deregulated on April 1, 1996. This was followed by a similar deregulation for price for Grade D coal in April 1997. For the remaining E, F, and G grades (power grade) partial deregulation has been introduced with coal companies having the right to revise coal prices bi-annually up to December 1999, after which prices stand deregulated automatically.

The predominant position of coal in meeting the country's energy need is reflected in the above data. India is poised to produce 348 m tonnes of coal p.a. at the end of 2001-2002, which is well within the estimated reserves of the country. There is shortage of oil in the country, and the crude oil import in 1995-96 amounts to 27.34 million tonnes. Gas reserves stand at 707 billion cubic meters and can sustain a production of 30 million cubic meters per year for the coming 23 years. By the end of the ninth five-year plan only 31% of the demand of natural gas is likely to be met from indigenous sources.

Under the circumstances, India will continue to be largely dependent on coal for its energy requirements. This, however, will occur with negative environmental impacts brought about by the continued high emissions of methane and carbon dioxide. In this context, it is important to exploit and utilize the available resources of coalbed methane, which will supplement natural gas resources and partially reduce the dependence on coal. The substitution of coal by methane gas for specific end uses can serve as an instrument for GHG mitigation.

A.3 EXISTING PROGRAMMES AND ENERGY SECTOR STRATEGY

In the Ninth Plan (1997-98 to 2001-02), the annual growth in coal demand is assessed at 7% and the total coal demand is estimated to be 439.2 million tonnes at the end of plan period. The power sector has been identified as the largest consumer of coal in the ninth, tenth and eleventh plan period. At the end of eleventh plan, a demand forecast of 328.2 million tonnes has been projected for the power sector out of which 299.7 million tonnes will be by power utilities.

In the plan documents, the importance of exploitation of coalbed methane to meet the country's energy needs has been fully recognized. The Ninth Plan has envisaged active work in this field leading to extraction and utilization of this important resource. According to estimates of the Central Mine Planning & Design Institute/Coal India Limited, coalbed methane resources could add about 400 billion cubic meters to the conventional gas inventory of 707 billion cubic meters. Presently advanced methods of methane recovery are available in the world, using particularly specialized methods of drilling (vertical as well as horizontal) that could produce large amounts of coalbed methane. Development of coalbed methane is consistent with India's medium and long-term energy strategy, which directs intensification of research and development activities in the field of new energy resources. It will also decrease GHG emissions from the coal mining sector in a very cost-effective manner.

A.4 PREVIOUS AND ONGOING ASSISTANCE

A number of projects in the coal sector with support from multilateral and bilateral agencies are currently under implementation. These have addressed issues such as mine safety, environmental benefits, productivity and production. GoI has taken up several of these projects as a part of the Ministry of Coal initiatives. These support programmes have addressed such issues as laboratory facilities, coal washing and mechanization of underground and open cast mines. UNDP has also supported several coal sector projects, namely:

IND/80/052	Extension of lab facilities in Central Mine Planning & Design Institute Ltd. (CMPDIL) for application of advanced techniques in coal mines operations;
IND/86/014	Modeling and control of water systems in coal mining environment;
IND/87/001	Improvement of working conditions in mines; and
IND/92/005	Human resource development for improving health and safety standards in mines.

Two of the four projects listed above have addressed the issue of mine safety, developing measures to protect the miners from inhaling excessive gas and dust released during mining operation as well as addressing issues of heat and moisture control. To date, projects have not been developed that reduce the volume of methane released within a mine, preceding and during mining activity.

In the past, some national and multinational private sector enterprises have expressed interest in harnessing coal bed methane in India. To date, they have had little success because they faced institutional problems regarding resource ownership and modalities of payment to the nationalized companies. While GoI has been supportive of initial moves to develop and recover methane (by providing working blocks without bidding or production bonus and a 12.5 percent royalty), the US-based multinational company AMOCO India Petroleum Ltd. scrapped its multi-million project in India after 2 years of passing the Foreign Investment Board (FIB) approval. The status of similar private sector initiatives are reflected in the following table:

TABLE 1. Status of Coalbed Methane Exploration /Exploitation in India

		Area Allotted			
Sl. No.	**Company**	**Coalfield**	**In sq. Km.**	**Status**	**Remark**
1	M/S Modi McKenzie Methane Ltd.	Raniganj	225	Exploratory drilling taken up since 1996	
2	M/S AMOCO India Petroleum Ltd.	Jharia North Karnapura	72 266	So far no activity	Have withdrawn
3	M/S Reliance Industries Ltd.	Raniganj Sohagpur	150 200	So far no activity	
4	M/S ESSAR Oil Ltd.				Application for allotment of area in Raniganj coalfield is under consideration.
5	Reliance Texaco	Mehsana area of Gujarat			Under consideration

B. PROJECT JUSTIFICATION

B.1 PROJECT STRATEGY

CBM is a newly developed energy source in the world and its exploitation started over a decade back in USA. The major coal producing countries later also became aware of this energy source. Some international coal companies as well as some joint venture companies firmed up with Indian entrepreneurs along with international companies having expertise in CBM exploitation and started showing interest in exploitation of CBM in India in the early 90's.

CBM as a mineral did not figure in any of the Indian statutes. CBM being an associate of coal, the Coal Ministry became the administrative Ministry for regulating the three joint ventures/international companies, who came up with proposals for exploitation of CBM. All the three were given Government approval for exploration/exploitation of CBM in specific blocks. One company is going ahead with the work in accordance with the Government approval. Another company of USA, for reasons of their own, decided to withdraw even through they were issued Government approval for CBM extraction. The third company is still finalising the exploitation arrangements with various government agencies.

For a workable institutional arrangement, it has now been decided to treat CBM as a natural gas. The statute regulating the exploitation of Natural Gas are well-defined in India and as such there is no further problem in going ahead with the exploitation of CBM in India. However, the laws governing natural gas are being administered by the Ministry of Petroleum & Natural Gas, and CBM being an associate of coal, the exploration/exploitation of CBM would now be regulated jointly by Ministry of Petroleum and Natural Gas & Ministry of Coal.

Since at present 98% of the coal production is being done by government sector in India and hardly any exploration/exploitation of CBM has taken place in India, it would be considered premature to involve any private parties in this demonstration project. It is expected that once the demonstration project is

successfully implemented, its results would certainly attract more and more private entrepreneurs and/or commercial financing in the field of exploration/exploitation of CBM. It may also be informed that Government of India would be offering 6 to 7 blocks for CBM exploitation for global competitive bidding in the immediate near future.

This project will address two major issues that have presented barriers to adopting measures that effectively drain, recover and use methane during mining:

1. The methane that is released during mining is often viewed as a nuisance and not a valuable resource since most of it is released in the ventilation air and although the volume of gas that is released is large the concentration is low. Prior attempts to drain gas for the purpose of increasing safety were attempted in mines where the mining face advance rate was low and the attendant relaxation of the adjoining strata was not significant. Furthermore, the attempts were not long-lived and the lack of immediate success thwarted additional attempts. Due to the low initial production rates there was no attempt made to recover and use the gas. The drainage technology proposed for this project are advanced, and provisions have been made to study the behavior of the strata that releases the methane during and after mining; so that fact based approaches to location and design of the underground drainage bore holes and surface wells into virgin coal and gob areas are optimized.

2. Mines and the local communities do not have access to clean burning fuel due to lack of infrastructure. The resources of coalbed methane are large and the potential for production of significant volumes of gas for sale and use at the mine and surrounding community is great. After production is established, installation of gas fired power generation facilities and a methane vehicle refueling station will demonstrate the end feasibility of uses sited near to the source.

B.2 EXPECTED SITUATION AT THE END OF THE PROJECT

The duration of the project is five years. At the end of the project it is expected that:

- A power generation facility installed at the Moonidih mine will be operational. The facility will be fueled by methane recovered from coal and adjoining strata ahead of mining and from the gob areas left as mining passes through a mine. The gas will be transported via a pipeline system from a gas plant which will be the central collection point where gas from various sources will be blended and concentration will be normalized.

- Capacity will be expanded and strengthened in CMPDIL so that this institute can provide services ranging from conceptualization of coalbed methane recovery projects through planning, staging, performing drilling, testing, evaluation and development of coalbed methane deposits.

- Capacity will be expanded and strengthened in BCCL. Capability for planning and executing underground drilling projects using state-of-the-art underground drilling equipment to drain gas from coal and surrounding well strata be proven. These strategies for recovery will be incorporated into mine planning for extraction of gassy coal deposits.

- Expanded numerical reservoir and strata relaxation modeling capabilities and understanding of the economics of coalbed methane development will be incorporated into the curriculum of the India School of Mines. Experience gained during the demonstration project will be the basis for providing training to geologists and engineers whom will be the future developers of coalbed methane depots.

- Expanded laboratory facilities in which advanced technology for measuring the sorption characteristics of coal can be tested. Permeability tests will also be performed under in situ stress conditions allowing reservoir characteristics to be used in project evaluation.

- There will be a measurable reduction in GHG emissions derived from mining activities through drainage recovery and use of methane while substituting for coal burned in power generation and diesel used in mine transport.

- There will be an action plan laying out policy and future activities for development of coal mine related coalbed methane.

- There will be a coalbed methane clearinghouse located on the CMPDIL campus that will serve as an interface for GoI cognizant agencies and a source of information and contacts for national and international parties interested in development of coalbed methane in India. The clearinghouse will also act as a library and Internet gateway connected via Intranet with linkage to Ministry of Coal, CIL, Regional CMPDIL offices.

B.3 TARGET BENEFICIARIES

The target beneficiaries of the project may be divided into two groups. The first group comprises those that directly benefit from participating in the Activities and the Outputs produced by the demonstration project at the Moonidih and Sudamdih coal mines. Second group comprises future beneficiaries dependent on successful replication of such project based on its success.

B.3.1 BENEFICIARIES OF THE DEMONSTRATION PROJECT

The following comprise organizations and institutes that will directly benefit from the demonstration project;

1. Central Mine Planning and Design Institute Ltd., Ranchi by strengthening and increasing its capacity and capability for development of mine associated CBM recovery and use.

2. Educational and research institutions such as Indian School of Mines (ISM), and Central Mining Research Institute (CMRI) both located at Dhanbad. ISM by means of increasing its capacity and capability academically and CMRI in terms of additional laboratory facilities and their involvement in analysis of the results of the demonstration project as a technical service organization

3. Coal companies (public and private) involved in underground coal mining of gassy coal seams will benefit through the dissemination of information and development of training database and laboratory facilities in CMPDIL, CMRI, and ISM. Private enterprises willing to invest in CBM development projects will benefit from the increased availability of information and services.

4. Bharat Coking Coal Ltd., Dhanbad BCCL, in whose mines the project is being undertaken, may enjoy significant tangible benefits by degasification of their mines resulting in increased safety, a likely increase in production, and increase reserves of minable coal in areas currently considered unworkable due to high gassiness. In addition, BCCL will enjoy the availability of electric power generated from what is now a wasted resource for its own use and/ or sales to the DVC grid; and the use of low cost compressed methane fuel in heavy duty open pit trucks rather than diesel.

5. Local mining community may benefit from reduced electricity shortages accompanied with frequent load shedding due to generation of additional electric power in the area. Local community will also be benefited by availability of a cleaner and more efficient source of vehicle fuel as a substitute to diesel fuel if surplus power generated by the demonstration project is supplied to local community.

6. To the extent that recovered methane is utilized as an alternative source of energy in the coalfield, it will reduce the combustion of coal and diesel in the area resulting in reduced environmental pollution from CO_2 and particulate matter. Due to the size of the demonstration project, benefit from this project to the local community will be limited, but would increase with replication of the project. This local environmental benefit in due course could become a regional and national environmental benefit.

7. Indian governmental and non–governmental organizations will benefit from the project through extensive exposure to state-of-the-art coal mine methane recovery and utilization, a technology management data base, research facilities, and a clearinghouse. Under the project they will also be able to interact with foreign experts to formulate the projects. This interaction and exchange between the Indian agencies and foreign experts will enhance understanding on both sides.

8. Ultimately the global environment will benefit from reduced CH_4 emissions.

B.3.2 FUTURE BENEFICIARIES ASSOCIATED WITH THE REPLICATION OF THE PROJECT

1. Existing coal companies in public and private sectors that are working on gassy underground coal mines in Jharia and Raniganj coalfields in eastern India would benefit by replication of such projects. Besides public sector coal companies (e.g. Bharat Coking Coal in Jharia Coalfield and Eastern Coalfields Ltd. In the Raniganj Coalfields), there are gassy underground coal mines belonging to private sector steel companies such as TATA Iron and Steel Company (TISCO) and also to the Steel Authority of India under its Indian Iron & Steel Co. (IISCO) adjoining one of the project sites. These companies can benefit immediately by replication of the project.

   Under the liberalized policy of the Government of India, the private sector has the freedom to mine coal. This is attracting many national and foreign investors in joint venture. Solving the problem arising from extraction of gassy coal could attract them toward developing high quality but gassy sources of coking coal.

2. Replication of the project will provide all the immediate benefits indicated in B.3.1. Beneficiaries will be the coal companies (private and public) and the local communities as local and regional industrial development increases with growing availability of a substantially cleaner and efficient source of primary energy. It will also benefit industry engaged in manufacturing of equipment for power generation, manufacturers of bi-fuel conversion systems. Other possible uses of methane (e.g. bottled methane, piped methane etc.) may develop both regionally and nationally.

3. CMPDIL, CMRI, ISM and other agencies involved in planning, designing, research, education and training in this sphere will benefit by increased work and further research and development.

4. Investors (Indian and foreign) interested in investment and development of this new source of energy, as well as those interested in the manufacturing of equipment and providing services for its utilization

will benefit from replication of the project.

5. The global environment will benefit due to substantially reduced methane emitted from coal mining and the reduced use of coal and petroleum products to that extent.

B.4 PROJECT STRATEGY AND INSTITUTIONAL ARRANGEMENT

This present technical assistance project draws on the recommendation put forth in India's Ninth Five Year Plan recommending the development of new sources of energy. An interministerial meeting organized in October 1996 identified methane harness and utilization as one of the immediate GHG mitigation priority measures to be undertaken. To date, it has not been tapped because of lack of access to state-of-the-art know-how and confidence in the commercial viability of gas-recovery techniques. Currently, many developing countries, including India, use degasification technologies to maintain mine safety, but none of this gas is used as fuel, thereby leaving a potential high quality fuel untapped.

The UNDP-GEF project will support technical assistance and in-country capacity building for expanded methane recovery and use. Through representative demonstration plants, the project will introduce advanced techniques of gas resource assessment and recovery and utilization methods relevant for Indian coal-mining conditions. Since appropriate methane recovery and use techniques can be heavily influenced by local geological conditions, mining methodologies, and gas quality, identification and techno-economic feasibility of projects have to be site-specific. The area chosen for the demonstration project, a representative sample of mines drawing on the CBM resource characteristics existing in many parts of the country, is in the state of Bihar and is principally located in the Jharia coal field. The coalfield lies within a structurally-aligned basin located in the central and eastern part of the state. The maturation of the resources found in these fields ranges from high volatile bituminous coal to low volatile bituminous coal, and there are occurrences of naturally coked coal. Maturation of the coal has resulted in the widespread occurrence of coalbed methane resources. Some of these resources have migrated or have been lost to the atmosphere long ago, but much of the methane remains trapped at depth until the gassy coal seams are extracted.

The project concept is to effectively capture methane in working coal mines from:

- the mined out areas that contain and potentially emit methane to active workings by vertical wells drilled from the surface,
- the coal face being mined via deep inseam drilling of long holes in coal and in strata above and below and,
- in the coal reserves by drilling surface boreholes ahead of the coal face being mined.

Through boreholes from the surface, methane is brought to a central point on the surface and can be utilized for power generation, or as a substitute for diesel fuel in 50-ton open-pit dump trucks. In addition to increasing the safety in gassy mines, this will prevent emission of methane in mining operations thereby preventing methane from being released to the atmosphere and contributing to global warming. The energy being made available from methane, which is being or likely to be released, will in turn reduce the requirement of the utilization of coal and/or diesel thus further contributing to reduction of CO_2 emission. This energy produced from methane that was being released to the atmosphere will also add to the revenue of the coal mine.

Methane capture from coal mines and its utilisation is not being undertaken in India due to:

- the lack of latest available technology,
- lack of expertise and experience; and
- a pervasive perception that commercial viability of exploitation and utilization of methane is problematic.

The lack of latest technology and expertise can be remedied with through acquisition of the appropriate technology and expertise; but the pervasive view that commercial viability is problematic can only be mollified by a full-scale demonstration.

In addition, effective capture and utilization of coal mine methane with commercial viability requires multi-institutional efforts involving the coal company, and institutions/organizations by way of technical knowledge, research, training etc. for recovery and commercial utilization for power generation distribution and other areas by the community.

The project strategy is to overcome both the technological and institutional barriers by :

1. Strengthening and increasing capacity of CMPDIL, BCCL, Ministry of Coal, CIL, and the Ministry of Environment to develop and support of mine associated CBM recovery and use projects. Providing training and experience in the identification, design, and implementation of programmes to recover and use coalbed methane (CBM) in a safe, cost effective, and environmentally acceptable manner. Creating a Coalbed Methane Clearinghouse to manage data and information related to CBM technology.

2. Preparing and executing projects at the Moonidih and Sudamdih coal mines located in the Jharia coalfield demonstrating recovery and use of mine associated CBM in the Jharia coalfield. Conducting CBM resource recovery programmes using three different drilling technologies at two proposed demonstration sites.

Three strategies for developing the coalbed methane resources associated with mining are proposed:

- to drill ahead of mining by a number of years to pre-drain the gas that has existed in the coal seams for which mining is planned.
- to recover methane from the surface by vertical drilling into the gob areas. This technology can recover a large volume of high-quality gas if appropriate monitoring and quality control systems are in place.
- to recover gas in inseam longhole horizontal drilling. Inseam longhole horizontal drilling has two benefits:
  - ⇒ longhole drilling not only can develop a borehole that can be used as a drainage pathway but also as a tool for exploration. Areas that are structurally complex, such as the Jharia coalfield, allows for additional structural, stratigraphic and gas content data to be collected in advance of mining, and
  - ⇒ the borehole can be drilled not only inseam but also up and into the overlying strata so that as mining takes place, the borehole can be used a gob drainage borehole This has been proven to be effective in a number of mines. A borehole of this type be used for drainage of water form adjoining strata if necessary. Development of this inseam in mine drainage and exploration system will be key in not only increasing the safety and the amount of coalbed methane drained from the seam in overlying strata, but will increase the efficiency of mining if exploration in advance of mining and water drainage is also taken into account.

1. Using gas recovered from successful execution of the above objectives for vehicle refueling and electric power generation using:
   - Stationary IC engines fueled by medium quality methane and use of ventilation air as the combustion air
   - Diesel engines that have been converted to bi-fuel engines using compressed methane and having the capability to switch to diesel when necessary.
2. Developing and adopting an action plan for replication of successful aspects of demonstration projects. Use the CBM Clearinghouse to disseminate information, educate, promote, and facilitate interaction with potential foreign investors.

To augment and sustain successful CBM resource recovery and utilization that demonstrates commercial viability, the need exists for development of an action plan that encourages replication of successful aspects of demonstration project. Establishing a clearinghouse that disseminates information, provides educational training, promotes CBM project concepts and facilitates interaction with potential investors are key to ensuring sustainability. Although there is potential of capturing and utilizing coal mine methane in India, where coal will remain the predominant primary source of energy for the foreseeable future; demonstration of the efficacy and economic potential is needed. By adapting readily available CBM recovery and use technology to conditions unique to India's coal industry as the mining gets ever deeper and conditions become gassier, it is possible to ameliorate energy shortages and simultaneously mitigate release of greenhouse gases to the atmosphere.

Local and regional environmental conditions could improve to the extent methane is a clean source of energy and can substitute for coal used in power generation and diesel which fuels heavy-duty vehicles.

B. 4.1 INSTITUTIONAL ARRANGEMENTS

It is important that the institutional arrangements for project implementation are well defined and compatible with the project's overall objectives, and workable within the context of the changing structure of Coal Industry in India.

The Ministry of Coal will take overall responsibility to the execution and implementation of the project. A National Steering Committee comprising of members drawn from other ministries including DEA and MoEF, Directorate of Mine Safety, Coal India Ltd., CMPDIL, BCCL and other participating institutions, and UNDP will be set up under the chairmanship of Secretary, Coal. The Steering Committee will provide the necessary guidance and oversight to the project implementation, and will invite members and experts for specific meetings, as needed.

Additional Secretary dealing with the subject matter in the Ministry of Coal will be the National Project Director (NPD), and will also act as the convenor of the National Steering Committee. The NPD will carry out the directions of the Steering Committee, and will also be responsible for the monitoring and adherence of the workplan which forms the basis for project execution.

Since the project requires full time attention within the Ministry of Coal for coordination of various activities, NPD will be assisted by a full time national consultant who will be designated as Project Advisor (CBM) to carry out coordination of the project with various line ministries including Department of Economic Affairs and MoEF, and other participating agencies and institutions. The role of Project Advisor (CBM) will be pivotal keeping in view the interdisciplinary nature and involvement of multiple agencies in

the project. He will provide guidance to the project team for execution and adhering to the Government's official position as conveyed from time to time. He will also coordinate with the consultants, contracting and sub-contracting agencies, and review their reports, and look after other administrative arrangements as required under the Ministry of Coal and UNDP procedures. The members of the Policy Advisory Committee will be selected on the basis of their background in the relevant field, and their association and involvement during the implementation of the project activities, and later on, for replication of similar projects and allied ancillaries. The members will be drawn specifically from the NGOs and volunteer groups, and local communities and consumer groups to ensure their inputs and active involvement in the project. The process of selection will be in an open and competitive basis and the candidates must qualify under the Terms of Reference described in Annex 3.

The National Steering Committee will set up a Selection Sub-Committee which will finalize the selection of Project Advisor (CBM), Chief Project Manager, Project Administrative and Finance Manager, and Chief Technical Advisor and Senior National technical Advisor. The selection of suitable candidates for the management posts of the Project Advisor, Chief Project Manager and Project Administrative and Finance Manager will be made through an open, transparent and competitive process. The selection sub-committee will also identify suitable international and national consultants to work as Chief technical Advisor and Senior National Technical Advisor respectively according to the TORs annexed with the document.

The procurement of project equipment will be the responsibility of the Government of India (GOI), specifically the Ministry of Coal. For undertaking procurement activities, the procurement cell, comprising of CMDs from CMPDIL and BCCL, project advisor, and chief technical advisor, will take the responsibility. In undertaking these tasks, the chief technical advisor (international) and international specialists with experience in CBM equipment will help draw up a list of suppliers, prepare tendering procedures, and evaluate the bids, including preparation and execution of purchase orders. For the equipment listed in Annex 5A and 5B, locally available equipment will be procured on an open national competitive bidding. For equipment not available domestically, the GOI must apply an open international competitive bidding procedure. The equipment will be used exclusively for the purpose of the project.

Prior to completion of UNDP/GEF assistance to the project, the Government of India and the UNDP/GEF shall consult as to the disposition of all project equipment provided from the UNDP/GEF funds. Title to such equipment shall normally be transferred to the Government, or to an entity nominated by the Government, when it is required for continued operation of the project or for activities following directly therefrom. In the case of this project, the title of the equipment will be passed on to the responsible ministries of GOI, i.e. Ministry of Coal, at the end of the project. The UNDP, however, at its discretion, retain title to part or all of such equipment.

The Government will provide the Resident Representative with certified periodic financial statements, and with an annual audit of the financial statements relating to the status of UNDP (including GEF) funds according to the procedures set out in Section 30503 of the UNDP Policies and Procedures Manual (PPM) and Section 10404 of the UNDP Financial Manual. The Audit will be conducted by the legally recognized auditor of the Government, according to the GOI auditing procedure, or by a commercial auditor engaged by the Government.

Institutional interaction and cooperation is essential to the success of the project. It is, therefore, proposed to set up two more committees to provide a forum for programming, review and remedial measures on key operational and advisory issues that will arise in the course of implementation of the project. These committees will be designated as (a) Operational Steering Committee and (b) Policy

Advisory Committee. Exhibit 1 illustrates the organizational and institutional relationships that will be active during this project.

The functions of the Operational Executive Steering Committee would include planning and reviewing the progress of work on a regular and continuing basis, and to take timely decisions and actions for efficient execution of the project. The Chairpersons of CMPDIL and BCCL will chair the meeting on a rotational basis as both will be equally responsible for the timely implementation of the project (CMPDIL is the main local implementing agency, while BCCL is the adhoc implementing agency due to the fact that the two project sites are located in their mining areas).The other members of the Committee will be the Director, CIL, and DGMS (Representative), Project Adviser (CBM). and Chief Project Manager who will also act as the convenor.

The Policy Advisory Committee will be a forum to discuss broader policy issues, and seek inputs from its members drawn from educational and research institutes, non-governmental agencies, representatives of allied industry, political representatives and consumer groups, besides senior officials of the organizations and participating institutions involved in the project. Their active participation would ensure meaningful progress of the project. This Committee which will be headed by the Project Adviser (CBM), and the Chief project Manager as its convenor, will also link-up and provide inputs to the Steering Committee and Ministry of Coal.

Detailed Terms of Reference of the Committees are given in Annex 3.

At the field level, CMPDIL will assume the primary responsibility of the local implementing agency. However, due to the location of the methane recovery and use demonstration projects at the Moonidih and Sudamdih mines, BCCL will assume ad hoc responsibilities for implementation and facilitation as well. Primary elements of responsibility that will serve to strengthen, build, and add capacity to CMPDIL and BCCL are activities such as:

- training prior to and during the preparation and execution of projects;
- activities that will require application of training and concepts received during the course of this project;
- organizational and managerial requirements;
- development of an action plan implementing recommendations arising from the analysis of the results of the project;
- replication of the successful elements of the demonstrated technologies and methods into a cohesive and sustainable programme for development of coal mine associated CBM recovery and use projects;
- establishing a clearinghouse dissemination of information, training; interaction with potential investors and promotion of mine related CBM recovery and use projects.

In addition to CMPDIL and BCCL, nearby educational and research institutes involved in coal, coal mining, oil and gas sector will also participate in the project. The Indian School of Mines (ISM) is the premier professional educational institute of India recognized for its contributions in the field of mining, applied geology and petroleum. Some basic research and studies regarding CBM occurrences and mine gassiness have been conducted by instructors and student as ISM. The Central Mining Research Institute is the premier research institute of India in all mining related fields. Senior researchers at this institute have performed research on methane sorption capacity of Indian coals and emissions of methane gas from coal mines. Both institutes are located at Dhanbad adjoining to Jharia Coalfield. They are ideally situated to participate in the demonstration projects at the Moonidih and Sudamdih mine by providing services from their laboratory facilities and information and data; and, in return, their laboratory facilities and modeling

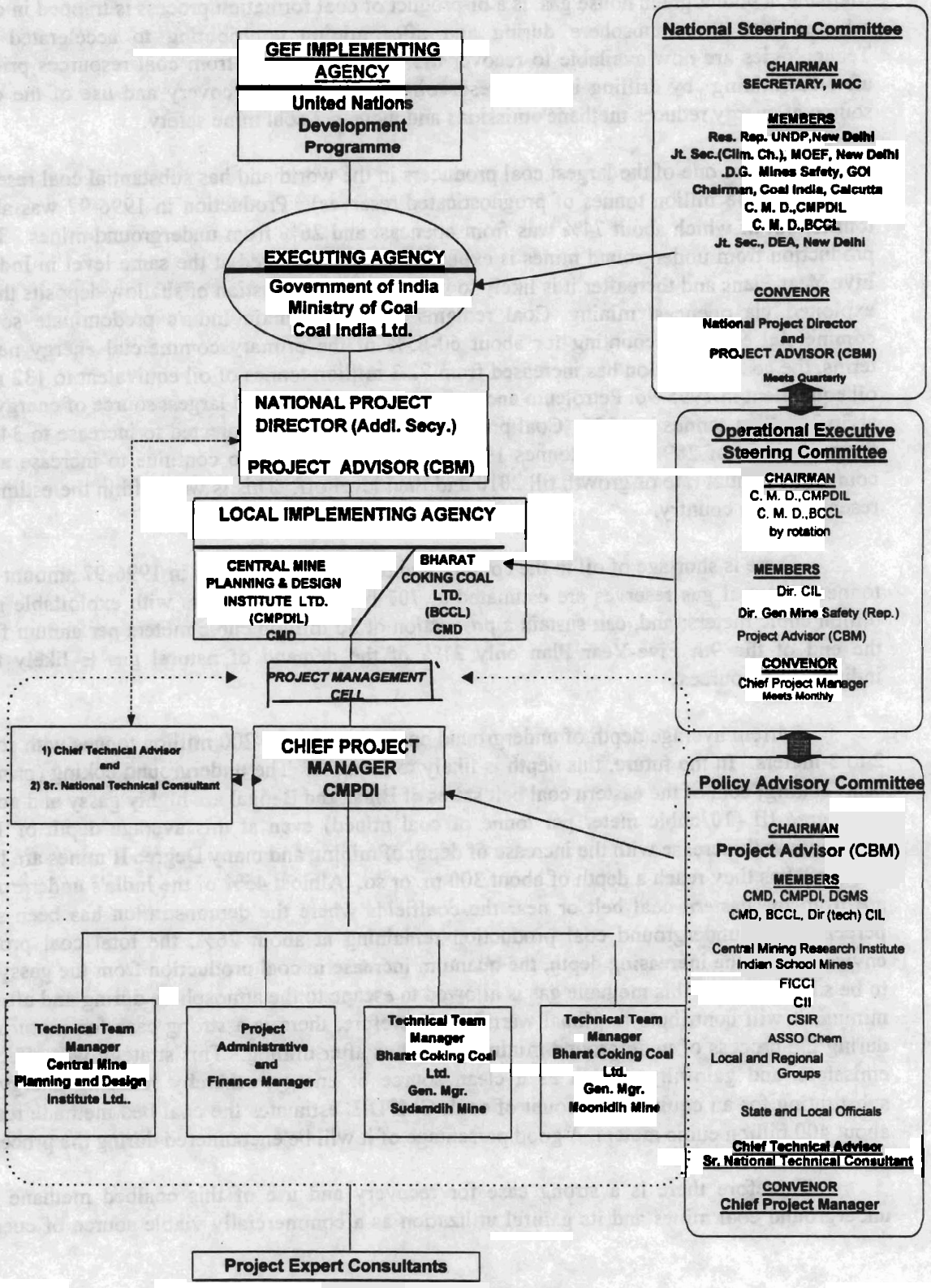
capabilities will be broadened and strengthened. Ensuring that there is future development of professionals capable of investigating scientific issues and supplying engineering solutions is key to establishing sustainable development of CBM resources. Development, strengthening, and expanding professional capabilities as well as providing state- of the art testing, analysis and research will be crucial for future replication of projects based on the successes of this demonstration project.

Methane becomes explosive when mixed with air and reaches critical concentrations, ranging from about 5 to 15 percent methane. Unsafe practices and use of equipment that is not permissible according to safety regulations can lead to life threatening disasters which may include, explosions of methane and coal dust, fires, and damage to the structural integrity of mine workings. Furthermore, the coal being mined in the Jharia coalfield is susceptible to spontaneous combustion, requiring that the coal working face and gob areas exposure to air in the underground environment must be careful controlled. Regulations regarding mine safety are enforced by the Directorate General of Mines Safety (DGMS). The DGMS must give permission before exploitation of coal may begin under any of the various mining conditions that may exist. It also certifies that new technologies and equipment are permissible, meaning that they are flame proof and/or intrinsically safe in a potentially explosive methane environment.

Therefore, the role of Directorate General of Mines Safety is key to the success of this project as demonstration of new technologies and importation of new equipment to work in gassy environment, will be required. For some of the activities to be undertaken in the project, new protocols will have to be developed which must adhere to DGMS regulations and policy. The NPD will supervise the preparation and approval of these protocols.

The economic and sustainable recovery and use of methane gas and concomitant reduction of methane emissions into the atmosphere is the desired achievement that underpins the success of the project. Therefore, the involvement of the Department of Economic Affairs and Ministry of Environment and Forest, Government of India, is essential to monitoring the progress of the project, and assessing the impact on reductions of greenhouse gas emissions.

PROJECT IMPLEMENTATION ARRANGEMENT



B.5 REASONS FOR ASSISTANCE FROM GEF

Coal mining is estimated to account for about 10% of all human related methane emissions. Methane, a potent green house gas, is a bi-product of coal formation process is trapped in coal bids and gets released into the atmosphere during and after mining contributing to accelerated climate change. Technologies are now available to recover the trapped methane from coal resources prior to mining and after the mining by drilling into the reservoir and using it. Recovery and use of the otherwise wasted source of energy reduces methane emissions and increases coal mine safety.

India is one of the largest coal producers in the world and has substantial coal reserves (204 billion tonnes, plus 68 billion tonnes of prognosticated reserves). Production in 1996-97 was about 289 million tonnes, out of which about 74% was from opencast and 26% from underground mines. The share of coal production from underground mines is expected to be maintained at the same level in India's 9th and 10th Five Year Plans and thereafter it is likely to increase with exhaustion of shallow deposits that are now being exploited via opencast mining. Coal remains and will remain India's predominate source of primary commercial energy accounting for about 60-65% of the primary commercial energy needs. In absolute terms, the coal production has increased from 72.3 million tonnes of oil equivalent to 132 million tonnes of oil equivalent in 1995-96. Petroleum and natural gas are the second largest source of energy to the economy at 36.2 million tonnes in 1996. Coal production by 2001-02 is projected to increase to 348 million tonnes from the level of 289 million tonnes 1996-97 and is expected to continue to increase at about 5 to 6% compound annual rate of growth till 2010 and then level off. This is well within the estimated recoverable reserves of the country.

There is shortage of oil in the country and the crude oil imports in 1996-97 amount to 27.34 million tonnes. Natural gas reserves are estimated at 707 billion cubic meters with exploitable resources at 307 billion cubic meters; and, can sustain a production of 30 million cubic meters per annum for 23 years. By the end of the 9th Five-Year Plan only 31% of the demand of natural gas is likely to be met from indigenous resources.

Current average depth of underground coal mines is 150-200 million tonnes with seam thickness of 2 to 3 meters. In the future, this depth is likely to increase. The underground coking (prime, medium and semi-coking) coal of the eastern coal belt states of Bihar and Bengal are highly gassy and go up to gassiness to Degree III (10 cubic meter per tonne of coal mined) even at this average depth of 150-200 meters. Gassiness will increase with the increase of depth of mining and many Degree II mines are likely to become Degree III as they reach a depth of about 300 m. or so. Almost 45% of the India's underground coal output are from the eastern coal belt or near the coalfields where the demonstration has been sited. With the percentage of underground coal production remaining at about 26%, the total coal production growth envisaged and the increasing depth, the quantum increase in coal production from the gassy seams is likely to be substantial. If this methane gas is allowed to escape to the atmosphere during and after the process of mining, it will contribute to global warming. Therefore, there is a strong case for capturing it ahead and during the process of underground mining as well as after mining. This strategy will effectively, mitigate emissions and gainfully used it as a clean source of energy, thereby reducing energy shortages and substituting for an equivalent amount of coal. CMPDIL estimates the coal bed methane resource could be about 400 billion cubic meters. A good percentage of it will be encountered during the process of mining.

Therefore there is a strong case for recovery and use of this coalbed methane encountered in underground coal mines and its gainful utilization as a commercially viable source of energy. It will halt

global warming and climate change in two ways:

- preventing its release into atmosphere and climate
- using it as clean source of energy thereby reducing the quantum of coal or petroleum products used to that extent and their higher yield of carbon dioxide

This project focuses on two mine sites; Moonidih and Sudamdih coal mines in the Jharia coalfield in eastern India. These mining properties contain sizeable prognosticated reserves of coal bed methane in metallurgical quality coal seams primarily suited to underground exploitation technology. The project is designed to recover methane using three different technologies i.e.

1. drilling from surface and capturing methane ahead of coal mining face by a number of years;
2. drilling and recovering methane in seam at coal face and
3. drilling and recovery of methane from old gob areas with high methane concentration using it as a fuel source for generation of electric power and also as compressed methane for use in heavy duty vehicles as substitute to diesel.

As indicated in Annex 6B, the cost effectiveness of the initiative is reflected in cost of CO2 saved which continues to improve, as the size of coal/over burden transport vehicles, used at the mine sites increases.

Successful completion of the project will lead to establishing the state-of-the-art capacity to judge both the quantum of coalbed methane in a potential area and the economics of extracting and utilizing it commercially for alternate end users. The emission of methane to the environment from coal mining activities and consumption of coal diesel fuel for energy process will be reduced.

Thus the project meets the objectives of GEF to reduce methane emission taking place (which will increase in future if not mitigated) by beginning the process of capturing and removing the methane from being released into the atmosphere at various stages of mining activities. By demonstration of the technical and economic efficacy of the technology and methods, replication of the project by public and private sector coal companies will result in widespread adoption of methane recovery techniques in gassy mines and the use of clean fuel to augment the supply of energy source. For various reasons including the lack of technology, prior experience, and doubt about the economic viability of such a project in Indian coal mining conditions have thus far prevented independent development of CBM, up until now.

B.6 REASONS FOR UNDP ASSISTANCE

Environmental protection is an overriding issue for projects of UNDP. The project will address environmental issues at global, national and regional level. Recovery capture and utilization of coal bed methane in gassy underground coal mines will not only mitigate negative environmental impacts, but will also serve to provide valuable clean energy source and services. The project goal is to develop methane recovery and use programme appropriate and necessary for gassy underground coal mines of India whose production is going to increase. The specific emissions of methane expressed in cubic meters per tonne of coal mined is also likely to increase with ever increasing depth of mining. The success of the project and its replication are dependent on developing capacity and capability of Indian technical know-how and creation of database of information and technology residing in a clearinghouse for dissemination of information. The clearinghouse will function as source of information to new investors and promote research in this field and it also aids in supplying necessary information to government agencies as they establish regulatory and institutional structure. This process is essential for implementation and development of measures to encourage development of a strategy for replication of the successful technological approaches within the

country.

UNDP has extensive experience in providing technical assistance in India's environmental protection and energy development. It is well placed to work with and advise the government on policy, strategy and best approaches to meet serious environmental challenges. A large group of national experts and engineers will be trained in the next four years to make sure that the process started with this project will be sustained.

Furthermore, as recovery of methane from coal mining is replicated, additional uses of methane such as: bottled methane gas for domestic and commercial use in local areas; compressed methane for use in truck transport; and its distribution would help in creating new job opportunities and wealth while reducing the chronic electricity shortage in the area. The projects will by this means, play a role in increasing employment and reducing poverty, both of which are UNDP priorities.

C. DEVELOPMENT OBJECTIVE

The development objectives of this project are to :

- reduce the potential adverse social, environmental and economic consequences of global climate change;
- improve the health and safety of underground miners who are required to mine coal from gassy coal deposits;
- improve the local and regional environment by introducing technology to recover and use an otherwise wasted clean energy source that is presently being vented to the atmosphere;
- promote the development of indigenous enterprises engaged in recovery, transportation, conversion, and use of coal mine associated coalbed methane.

D. IMMEDIATE OBJECTIVES, OUTPUTS AND ACTIVITIES

D. 1 IMMEDIATE OBJECTIVE I

Strengthen and increase capacity of CMPDIL, BCCL, ISM, CMRI, Ministry of Coal, CIL, and the Ministry of Environment to develop and support mine associated CBM recovery and use projects, through training and experience in the identification, design, and implementation of programmes to recover and use coalbed methane (CBM) in a safe, cost effective, and environmentally acceptable manner.

Output 1.1

Members of teams within CMPDIL and CMRI trained in reservoir modeling and prediction of production parameters for wells drilled in and above a coal mining area.

Activity 1.1.1

Nominate and select members from CMPDIL and the faculty of CMRI to be trained in modeling of coalbeds and other strata, which behave as reservoirs, and potential sources of methane. Select and contract an expert in modeling of reservoirs emphasizing in-mine and near coal mine setting.

Output 1.2

Members of a team trained in the latest technology for drilling, testing, evaluation and completion of vertical well drilled in advance of mining and gob wells prepared to specify equipment to be purchased and to accomplish Immediate Objective 2, Activities 2.1.

Activity 1.2.1

Nominate and select individuals from within CMPDIL as a team to be trained in current practices and use of technology employed in drilling, completion and production management of gas deposits that are produced from vertical well drilled in advance of mining and gob wells drilled in post mining areas. An international consultant will arrange for a study tour appropriately designed to accommodate the team mission. The team will travel abroad to gain an overview of the available technology and will identify vendors for specific equipment to be purchased for the purposes planned in this programme. An end of the trip report shall be submitted that includes equipment specifications and potential vendors. This report will be jointly authored by the team leader and the consultant. Training will be a combination of on-the-job and classroom work taught by equipment manufacturers from whom equipment is purchased and consultants contracted during execution of Activities 2.1 and 2.2.

Activity 1.2.2

Nominate and select from within CMRI and CMPDIL, individuals to form a team responsible for collection and analysis of coal samples for sorption and permeability testing. Team shall be trained in the USA at an internationally reputable laboratory to learn technology and methodology used for testing coal samples for desorption, adsorption capacity, and permeability. An international consultant will arrange for a study tour appropriately design to accommodate the team mission. This study tour will prepare the team leader to develop tender specifications for laboratory adsorption and permeability testing equipment and equipment for field-testing. An end of the trip report shall be submitted that includes equipment specifications and potential vendors. This report will be jointly authored by the team leader and the consultant.

Activity 1.2.3

Nominate and select a team from CMPDIL to be responsible for use of state-of-the art equipment for mudlogging, geophysical logging, and formation testing. An international consultant will arrange for a study tour appropriately designed to accommodate the team mission. During study tour team shall identify vendors and develop tender specifications for procurement of equipment. An end of the trip report shall be submitted that includes equipment specifications and potential vendors. This report will be jointly authored by the team leader and the consultant.

Output 1.3

Members of a team within CMPDIL and BCCL trained in the latest technology for design and implementation of an underground gas drainage system.

Activity 1.3.1

Nominate and select members from CMPDIL and BCCL as a team to be trained in: current practices and use of technology employed in design of gas drainage systems; drilling, completion and production management of gas deposits that are produced from directionally drilled boreholes. These directionally drilled boreholes will be drilled from underground into seams and adjoining strata in advance of mining and gob wells drilled in post mining areas. An international consultant will arrange for a study tour appropriately design to accommodate the team mission. The team will travel abroad to gain an overview of the available technology and will identify vendors for specific equipment to be purchased for the purposes planned in this programme. An end of the trip report shall be submitted that includes equipment specifications and potential vendors. This report will be jointly authored by the team leader and the consultant.

Training will be a combination of on-the-job and classroom work taught by equipment manufacturers from whom equipment is purchased and consultants contracted during execution of Activities 2.8.1, 2.8.2, and 2.9.1.

Output 1.4

A team will be trained in the application of current stationary, methane-fueled, internal combustion engine power generation technology, and capable of specifying equipment needed to execute Activities 3.5.1 and 3.5.2.

Activity 1.4.1

Nominate and select members from CMPDIL and BCCL for training and knowledge development in current practices and applied technology employed in gas fueled electric power generation. An international consultant will arrange for a study tour appropriately designed to accommodate the team mission. The team will develop a knowledge base by participating in a study tour of Australia to visit the Appin and Tower Collieries, and to the USA to visit equipment manufacturers and a Department of Energy sponsored demonstration project. Both projects employ internal combustion (IC) engines fueled by methane gas drained from nearby mines for electric power generation. In addition, one of the collieries in Australia uses ventilation air as combustion air. An end of the trip report shall be submitted that includes equipment specifications and potential vendors. This report will be jointly authored by the team leader and the consultant.

Class room training and hands-on training will be provided by consultants selected for their familiarity with installation and operation of IC engines for electric power generation using medium heating value methane for fuel and ventilation air for combustion air. Hands-on operational and maintenance training will be provided by the manufacturers of equipment used for Activities 3.5.1 through 3.5.3.

Output 1. 5

A team trained in application of compressed natural gas fueled internal combustion engine technology to vehicular transport systems, and prepared to specify the equipment needed to conduct Activities 3.6.1 through 3.6.8.

Activity 1.5.1

Nominate and select members for a team to be trained in current technology employed in use of natural gas and methane as a vehicular fuel. An international consultant will arrange for a study

tour appropriately design to accommodate the team mission. Emphasis should be on conversion of large diesel engines to be converted to bi-fuel (methane or diesel) systems. Training shall be a combination of study tour and classroom lecture. The study tour will be undertaken within USA or another country where large engine vehicle fleets have been converted to natural gas. Information to be gained during the study tour will include but should not be limited to: concepts for fueling station design and identification of potential manufacturers and vendors; fueling station safety and maintenance requirements, vehicle maintenance and safety requirements, potential operational problems and solutions. An end of the trip report shall be submitted that includes equipment specifications and potential vendors. This report will jointly authored by the team leader and the consultant.

Classroom training will include information and data specific to the equipment that is purchased and installed during Activities 3.6.1 through 3.6.7.

Output 1.6

Members of a team within CMPDIL, BCCL and DGMS trained by outside experts, to develop safety protocols for: drilling vertical boreholes into coal seams and gob areas; underground directionally drilled methane drainage boreholes using advanced technology; installation and maintenance of gas drainage and recovery systems; compressed gas refueling stations and gas fired electric power generator systems.

Activity 1.6.1
Nominate and select from CMPDIL and BCCL a safety oversight team to develop protocols for drilling vertical wells in advance of mining and into gob areas. Team shall be responsible for instructing surface drilling crews in safety practices mandated by the protocols.

Activity 1.6.2
Nominate and select from CMPDIL and BCCL a safety oversight team to develop protocols for drilling directionally drilled methane drainage boreholes. Team shall be responsible for instructing underground drilling crews in safety practices mandated by the protocols.

Activity 1.6.3
Nominate and select from CMPDIL and BCCL a safety oversight team that will be responsible for developing protocols. The team shall provide instruction in safety practices mandated by the protocols for the engineers and workmen that will install and maintain gas drainage and recovery systems.

Activity 1.6.4
Nominate and select from CMPDIL and BCCL a safety oversight team that shall be responsible for developing protocols and providing instruction in safety practices mandated by the protocols for engineers, workmen and operators during construction and operation of a compressed gas refueling station.

Activity 1.6.5
Nominate and select from CMPDIL and BCCL a safety oversight team that will be responsible for developing protocols. Team shall provide instruction in safety practices mandated by the protocols for engineers, workmen and operators during the construction, installation, and operation of the internal combustion engine power generation facility.

Activity 1.6.6

Nominate and select a team for developing protocols and providing training for engineers and operators who will be responsible for establishing and maintaining carbon monoxide and oxygen detection system in sealed gob areas that are being drained. The system will monitor the potential incursion of oxygen into the gob area or the spontaneous combustion products.

Output 1.7

Members of a team within CMPDIL and ISM trained in the assessment of the economic and financial aspects of CBM resource development.

Activity 1.7.1

Nominate and select members to be trained in state-of-the-art financial and economic modeling methods for CBM recovery and utilization projects. Select and contract with an expert to conduct a one-week seminar on financial and economic modeling and project evaluation.

Output 1.8

A comprehensive and fully integrated Coalbed Methane Information System comprising a comprehensive CBM library, an Internet gateway, an Intranet system among CMPDIL headquarters and its regional offices.

Activity 1.8.1

Acquire space on the CMPDIL campus and establish a library dedicated to CBM literature and information. Obtain spare copies of information and literature through establishing contact with coalbed methane clearinghouses in other countries, contacting governmental agencies such as USEPA, USDOE, USAID, and by contacting NGOs, such as the Gas Research Institute in Chicago Illinois, USA. Purchase information where required to provide the library with full coverage of the full range of technical and economic topics pertinent to commercial exploration and development of CBM resources.

Activity 1.8.2

Establish an Internet gateway on the CMPDIL campus CBM library facility. Contract with telecommunications and information management systems experts to procure and install high quality telecommunications allowing high speed access to the Internet. Procure and install as an enterprise grade computer Internet server and link the server to the telecommunications line.

Output 1.9

An Intranet system installed in the regional CMPDIL offices and linking them together with CMPDIL Headquarters, CIL Headquarters, and an office at the Ministry of Coal.

Activity 1.9.1

Procure and install telecommunications and workstation equipment linked in an Intranet configuration with CMPDIL headquarters in each of the regional CMPDIL field offices, CIL headquarters, and Ministry of Coal office.

Output 1.10

A CBM Clearinghouse established to disseminate information, educate, promote, and facilitate

interaction with potential foreign investors.

Activity 1.10.1
Establish a CBM clearinghouse modeled after the successful clearinghouses in China and Russia. Establish a cooperative relationship with each of the clearinghouses.

Activity 1.10.2
Visit the coalbed methane clearinghouse in Beijing, China. Develop formal cooperative agreement and learn from successful ventures undertaken by the China Coalbed Methane Clearinghouse, to adapt to conditions in India.

D.2 IMMEDIATE OBJECTIVE II

Prepare and execute demonstration Projects at the Moonidih and Sudamdih coal mines located in the Jharia coalfield for the recovery and use of mine associated CBM in the Jharia coalfield. Design and execute CBM resource recovery programmes using three different drilling technologies at two proposed demonstration sites.

Output 2.1

A fully equipped and trained drilling unit prepared for drilling vertical wells in advance of mining and in gob areas at the Moonidih and Sudamdih mines.

Activity 2.1.1
Identify, specify and procure one fully outfitted deep capacity and one fully outfitted medium capacity vertical drilling rig, bits, spares of casing and tubulars, geophysical well logging equipment, two-phase well testing equipment, hydrofracturing system, completion equipment and completion fluids, and cementing equipment. Transport equipment from purchase location to Ranchi. Obtain any safety inspection certification necessary.

Activity 2.1.2
Select and commission a vertical drilling team comprising engineers, geologists, and workmen that have undergone training provide during Activities 1.3.1, and 1.4.1.

Output 2.2

A plan for drilling vertical wells into coal seams and adjoining strata in advance of mining at the Moonidih and Sudamdih coal mines. At a minimum the plan shall include nine wells to be drilled at the Moonidih mine and eight wells at the Sudamdih mine.

Activity 2.2.1
Management of the vertical drilling team shall coordinate with members of the CMPDIL CBM cell trained in reservoir modeling under Activity 1.2.1, and mine management to locate vertical boreholes so as to maximize gas production and minimize negative impact on the production of coal without compromising safety.

Output 2.3

A fully equipped drilling camp, from which all drilling operations can be staged, located conveniently near to the Moonidih and Sudamdih coal mines.

Activity 2.3.1.

Obtain permission and necessary support from BCCL to locate and construct a semi-permanent drilling camp.

Activity 2.3.2

Construct the drilling camp and mobilize equipment and personnel.

Output 2.4

Vertical wells located, drilled and completed in coal seams and adjoining strata so that gas production is maximized from these horizons thereby lowering the overall emissions into the mine workings and atmosphere.

Activity 2.4.1

Drill and log vertical wells into coal and adjoining strata. Conduct downhole well testing at geologic horizons that appear to be promising based on mud and geophysical logs. Based on tests, develop a customized completion programme for each well, and flow each well to verify success.

Output 2.5

A plan for drilling vertical wells into sealed gob areas at the Moonidih and Sudamdih coal mines. At a minimum the plan shall include five wells to be drilled at the Moonidih mine and five wells at the Sudamdih mine.

Activity 2.5.1

Management of the vertical drilling team shall coordinate with members of the CMPDIL CBM cell trained in reservoir modeling under Activity 1.2.1, and mine management to locate vertical boreholes so as to maximize gas production and minimize negative impact on the production of coal without compromising safety.

Output 2.6

Vertical gob wells located and drilled and completed in coal seams and adjoining strata so that gas production is maximized from these horizons thereby lowering the overall emissions into the mine workings and atmosphere.

Activity 2.6.1

Drill vertical wells into gob area, and log borehole (where practical). Complete wellscementing casing and installing liner.

Output 2.7

Oxygen and carbon monoxide monitoring system installed on wellhead and wherever possible, in seals at gob areas to monitor the level of oxygen incursion into the sealed gob areas and to give early

warning of heating and combustion products resulting from potential spontaneous combustion of the remaining coal.

Activity 2.7.1
Identify appropriate vendors for temperature, oxygen and carbon monoxide detectors and computerized monitoring and recording systems. With vendor assistance design a monitoring system for use in the gob drainage demonstration programme at the Moonidih and Sudamdih coal mines, procure and install. Coordinate activities with DGMS officials and utilize protocols developed under Activities 1.6.1 and 1.6.3. Have vendor obtain any necessary certification before installation

Output 2.8

A fully equipped and trained underground drilling unit prepared to directionally drill methane drainage boreholes into coal seams and adjoining strata in advance of mining at the Moonidih and Sudamdih coal mines.

Activity 2.8.1
Identify, specify and procure two fully outfitted medium capacity horizontal underground drilling rigs, directional drilling equipment for each, bits, and spares of casing and tubulars.

Activity 2.8.2
Have vendors contact and notify the DGMS with the intent to import drilling equipment. Have vendors file for safety certification with DGMS.

Activity 2.8.3
Transport equipment from purchase location to site/CMRI. Obtain all safety inspection certification necessary from D.G.M.S. Transport equipment to the Moonidih and Sudamdih coal mines.

Activity 2.8.4
Select and commission an underground drilling team comprising engineers, geologists, and workmen that have undergone training activities provided during Activities 1.3.1, and 1.5.1.

Output 2.9

A plan for drilling directionally drilled drainage boreholes into coal seams and adjoining strata in advance of mining at the Moonidih and Sudamdih coal mines. At a minimum the plan shall include five wells to be drilled at the Moonidih mine and five wells at the Sudamdih mine.

Activity 2.9.1
Management of the underground drilling teams shall coordinate with members of the CMPDIL CBM cell trained in reservoir modeling under Activity 1.1.1, and mine management to locate drainage boreholes so as to maximize gas production and minimize negative impact on the production of coal without compromising safety.

Output 2.10

A fully equipped storage area and center of operations, from which all drilling operations can be staged, at the Moonidih and Sudamdih coal mines.

Activity 2.10.1
Obtain permission and necessary support from BCCL to locate and maintain storage area and center of operations.

Activity 2.10.2
Mobilize equipment and personnel.

Output 2.11

Directionally drilled drainage boreholes located, drilled and completed in coal seams and adjoining strata so that gas production is maximized from these horizons thereby lowering the overall emissions into the mine workings and atmosphere.

Activity 2.11.1
Drill and produce a geologic log of the drainage boreholes drilled into coal and adjoining strata. Based on experience and testing, develop a programme for determining and specifying the optimum angle and length of the holes for each well, flow each well to verify success.

D.3 IMMEDIATE OBJECTIVE III

Use gas recovered from successful execution of the above objectives for vehicle refueling and electric power generation.

Output 3.1

A surface gas gathering system designed and connecting each of the vertically drilled wells to a pipeline that will deliver the gas to a central location at the Moonidih and Sudamdih coal mines.

Activity 3.1.1
Contract with consulting firm to aid in producing a design and specifications for a gathering system connecting producing vertical wells drilled into unmined coal seams and adjoining strata.

Activity 3.1.2
In addition to Activity 3.1.1, have contractor design a compression and distribution system that will deliver the gas to a central location appropriate for end use.

Activity 3.1.3
Procure all necessary materials including but not limited to pipeline, flanges, valves and compressors. Transport to appropriate location for construction.

Activity 3.1.4
Contract with construction company to construct a gathering and delivery system according to design and specification. Test system and connect to wellheads.

Output 3.2

A surface gas gathering system designed and connecting each of the vertically drilled gob wells to a pipeline that will deliver the gas to a central location at the Moonidih and Sudamdih coal mines.

Activity 3.2.1
Contract with consulting firm to aid in producing design and specifications for a gathering system connecting producing vertical wells drilled into gob areas.

Activity 3.2.2
In addition to Activity 3.2.1, have contractor design a compression and distribution system that will deliver the gas to a central location appropriate for end use.

Activity 3.2.3
Procure all necessary materials including but not limited to pipeline, flanges, valves and wellhead blowers and compressors. Transport to appropriate location for construction.

Activity 3.2.4
Contract with construction company to construct gathering and delivery system according to design and specification. Test system and connect to wellheads.

Output 3.3

Two subsurface gas gathering systems designed and installed, which connect each of the directionally drilled drainage borehole manifolds to a surface pipeline that will deliver the gas to a central location at the Moonidih and Sudamdih coal mines.

Activity 3.3.1
Contract with consulting firm to aid in producing a design and specifications for gathering systems connecting producing underground drainage boreholes drilled into unmined coal seams and adjoining strata.

Activity 3.3.2
In addition to Activity 3.3.1 have contractor design for each coal mine a compression and distribution system that will deliver the gas to a central location appropriate for end use.

Activity 3.3.3
Procure all necessary materials including but not limited to pipeline, flanges, valves and compressors. Transport to appropriate location for construction.

Activity 3.3.4
Contract with construction company to construct a gathering and delivery system according to design and specification. Test system and connect to drainage boreholes.

Output 3.4

A small gas blending plant located at each of the coal mines at which gas produced from gob wells, underground drainage boreholes, and vertical wells into unmined strata is blended to meet end use requirements.

Activity 3.4.1
After initial production testing and reservoir modeling, contract with a gas production-engineering firm to design a low-cost system to facilitate blending the gas produced from each of the production sources to a desired quality for end use.

Output 3.5

An internal combustion (IC) stationary engine generator set with 1 MW installed capacity fueled by methane produced at the Moonidih mine.

Activity 3.5.1
Based on information and training received during Activity 1.6.5, identify equipment necessary to install a fully functional and reliable stationary IC engine generation facility. Specify, procure and transport.

Activity 3.5.2
Engineer and make necessary alterations or additions to the mine's substation so that it will be able to accept the power generated by the methane fueled IC engine generation facility.

Activity 3.5.3
Install, test and commission generator and monitoring system, which will include meters measuring input of fuel and output of electricity. Train operators placing special emphasis on safety protocols developed in Activities 1.6.4 and 1.6.5.

Output 3.6

A fully equipped and functional compressed methane fueling station located at or nearby the Sudamdih coal mine, used to refuel BCCL 50-ton dumpers powered by engines that have been converted to operate on either diesel or compressed methane.

Activity 3.6.1
Based on the activities conducted under Activity 1.5.1, identify vendors that have appropriate technologies for compressed methane fueling stations. Design, specify and develop procurement tender.

Activity 3.6.2
Procure and ship components of methane refueling station to India and receive any necessary safety certifications.

Activity 3.6.3
Transport equipment to the Sudamdih mine and construct refueling station

Activity 3.6.4
Connect to methane supply. Train operators with special emphasis placed on safety protocols developed under Activity 1.6.4 .

Activity 3.6.5
Identify suppliers of diesel engine bi-fuel conversion kits. Develop tender and procure kits for installation on BCCL 50 ton dumper.

Activity 3.6.6
Install engine conversion kits and test bi-fuel engines during dumper operations.

Activity 3.6.7
Train dumper drivers in operation of bi-fuel dumpers. Develop and implement a simple record keeping system to monitor consumption of methane by each dumper so that fuel efficiency and costs can be recorded.

Activity 3.6.8
Begin operation of facility, keep accurate records of volume of methane used as fuel and the mileage and hours of operation using methane.

D.4 IMMEDIATE OBJECTIVE IV

Develop and adopt action plan for replication of successful aspects of demonstration projects. Use the CBM Clearinghouse to disseminate information, educate, promote, and facilitate interaction with potential foreign investors.

Output 4.1

A report that presents analysis and recommendations for future activities based on analysis of the economic, environmental, and safety impacts of the technology and approach used in the demonstration project.

Activity 4.1.1
Commission a panel comprising members appointed from Ministry of Coal, CMPDIL, BCCL, CIL, Indian School of Mines, the Central Mining Research Institute and Ministry of Environment to review and analyze technical and economic data gathered during the demonstration project

Activity 4.1.2
Compare and analyze methane production and emission data collected during correlative and relevant periods throughout the demonstration project. Determine the impacts of the in-mine and gob drainage on the coal production, emissions of methane into the active working areas of the Moonidih and Sudamdih coal mines, and changes in the volume and concentration of methane emitted to the atmosphere.

Activity 4.1.3
Using data supplied by BCCL, compare and analyze cost versus savings accrued by the production and use projects sited at the Moonidih and Sudamdih coal mines. Determine the costs and savings associated with production and consumption of electricity produced from methane recovered at the Moonidih coal mine; and fuel produced at the Sudamdih coal mine and used in 50-ton coal dumpers at nearby open cast mines. Determine costs and benefits and determine potential modifications to the demonstrated use of technology so as to optimize beneficial economic, environmental and safety impacts.

Output 4.2

An action plan adopted by the Ministry of Coal, with input from CIL, CMPDIL and other stakeholders setting forth an agenda and recommended policy promoting sustainable recovery of coalbed methane resources in conjunction with coal mining activities.

Activity 4.2.1
Based on the information and analysis provided in the report produced as output 4.1, the executive steering committee shall develop an action plan that promotes the recovery of coalbed methane resources in conjunction with coal mining In India.

Activity 4.2.2
The action plan must, at a minimum, address issues and set out recommended policy to: development and integration of local and regional methane gas supply systems; use and sale of electricity produced by methane fueled electric power generators; end-use of the product; environmental concerns; impact on research; planning, and educational institutions and changes that must be promulgated to ensure sustainable growth of the industry.

Output 4.3

A CBM Clearinghouse located at the CMPDIL campus, Ranchi to provide general information, promotional material for Indian CBM recovery projects, and facilitates interaction between foreign investors and the relevant Indian entities.

Activity 4.3.1
Publish general technical information and data arising from activities undertaken during the CBM recovery and use projects at the Sudamdih and Moonidih coal mines.

Activity 4.3.2
Organize, announce and conduct a workshop that will provide a forum for the introduction of the proposed action plan and recommended policy. Participants shall include national and regional political leaders, leaders of the coal mining, gas, and electric power generation industry; leaders of governmental and non-governmental environmental organizations; and leaders of educational, planning and research institutes. Publish the proceeding and findings of the workshop.

Activity 4.3.3
Organize, announce, and conduct 2 workshops, open to international participation, that will provide a forum for discussion of current ideas, technology, and specifics of CBM recovery and use projects in India and abroad. One Workshop shall be conducted in the first year of project implementation and one shall be conducted in the last year of implementation. The first could be held in conjunction with the one being held November 1998, organized by the South Asian Association of Economic Geologist, which will act as an initial introduction of to the demonstration project to the global CBM community. The second will provide results of the project to the global CBM community.

Activity 4.3.4
Develop a database and a web page on the Internet promoting CBM recovery and use project opportunities in India.

Output 4.4

Additional courses added to curriculum taught at the Indian School of Mines covering subjects pertinent to recovery and utilization of CBM.

Activity 4.4.1
Develop course materials using information and data collected during the demonstration project.

Activity 4.4.2
Have graduate students participate in activities undertaken during the course of the demonstration project.

E. INPUTS/GEF INPUTS

E.1 GOVERNMENT/COUNTERPART INPUTS

The Government of India will provide the necessary counterpart staff and support for the implementation of the proposed activities. The Government (MoC) will also provide the necessary office accommodation, local transportation, support staff, data, information and other facilities that may be required by the NPD to perform his duties under this project. The MoC will provide the services of the NPD, support staff and nodal coordinators identified in each collaborating national institution. The Government will also provide the necessary office accommodation, support staff and other facilities that may be required by the national consultant who will be designated as Project Advisor (CBM) who will assist NPD to carry out coordination and supervision of the project. The Government will ensure release of trainees and resource persons for participation in the training courses and study tours. The Government will also provide local transportation for the consultants during their field visits and make other logistical arrangements for the experts.

In terms of input in kind, the Government will meet salaries of those personnel who will be assigned to the project. These would include technical team managers, CBM cell experts, executives, technical and support staff related to CBM recovery, utilization, etc. as detailed in the GOI budget. The Government would also provide space for CBM laboratory and office space for other technical and support staff.

In terms of input in cash, the Government will meet expenditure on procurement of indigenous equipment for recovery and utilization of CBM, establishment of camps for drilling, costs to carry out drilling and maintenance etc. In addition, Government would also provide funds to organize in-country training, workshops, and seminars, logistics to establish a CBM information system, and other miscellaneous expenditures.

The details of budget (in-kind and cash contribution) by the Government are given in Annex 1B (i) and (ii).

E.2 UNDP/GEF INPUTS

UNDP/GEF inputs would be provided primarily to meet the costs pertaining to extensive equipment component. Detailed list of equipment items and justification for procuring them are enclosed as Annex 4 and 5.

UNDP/GEF inputs will also finance the post of Project Advisor (CBM) to be located in the Ministry of Coal, and meet the costs of the Chief Project Manager, Project Administrative and Finance Manager in the Project Management Cell at CMPDIL, Ranchi. The UNDP/GEF will also meet the costs on mission travel, reporting costs and communications, and miscellaneous expenditures.

The Project Adviser (CBM) will assist the NPD on a full time basis and provide link between the Ministry and the local implementing agencies. The Chief Project Manager will coordinate and oversee various activities including evaluation of technologies, equipment tender, preparation of project reports and organization of training courses and study tours, and timely implementation of the project. The Project Administrative and Finance Manager will be responsible for financial management and financial reporting as per the UNDP/NEX guidelines. The TORs in respect of Project Adviser (CBM), Chief Project Manager and Project Administrative & Finance Manager, are under Annexure 3.

The details of UNDP/GEF budget are given at Annex 1C.

E.3 UNDP/INDIA INPUTS:

UNDP/India inputs will primarily provide for capacity building of participating institutions and nodal agencies, and will hence meet the costs of 30 p/m of international experts and 20 p/m of Senior National Technical Consultant to provide technical inputs in several fields including underground drilling, underground gas collection, surface drilling, gas plant, reservoir modelling, Lab. sorption and permeability analysis, economic modelling and telecommunication/information system/ Internet, etc. The UNDP/India will also meet the costs of study tours; and establishment of internet/intranet and telecommunication equipment.

UNDP/India will also provide funds for contracts/sub-contracts to various institutions and organizations to prepare detailed project reports under each identified sector. While preparing the detailed project reports, these institutions will take into account technical inputs provided by the international/national consultants.

To enhance capabilities of national institutions, UNDP/India will provide funds for organizing up to 6 study tours and at least 3 national workshops during the course of project implementation. UNDP will also provide other critical inputs including funds and institutional support for information dissemination, networking through e-mail and providing linkages between various institutions and agencies.

The terms of reference for consultants including those of Chief Technical Adviser and Senior National Technical Consultant will be reviewed and approved by the NPD in the first three months of project implementation.

The details of budgets pertaining to UNDP/India are given in Annex 1A.

F. MONITORING AND EVALUATION

The project will be subject to tripartite reviews (TPR) by representatives from GoI, UNDP and the Local Implementing Agency at least every 12 months from the start of the full implementation. TPR, chaired by the Secretary of MoC, or a designated representative, will review progress in light of the project document, identify problems, if any, and decide on the corrective actions, assigning responsibility to concerned parties. The National Project Director shall prepare and submit to each TPR meeting a Project

Performance Evaluation Report (PPER). Additional PPER's and/or progress report may be requested if necessary, during the project.

The project will be subject to mid-term evaluation in its third year of implementation. The evaluation, organized by UNDP and MoC, will look at effectiveness of implementation and recommend to the National Steering Committee and the Local Implementing Agency any action as necessary, to ensure that the objective of the project is successfully achieved. The terms of reference and timing of the review will be decided after consultation between the parties concerned. The review will take place after drilling and gas production is underway but before the installation of the end-use facilities. This will allow a review of the design and construction plans and will provide an opportunity for any modifications to take place. An evaluation report will be prepared.

Periodic reports from the Local Implementing Agency will be reviewed by the NPD, the National Steering Committee and the Operational Executive Committee. These reports shall be concise with monthly reports describing activities undertaken, issues confronting the Project Management Cell and the progress of work with respect to work accomplished and budget expended. These reports shall be available for the TPRs and mid-term evaluation.

The project shall be reviewed in light of the activities undertaken in meeting Immediate Objective 4, by an independent team of evaluators. An evaluation report, and a project terminal report, will be prepared and submitted to the final TPR. These shall be prepared in draft form sufficiently far in advance to allow review and technical clearance by the Local Implementing Agency.

G. RISKS AND MITIGATION

Development of the coalbed methane resources associated with mining will be beneficial to the local, regional and global environment, and will be valuable to local and regional economy. Availability of the methane gas as an energy source will augment or substitute for existing energy fuels. Risk factors related to the demonstration of recovery and use of coalbed methane is associated with active mines as listed below:

TABLE 2
Risks and mitigation measures

Description of the risk	Likelihood of occurrence and remedial measures
Non-appointment of NPD	Extremely low. The nodal point for this has been the Ministry of Coal. The Additional Secretary in the Ministry of Coal has been functioning in a coordinating capacity throughout the project definition phase and is expected to carry on as NPD.
National Steering Committee, Executive/Operational/ and/or Policy Advisory committees fail to convene.	Very low. Most of the members in the committees are stakeholders or constituents of the project. Level of desire to participate is high.
Appointment of national and international consultants.	Very low.
Changes in priorities of the line ministries.	Nil. Support and concurrence on the need for demonstration of coalbed methane recovery and use is evident through the participation during the formulation phase of the project.
Delays in procurement of equipment causing delays in initiation of production phase and installation of end-use equipment.	Moderate. Study tours to learn about available technology so that specifications for vendors can be written are essential. The study tours must be made early in the project. Timely procurement and fielding of equipment is key to success.
Insufficient gas production to supply vehicle refueling station or electric power generation facility.	Moderate, due to the fact that gas will be produced from several sources. Each well or drainage borehole will be evaluated and necessary adjustments made to location, drilling and completion practices, lowering the risk of insufficient production.
Recovery and use of methane from mining activities is not a sustainable activity.	Low. The need for a locally produced energy source is high and the environmental benefits of recovery of a gas that would otherwise be vented to the atmosphere are many. An Action Plan will be adopted at the end of the project.
Coordination of this project may be slowed due to the multi-institutional and multi-disciplinary involvement in the implementation of this project.	Moderate. Gaining input and support on project issues as and when they arise may be gradual since it involves numerous parties. However, by clearly defining the implementation arrangement at the project development phase where the institutions involved understand their role in the project implementation, the risk may be reduced..

Successful demonstration of commercial recovery and use of methane normally emitted to the atmosphere during mining activities will have a significant impact on future hard coal mining and development. Formation of a National Steering Committee and an Operational Executive Steering Committee will in many ways allow rapid resolution of problems or issues that may arise and otherwise thwart progress of the project. Incorporating a Policy Advisory Committee into the project concept will allow discussions on the issues that might act as barriers to sustainability of the project. An Action Plan will be adopted as an end-of-project deliverable.

H. PRIOR OBLIGATIONS AND PREREQUISITES

Prior Obligations

There are no prior obligations.

Prerequisites

The Ministry of Coal will constitute the National Steering Committee, and appoint a National Project Director. The National Steering Committee will select and approve candidatures of the Project Advisor (CBM), Chief Technical Advisor, National Senior Technical Consultant, Chief Project Manager and Project Administrative and Finance Manager on a highly competitive and open basis. The National Steering Committee will consist of members drawn from the line ministries, participating institutions and agencies. The National Steering Committee will meet quarterly. The Chief Project Manager, staff and Technical Teams will constitute a Project Management Cell. The Chief Technical Advisor and the National Senior Technical Consultant will advise the Chief Project Manager and provide inputs to the National Steering Committee via the NPD and Project Advisor (CBM) when asked or as warranted. The Government will provide the technical and support staff as specified under GoI inputs.

The Chief Project Manager and the Project Management Cell will carry out day to day working of the project under the overall supervision and guidance of the Project Adviser (CBM). The Local Implementing Agency will consult with the Operational Executive Steering Committee as needed, but in any case will meet the convened committee on a monthly basis. The Policy Advisory Committee will provide inputs to the project regarding socioeconomic, environmental, and developmental issues.

I. LEGAL CONTEXT

The project document shall be the instrument envisaged in the supplemental provision to the project document, attached hereto. The host country implementing agency shall, for the purpose of the supplemental provision to the document, refer to the Government cooperating agency described in the supplemental provisions.

The following types of revisions may be made to this project document with the signature of UNDP Resident Representative only, provided he or she is assured that the other signatories of the project document have no objections to the proposed changes:

1. Revision in, or addition of, any of the annexes of the project document;

2. Revisions which do not involve significant changes in the immediate objectives, outputs or activities of a project, but are caused by the rearrangement of inputs agreed to or by cost increases due to inflation; and

3. Mandatory annual revisions which rephase the delivery of agreed project inputs or increased expert or other costs due to inflation, or take into account agency expenditure flexibility.

The government executing agent designated on the cover page to this project document has been duly delegated by the Government coordinating authority, the Department of Economic Affairs, Ministry of Finance, to carry out this project and accordingly will follow the NEX accounting, financial reporting and auditing procedures set forth in the following documents as may be amended by UNDP from time to time.

a) The Accounting and Financial reporting procedures set out in UNDP Programme and Project Manual (PPM), Section 30503, sub-section 6.

b) The UNDP Audit Requirements set out in PPM Section 30503, sub-section 7.0 and,

c) The UNDP Government Execution Manual (GEM).

The above documents are an integral part of this project document although incorporated herein only be reference. They have already been provided to the Government and said Government Executing Agent.

Auditors to the project will be officially designated. Such auditors, and/or other officially appointed auditors shall undertake periodic management and financial audits of the project in accordance with UNDP auditing procedures for nationally executed projects, pursuant to the Government's overall national execution responsibilities under the Project Document and as set out in the documents listed above.

In addition, all accounts maintained by the Government for UNDP resources may be audited by the UNDP internal Auditors and/or the United Nations Board of Auditors or by public accountants designated by the United Nations Board of Auditors.

Annexure 1A

PROJECT BUDGET COVERING UNDP/INDIA CONTRIBUTION

Country: : **INDIA**
Project No. : **IND/97/912/A/01/99**
Project Title : **Coal Bed Methane Recovery and Commercial Utilization in India**

		TOTAL		1 YEAR		2 YEAR		3 YEAR		4 YEAR		5 YEAR	
10.0	Project Personnel	W/m	US$	W/m	US$	W/m	US$	W/m	US$	W/m	US$	W/m	US$
11.50	International Professional Chief Technical Advisor	5.0	125,000	1	25,000	1	25,000	1	25,000	1	25,000	1	25,000
	Underground drilling/ completion	4.0	80,000	-	-	-	-	2.5	50,000	1	20,000	0.5	10,000
	Underground Gas Collection Systems	5.0	62,500	-	-	-	-	2.0	25,000	2	25,000	1.0	12,500
	Surface Drilling/Completion Expert	4.0	80,000	-	-	-	-	2.5	50,000	1	20,000	0.5	10,000
	Gas Plant	5.0	62,500	-	-	-	-	2.0	5,000	2	25,000	1.0	12,000
	Reservoir Modelling Expert	1.5	20,000	-	-	-	-	1.0	13,000	0.5	7,000		
	Laboratory Sorption & Permeability Expert	1.5	20,000	-	-	-	-	1.0	13,000	0.5	7,000		
	Economic Modelling Expert	3.0	45,000	-	-	-	-	1.0	15,000	1.0	5,000	1.0	15,000
	Telecommunication/Info System/Internet	1.0	20,000	1	20,000								
		30.0	515,000	2	45,000	1	25,000	13.0	216,000	9	144,000	5.0	85,000
15.0	Official Travel		245,000		25,000		30,000		70,000		70,000		50,000
17.0	National Technical Consultant	20.0	50,000	4	10,000	4	10,000	4.0	10,000	4	10,000	4.0	10,000
19.0	Component Total	50.0	810,000		80,000		65,000		296,000		224,000		145,000
30.0	Training - Study Tours		169,000		169,000								
	Component Total		169,000		169,000								
40.0	Equipment - Internet Intranet Transportable Satellite Communicator		120,000 75,000		120,000 75,000								
49.0	Component Total		195,000		195,000								
	Miscellaneous		36,000				9,000		9,000		9,000		9,000
	Grand Total		1,210,000		444,000		74,000		305,000		233,000		154,000

Annexure 1B (i)

PROJECT BUDGET COVERING GOI CONTRIBUTION (In Cash)

Country : **INDIA**
Project Number : **IND/97/G34/A/1G/99**
Project Title : **COAL BED METHANE RECOVERY AND COMMERCIAL UTILIZATION IN INDIA**

Figures in '000

S.No.	Description	Total		Year 1		Year 2		Year 3		Year 4		Year 5	
		Rs.	US$	Rs.	US$	Rs.	US$	Rs.	US$	Rs.	US$	Rs.	US$
B.	In Cash Contribution												
1	Training/Workshop/Seminar & Establishment of CBM Information system	3000	84	1500	42	1500	42						
	Sub-total	3000	84	1500	42	1500	42						
2	CBM Recovery												
a	Procurement action for Equipments	300	8	150	4	150	4						
b	Camp Establishment	18660	518	6000	167	8220	228	2220	62	2220	62		
c	POL	7350	204			1370	38	2740	76	2740	76	500	14
d	Drilling	55841	1551			8445	235	23698	658	23498	653	200	6
e	Maintenance of Computer Hardware and Misc.	2800	78	560	16	560	16	560	16	560	16	560	16
	Sub-total	84951	2360	6710	186	18745	521	29218	812	29018	806	1260	35
3	CBM Utilization												
a	Equipment	68040	1890			68040	1890						
b	Related Expenditure	3600	100			1800	50	1800	50				
	Sub-Total	71640	1990			69840	1940	1800	50				
4	Project related Travel	4000	111	800	22	800	22	800	22	800	22	800	22
	Grand Total	163591	4544	9010	250	90885	2525	31818	884	29818	828	2060	57

Annexure 1B (ii)

PROJECT BUDGET COVERING GOVERNMENT OF INDIA CONTRIBUTION (In Kind)

Country : **INDIA**
Project Number : **IND/97/G34/A/1G/99**
Project Title : **COAL BED METHANE RECOVERY AND COMMERCIAL UTILIZATION IN INDIA**

Figures in '000

S.No. Description	Total			Year 1			Year 2			Year 3			Year 4			Year 5		
	m/m	Rs.	US $	m/m	Rs.	US $	m/m	Rs.	US $	m/m	Rs.	US $	m/m	Rs.	US $	m/m	Rs.	US $
A. in Kind contribution																		
Project Personnel salaries																		
I. CBM Cell																		
i) Executives	696	27853	774	144	4707	131	144	5178	144	144	5696	158	132	5844	162	132	6428	179
ii) Support Staff	480	6724	187	96	1101	31	96	1211	34	96	1333	37	96	1466	41	96	1613	45
iii) L.S.		2151	60														2151	60
Sub-Total	1176	36728	1020	240	5808	161	240	6389	177	240	7029	195	228	7310	203	228	10192	283
II. CBM Recovery																		
I) Surface Drilling	434	14065	391	21	575	16	164	4937	137	156	5166	143	93	3388	94			
ii) Underground Drilling	572	20600	572				108	3381	94	192	6612	184	192	7273	202	80	3333	93
III. CBM Utilization	352	11026	306	6	145	4	33	876	24	121	3532	98	96	3083	86	96	3391	94
IV. Space for CBM Lab		240	7		240	7												
V. Space		900	25		180	5		180	5		180	5		180	5		180	5
Grand Total	2534	83559	2321	267	6947	193	545	15763	438	709	22519	626	609	21233	590	404	17096	475

PROJECT BUDGET COVERING UNDP/GEF CONTRIBUTION

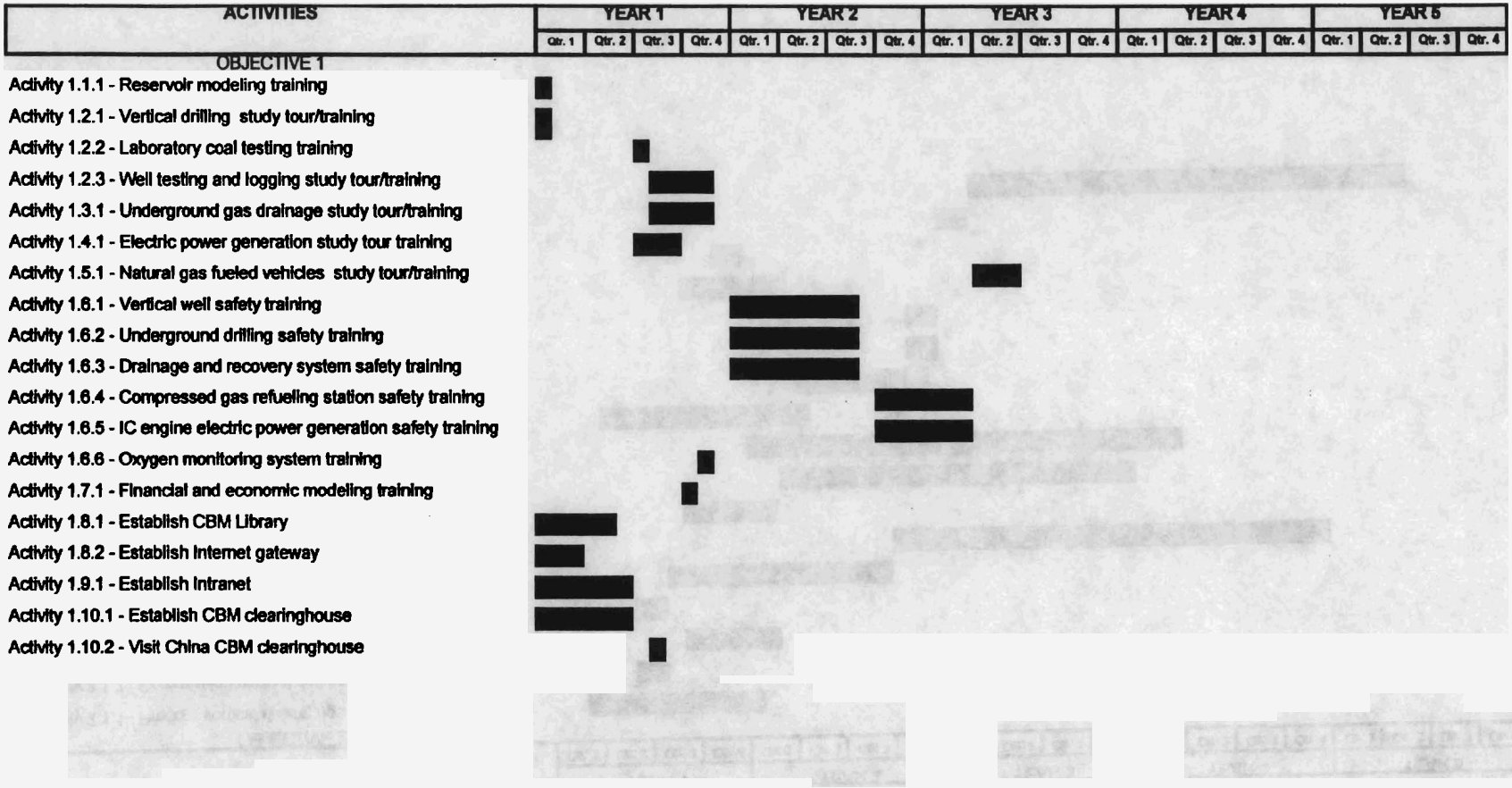
Country : **INDIA**
Project Number : **IND/97/G34/A/1G/99**
Project Title : **COAL BED METHANE RECOVERY AND COMMERCIAL UTILIZATION IN INDIA**

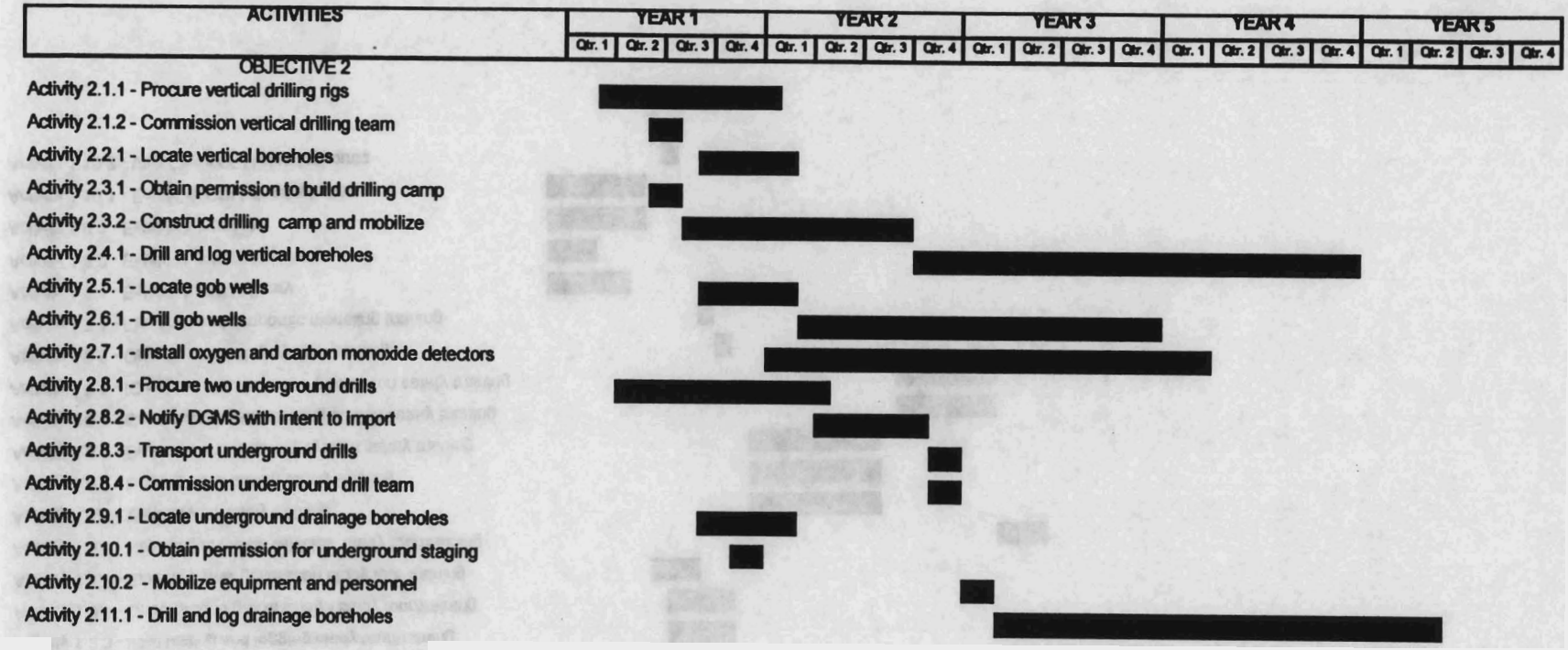
B/L	Project Component	TOTAL		1 YEAR		2 YEAR		3 YEAR		4 YEAR		5 YEAR	
		W/m	US$	W/m	US$	W/m	US$	W/m	US$	W/m	US$	W/m	US$
16.00	**Mission**												
16.01	Mission Costs		30,000		6,000		6,000		6,000		6,000		6,000
17.00	**Project Professional**												
17.01	Project Advisor (CBM)	60	120,000	12	24,000	12	24,000	12	24,000	12	24,000	12	24,000
17.02	Chief Project Manager	60	90,000	12	18,000	12	18,000	12	18,000	12	18,000	12	18,000
17.03	Project Administrative and Finance Officer	60	60,000	12	12,000	12	12,000	12	12,000	12	12,000	12	12,000
	Sub-total	*180*	*300,000*	*36*	*60,000*		*60,000*		*60,000*		*60,000*		*60,000*
40.00	**Equipment**												
45.01	Local Equipment		469,000		469,000		-		-				
46.01	International Equipment		8,101,000		7,531,000		200,000		370,000				
	Sub-total		*8,570,000*		*8,000,000*		*200,000*		*370,000*				
50.00	**Miscellaneous**												
53.00	Miscellaneous		10,000		2,000		2,000		2,000		2,000		2,000
54.00	Project support Services		227,367		167,367		15,000		15,000		15,000		15,000
	Sub-total		*267,367*		*179,367*		*22,000*		*22,000*		*22,000*		*22,000*
	Grand Total[1]		**9,107,367**		**8,233,367**		**276,000**		**446,000**		**76,000**		**76,000**

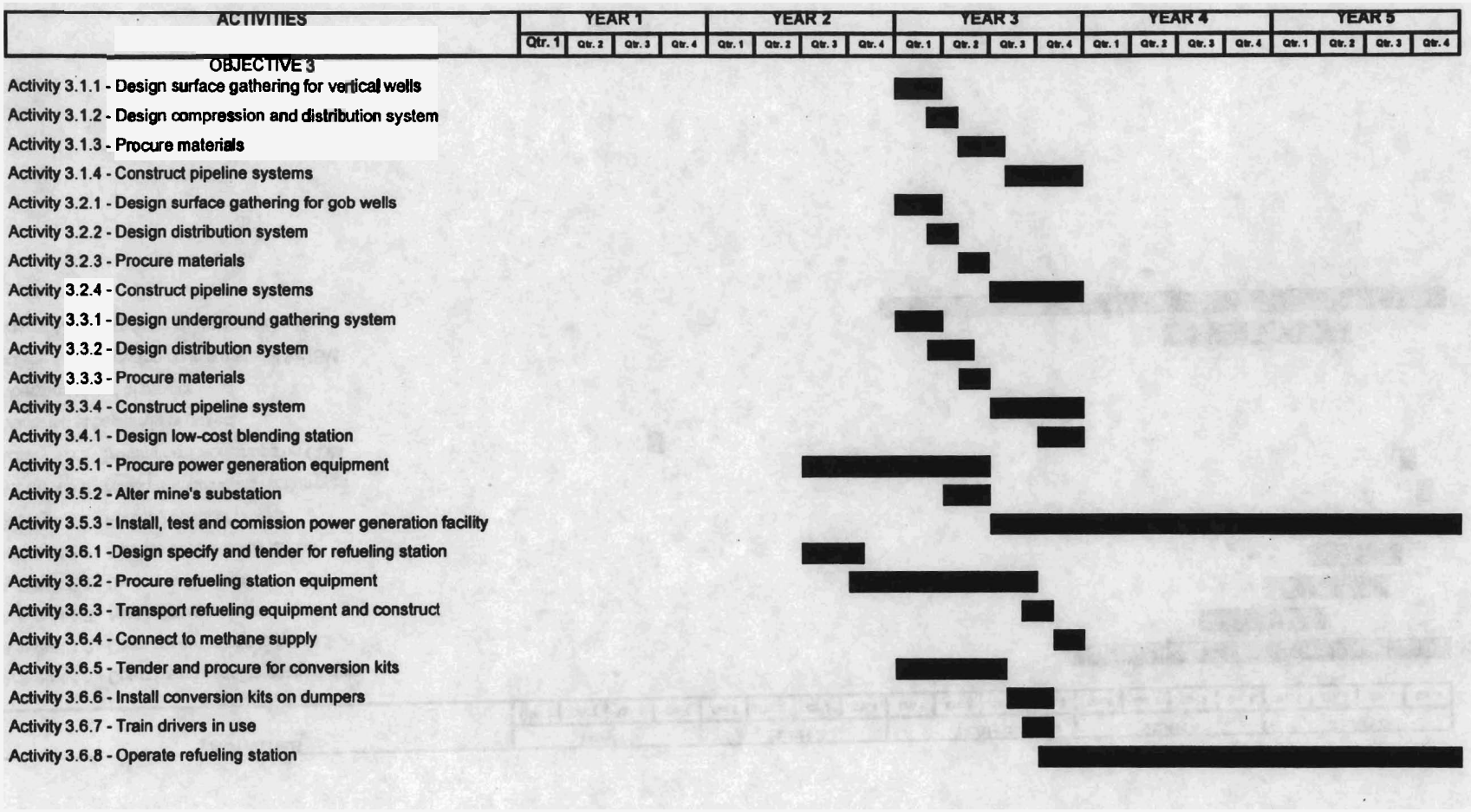
[1] excludes US $ 82,633 which has already been disbursed under IND/97/G31 Preparatory Assistance phase executed by UNOPS. This PA cost when added to the grand total amounts to US $ 9.19 million (total contribution by UNDP/GEF).

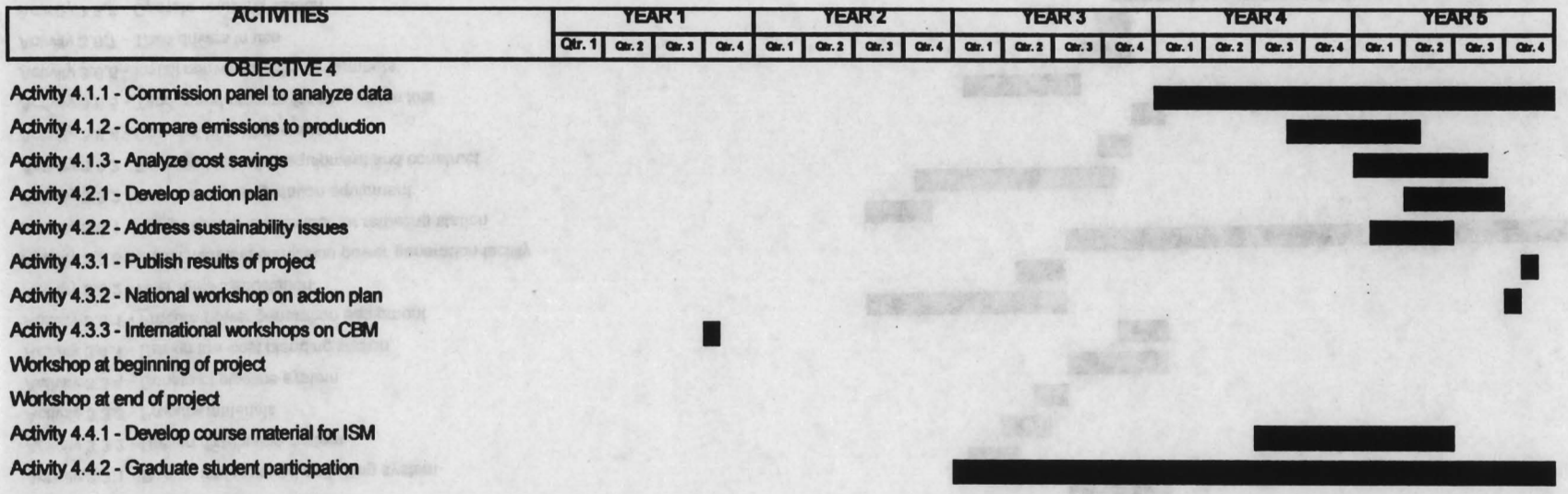
Annexure 2

WORKPLAN OF COMPONENT ACTIVITIES




ACTIVITIES
YEAR 1
YEAR 2
YEAR 3
YEAR 4
YEAR 5
Qtr. 1
Qtr. 2
Qtr. 3
Qtr. 4
OBJECTIVE 2
Activity 2.1.1 - Procure vertical drilling rigs
Activity 2.1.2 - Commission vertical drilling team
Activity 2.2.1 - Locate vertical boreholes
Activity 2.3.1 - Obtain permission to build drilling camp
Activity 2.3.2 - Construct drilling camp and mobilize
Activity 2.4.1 - Drill and log vertical boreholes
Activity 2.5.1 - Locate gob wells
Activity 2.6.1 - Drill gob wells
Activity 2.7.1 - Install oxygen and carbon monoxide detectors
Activity 2.8.1 - Procure two underground drills
Activity 2.8.2 - Notify DGMS with intent to import
Activity 2.8.3 - Transport underground drills
Activity 2.8.4 - Commission underground drill team
Activity 2.9.1 - Locate underground drainage boreholes
Activity 2.10.1 - Obtain permission for underground staging
Activity 2.10.2 - Mobilize equipment and personnel
Activity 2.11.1 - Drill and log drainage boreholes


ACTIVITIES
YEAR 1
YEAR 2
YEAR 3
YEAR 4
YEAR 5
Qtr. 1
Qtr. 2
Qtr. 3
Qtr. 4
OBJECTIVE 3
Activity 3.1.1 - Design surface gathering for vertical wells
Activity 3.1.2 - Design compression and distribution system
Activity 3.1.3 - Procure materials
Activity 3.1.4 - Construct pipeline systems
Activity 3.2.1 - Design surface gathering for gob wells
Activity 3.2.2 - Design distribution system
Activity 3.2.3 - Procure materials
Activity 3.2.4 - Construct pipeline systems
Activity 3.3.1 - Design underground gathering system
Activity 3.3.2 - Design distribution system
Activity 3.3.3 - Procure materials
Activity 3.3.4 - Construct pipeline system
Activity 3.4.1 - Design low-cost blending station
Activity 3.5.1 - Procure power generation equipment
Activity 3.5.2 - Alter mine's substation
Activity 3.5.3 - Install, test and comission power generation facility
Activity 3.6.1 -Design specify and tender for refueling station
Activity 3.6.2 - Procure refueling station equipment
Activity 3.6.3 - Transport refueling equipment and construct
Activity 3.6.4 - Connect to methane supply
Activity 3.6.5 - Tender and procure for conversion kits
Activity 3.6.6 - Install conversion kits on dumpers
Activity 3.6.7 - Train drivers in use
Activity 3.6.8 - Operate refueling station


ACTIVITIES
YEAR 1
YEAR 2
YEAR 3
YEAR 4
YEAR 5
Qtr. 1
Qtr. 2
Qtr. 3
Qtr. 4
OBJECTIVE 4
Activity 4.1.1 - Commission panel to analyze data
Activity 4.1.2 - Compare emissions to production
Activity 4.1.3 - Analyze cost savings
Activity 4.2.1 - Develop action plan
Activity 4.2.2 - Address sustainability issues
Activity 4.3.1 - Publish results of project
Activity 4.3.2 - National workshop on action plan
Activity 4.3.3 - International workshops on CBM
Workshop at beginning of project
Workshop at end of project
Activity 4.4.1 - Develop course material for ISM
Activity 4.4.2 - Graduate student participation

Annexure 3

TERMS OF REFERENCE

CHIEF TECHNICAL ADVISOR

1. Post Title:	Chief Technical Advisor
2. Duration:	5 m/m over life of the project
3. Date Required:	May 1998 (tentative)
4. Duty Station:	New Delhi, Ranchi, Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The Chief Technical Advisor will be responsible for : · Providing expertise and advice to the Chief Project Manager and if required or requested, the National Programme Director; · Assisting in the planning and executing the work plan consistent with the project document; · Aid in the identifying international expert consultants; · Assist in developing study tour agendas, and national and international workshops, and coordinating efforts of consultants during training and workshops; · Participate in tripartite reviews and other periodic progress reviews. . Actively responsible for identifying/selecting/and clearing the procurement of methane and gas equipment requiring close collaboration with the Project Advisor.
7. Qualifications	University degree in geology or mining engineering or allied field, with at least 20 years of experience in energy resource development. Must have several years of experience in coal bed methane project planning, development, management, gas resource assessment, drilling and production practices, and economic and financial evaluation techniques. International project experience is required.

Annexure 3

TERMS OF REFERENCE

UNDERGROUND DRILLING AND COMPLETION EXPERT

1. Post Title:	Underground Drilling and Completion Expert
2. Duration:	4.5 m/m over life of project
3. Date Required:	January 1999
4. Duty Station:	Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The underground drilling and completion expert will be responsible for : · Organizing study tours and providing on-the-job training for underground drilling teams at Moonidih and Sudamdih coal mines; · Providing input into development of safety protocols; · Providing list of potential international suppliers for underground drilling and completion equipment; · If desired by Chief Project Manager, inspection of underground drilling rigs before purchase; · Providing design and specifications for underground drainage boreholes and completion practices.
7. Qualifications	University degree in mining engineering or allied field with at least 10 years in underground drilling and methane drainage in coal mines. Must be capable of developing training programmes for application of up-to-date of MWD directional drilling technology. Required to have knowledge of current completion practices including hydrofracturing. International project experience is required.

Annexure 3

TERMS OF REFERENCE

RESERVOIR MODELING EXPERT

1. Post Title:	Reservoir Modeling Expert
2. Duration:	1.5 m/m over life of project
3. Date Required:	May 1998
4. Duty Station:	Ranchi, Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The reservoir modeling expert will be responsible for : · Providing expertise and training in current numerical modeling techniques for characterizing conventional, coal reservoirs and prediction of production of gas from in-seam underground drainage boreholes, vertical wells drilled from the surface into coal and surrounding strata; · Provide expertise in modeling relaxation of strata that accompanies underground mining and numerical modeling of the gob "reservoir"; · Provide expertise and methodology for modeling coal mine emissions and predicting gas drainage efficiency; · Provide recommendations for location of underground and surface boreholes to maximize production and recovery efficiency while lowering emissions into the mine workings and the atmosphere.
7. Qualifications	University degree in geology, petroleum engineering, mining engineering or allied fields with at least five years of experience in the latest numerical modeling technique and software. Must have experience and success in modeling coalmine emissions, recovery efficiency, and optimization of drainage programme. International project experience is required.

Annexure 3

TERMS OF REFERENCE

UNDERGROUND GAS COLLECTION SYSTEMS EXPERT

1. Post Title:	Underground Gas Collection Systems Expert
2. Duration:	5 m/m over the life of the project
3. Date Required:	January 1999
4. Duty Station:	Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The underground gas collection systems expert will be responsible for : · Assist in organizing study tours; · Providing on-the-job training for underground gas recovery teams at Moonidih and Sudamdih mines; · Providing input in development of safety protocols; · Design and specification of carbon monoxide and oxygen detection systems on gob gas recovery systems; · Providing design and specifications for underground gas collection system.
7. Qualifications	University degree in mining engineering of allied field with at least 10 years in design and installation of underground gas recovery systems. Must be capable of developing training programme that will provide instruction on planning design and installation of underground gas recovery systems. International project experience is required.

Annexure 3

TERMS OF REFERENCE

SURFACE DRILLING AND COMPLETION EXPERT

1. Post Title:	Surface Drilling and Completion Expert
2. Duration:	4.5 m/m over life of project
3. Date Required:	January 1999
4. Duty Station:	Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The surface drilling and completion expert will be responsible for : · Organizing study tour and providing on-the job training in advance techniques for drilling and completing vertical holes in structurally complex geologic terrain; · Providing input into safety protocols; · Providing list of potential international suppliers for surface drilling equipment; · If desired by Chief Project Manager, inspection of drilling rigs before purchase; · Providing design and specifications for drilling and completion vertical of wells into un-mined coal and surrounding strata and gob areas. · Providing expertise in well testing methods and geophysical logging.
7. Qualifications	University degree in petroleum engineering or geologic engineering or allied field with at least 10 years of field experience. Must be capable of supervising all drilling operations from well location construction through completion and setting of wellhead. Current knowledge of advanced drilling and completion technology is required. International drilling project supervision experience is essential.

TERMS OF REFERENCE

GAS PLANT EXPERT

1. Post Title:	Gas Plant Expert
2. Duration:	5 m/m
3. Date Required:	January 1999
4. Duty Station:	Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The Gas Plant Expert will be responsible for : · Organizing study tour and providing on-the-job training in gas plant design and installation to gas recovery teams at the Moonidih and Sudamdih mines; · Providing input into safety protocols; · Design and specifications for a low cost gas plant that will allow blending of gasses recovered from in-seam and gob areas so that gas quality will be consistent to end-user; · Coordinate with surface gas collection and distribution system manager to ensure compatibility in designed capacity and operation of the gas plant.
7. Qualifications	University degree in chemical engineering, mining engineering, or allied field with at least 10 years of experience in design of gas plants located in the coal-mining environment. Must be capable of developing a training programme to provide instruction in gas plant design installation and operation. International project experience is required.

Annexure 3

TERMS OF REFERENCE

LABORATORY SORPTION AND PERMEABILITY EXPERT

1. Post Title:	Laboratory Sorption and Permeability Expert
2. Duration:	1.5 m/m over the life of the project
3. Date Required:	June 1998
4. Duty Station:	Ranchi and Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The laboratory sorption and permeability expert will be responsible for : · Organizing study tour and providing on-the-job training in techniques and methodology for determination of sorption capacity and permeability of coals in the laboratory and coal desorption sampling in the field; · Providing assistance in developing specifications for procurement of laboratory and field desorption equipment; · Developing protocols for sampling and writing manuals for operation of laboratory equipment; · Correlation of data and information developed through laboratory testing with data collected from well testing; · Providing expertise in inputting sorption data into numerical models.
7. Qualifications	University degree in geology or allied field, with at least five years of experience in laboratory equipment design, testing techniques, and field testing methods and use of numerical models for characterizing reservoirs. Must have broad background in use of testing data for exploration and development purposes. International project experience is required.

TERMS OF REFERENCE

ECONOMIC MODELING EXPERT

1. Post Title:	Economic Modeling Expert
2. Duration:	3 m/m over life of the project
3. Date Required:	October 1998
4. Duty Station:	Ranchi and Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The economic modeling expert will be responsible for : · Developing training programme for CBM project team in economic and financial evaluation techniques; · Assisting in the development of a model for evaluating the economic performance of methane recovery and utilization programmes in India; · Proforma evaluation of the proposed methane recovery and utilization projects.
7. Qualifications	University degree in business, economics, or finance; or a degree in geology or mining engineering degree with at least five years experience in evaluating the economic performance of coalbed methane recovery and utilization projects. Must have experience evaluating the potential for a project to be financed by sources outside of the coal mining company. International project experience is required.

Annexure 3

TERMS OF REFERENCE

TELECOMMUNICATIONS/INFORMATION SYSTEMS/INTERNET EXPERT

1. Post Title:	Telecommunications/Information Systems/Internet Expert
2. Duration:	1m/m over the life of the project
3. Date Required:	June 1998
4. Duty Station:	New Delhi, Ranchi, Dhanbad
5. Project Purpose:	The purpose of this project is to demonstrate commercial feasibility of recovering and utilizing coalmine associated methane.
6. Duties	The telecommunications/information systems/internet expert will be responsible for : · Design, specification, and installation of an Internet Gateway using state-of-the art technology, compatible with telecommunication systems in India; · Design, specification, and installation of an Intranet that connects CMPDIL campus with their regional offices, MoC, and CIL to each other and allows Internet access; · Designing the system so that communications from the field via satellite telephone will be compatible with the Intranet system and data can be transferred digitally. · Providing operations manual for systems to all connected on the Intranet system.
7. Qualifications	University degree in electronics or telecommunications technology or allied field with at least five years experience in development of Intranet and Internet Gateway systems. Must be familiar with telecommunication systems in India. International project experience is required.

TERMS OF REFERENCE

NATIONAL PROJECT DIRECTOR

Project No.	IND/97/631
Project Title	Coal Bed Methane Recovery and Commercial Utilization India
Post Title	National Project Director
Duration	5 years
Duty station	New Delhi

A. Background:-

The proposed project is for capturing, recovery and the use of methane, a green house gas being released during the process of mining and its commercial utilization as a cleaner primary source of energy for generation of (i) Electrical Energy through stationary 1 M.W. internal combustion engines and (ii) as substitute to diesel in engines of 50 ton Dumpers.

Normally in gassy coalmines, methane, causes safety hazard by initiation and explosion when present in certain percentage in mine air and is emitted, during the process of mining. This is diluted by ventilating air, which in turn releases it to surface atmosphere. At times, the ventilating air may not be able to dilute it to safe limits. This may result in risk of methane ignition and/or explosion. Capture and recovery of methane in working gassy coalmines will eliminate/reduce GHG emissions, and improve/increase safety as well as production and productivity etc.

Therefore the success of the project will demonstrate:

- Reduction of methane emission at coal face with improved safety and incidental benefits of better production, productivity etc.

Prevention of release of a high potential greenhouse gas into atmosphere with resultant benefits.

- Utilization of a cleaner primary source of energy reducing coal or diesel and to that extent providing local, regional and national environmental benefits.
- Addition to the resources of the coal mine and its economics.
- Availability of additional power thus reducing power shortage in industry and local community.
- Increase in local employment opportunity by use of methane as fuel/ substitute to diesel in transport vehicles and further future likely use as piped gas or bottled gas for local use.

B. Project Purpose :-

In brief the purpose of the project is to demonstrate commercial feasibility of recovering and utilizing coal mine associated methane with benefits to coal mines , community, local regional and national environment and global climate change.

C. Duties:-

The National Project Director (NPD) will:

- coordinate the management and implementation activities of the project as set out in the project document;
- provide assistance to the Steering Committee to ensure that project activities conform to the agreed project document;
- provide overall guidance to the Project Advisor (CBM) and the project team for project execution, and conveying GoI's official position as may be requested during the project implementation;
- coordinate with other institutions/agencies involved in the project execution;
- review and approve TORs for project team including consultants and contracting/subcontracting agencies
- organize Tripartite Review Meetings as per UNDP procedures.

D. Qualifications

Should be a senior level official in the Ministry of Coal.

TERMS OF REFERENCE

PROJECT ADVISOR (CBM)

Project No.	IND/97/631
Project Title	Coal Bed Methane Recovery and Commercial Utilization India
Post Title	Project Advisor (CBM)
Duration	5 years (yearly contract)
Duty station	New Delhi

A. Background:-

The proposed project is for capturing, recovery and the use of methane, a green house gas being released during the process of mining and its commercial utilization as a cleaner primary source of energy for generation of (i) Electrical Energy through stationary 1 M.W. internal combustion engines and (ii) as substitute to diesel in engines of 50 ton Dumpers.

Normally in gassy coal mines, methane, causes safety hazard by initiation and explosion when present in certain percentage in mine air and is emitted, during the process of mining. This is diluted by ventilating air, which in turn releases it to surface atmosphere. At times, the ventilating air may not be able to dilute it to safe limits. This may result in risk of methane ignition and/or explosion. Capture and recovery of methane in working gassy coal mines will eliminate/reduce GHG emissions, and improve/increase safety as well as production and productivity etc.

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Prevention of release of a high potential greenhouse gas into atmosphere with resultant benefits.

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- Addition to the resources of the coal mine and its economics.
- Availability of additional power thus reducing power shortage in industry and local community.
- Increase in local employment opportunity by use of methane as fuel/ substitute to diesel in transport vehicles and further future likely use as piped gas or bottled gas for local use.

B. Project Purpose :-

In brief, the purpose of the project is to demonstrate commercial feasibility of recovering and utilizing coal mine associated methane with benefits to coal mines, community, local regional and national environment and global climate change.

C. Scope of Work/Duties:-

The Project Advisor (CBM) will be responsible for:

- assisting the NPD in the management and implementation activities of the project;
- providing assistance to the NPD, and the Steering Committee to ensure that project activities conform to the agreed project document;
- providing the overall guidance to the project team for execution and adhering to GoI's official position as may be requested during the project implementation;
- coordinating with the line ministries, state governments and participating institutions/agencies involved in the project execution;
- coordinating with the consultants, contracting and sub-contracting agencies;
- preparing the terms of reference and candidates/agencies for consultancy assignments;
- assisting the consultants in carrying out their assignments by facilitating interaction and contacts with relevant Indian administrations and institutions;
- reviewing consultants' reports, project budget revisions, and all other administrative arrangements required as per MOC and UNDP procedures;
- maintaining close collaboration with the international consultant on equipment procurement.

C. QUALIFICATIONS AND EXPERIENCE:

(a) Qualifications:- Graduate in Mining Engineering and a Certificate of Competency to manage a Coal Mine.

(b) Experience:- At least 20 years of experience in operation and management of large mechanized coal mines, planning and design of coal mines, planning, development, management, gas assessment, drilling, production practices, and economic and financial evaluation-techniques. Experience of working in gassy mines, project planning, development and implementation is essential. Out of the above, at least 10 years experience must be in project appraisal, implementation and monitoring. He should have worked at very senior level positions in the Government involving appraisal and monitoring of large projects."

TERMS OF REFERENCE

CHIEF PROJECT MANAGER

Project No.	IND/97/631
Project Title	Coal Bed Methane Recovery and Commercial Utilization India
Post Title	Chief Project Manager
Duration	5 years
Duty station	Ranchi

A. Background:-

The proposed project is for capturing, recovery and the use of methane, a green house gas being released during the process of mining and its commercial utilization as a cleaner primary source of energy for generation of (i) Electrical Energy through stationary 1 M.W. internal combustion engines and (ii) as substitute to diesel in engines of 50 ton Dumpers.

Normally in gassy coal mines, methane, causes safety hazard by initiation and explosion when present in certain percentage in mine air and is emitted, during the process of mining. This is diluted by ventilating air, which in turn releases it to surface atmosphere. At times, the ventilating air may not be able to dilute it to safe limits. This may result in risk of methane ignition and/or explosion. Capture and recovery of methane in working gassy coal mines will eliminate/reduce GHG emissions, and improve/increase safety as well as production and productivity etc.

Therefore the success of the project will demonstrate:

- Reduction of methane emission at coal face with improved safety and incidental benefits of better production, productivity etc.

Prevention of release of a high potential greenhouse gas into atmosphere with resultant benefits.

- Utilization of a cleaner primary source of energy reducing coal or diesel and to that extent providing local, regional and national environmental benefits.
- Addition to the resources of the coal mine and its economics.
- Availability of additional power thus reducing power shortage in industry and local community.
- Increase in local employment opportunity by use of methane as fuel/ substitute to diesel in transport vehicles and further future likely use as piped gas or bottled gas for local use.

B. Project Purpose:-

In brief the purpose of the project is to demonstrate commercial feasibility of recovering and utilizing coal mine associated methane with benefits to coal mines, community, local regional and national environment and global climate change.

C. Scope of work/ Duties

- Will carry out all day to day work of the project with support of Project Management Cell .
- Will be responsible for the implementation of activities to be carried out under the direction and control of the local implementing agency.
- Will be responsible for the timely achievement of the development objectives and outputs of various related activities stated in the project document.
- Interact with all agencies (Implementing and support) for efficient and execution of the project as per project schedule.
- Initiate jointly with appropriate authorities of Monidih and Sudamdih Coal Mines of B.C.C.L. Appropriate action and follow up of D.G.M.S. clearance for new technologies, new equipment etc. at the proposed sites.
- Preparation of annual workplan and budget of the project and its timely submission.
- Carry out all managerial and organizational functions for timely implementation of the project within delegated authority and responsibilities.
- Initiate proposals for clearance to appropriate authorities in the implementing agencies, operational committee, for award of contracts and work orders.
- Delegate authority and responsibilities to technical team leaders commensurate with needs of the work.
- Coordinate with technical team leaders and experts trained for this project for its efficient and timely execution.
- Will be responsible for all operational details delegated to CPM and Project Management Cell.
- Carry out a monthly programme and a review with technical team leaders/ Management Cell and submit the programmes and review reports to Operational Executive steering committee, Project Advisor (CBM) and the National Project Director
- Suggest and carry out remedial measures for issues delaying the project.
- Carry out manpower planning and scheduling and requisition of manpower for project implementation.
- Carry out such other tasks as may be assigned by local implementing agency, Operational Executive Steering Committee and National Project Director.
- Carry out a regular interaction with Project Adviser, Chief Technical Advisor and Sr. National Technical Consultant for assistance and technical support as and when required.
- Submit regular progress report to the local implementing agency, Ministry of Coal, and UNDP.

D. Qualifications, experience, status

1. Qualifications

- Graduate in mining engineering,
- certificate of competency to manage a Coal mine.

2. *Experience*

At least 15 years experience in Operation, Management, Planning & Design of Coal Mines and also in related Project Planning, Development, Management, Drilling, Production Practices and Economic and Financial Evaluation Techniques. Part of the above experience must be related to gassy coal and coal mines.

Status/position reached

- General Manger or Chief General Manager.
- At least 2 years experience as General Manager.

Annexure 3

TERMS OF REFERENCE

SR. NATIONAL TECHNICAL CONSULTANT

Project No. IND /97/631
Project Title Coal Bed Methane Recovery and Commercial Utilization
Post Title Senior National Technical Consultant
Duration 20 m/m/ over the life of the project . 4 m/m per year
Duty Station Head Qrs. New Delhi ,Field sites Dhanbad and Ranchi
Date Required May 1988 (tentative)

A. Background:-

The proposed project is for capturing, recovery and the use of methane, a green house gas being released during the process of mining and its commercial utilization as a cleaner primary source of energy for generation of (i) Electrical Energy through stationary 1 M.W. internal combustion engines and (ii) as substitute to diesel in engines of 50 ton Dumpers.

Normally in gassy coal mines, methane, causes safety hazard by initiation and explosion when present in certain percentage in mine air and is emitted, during the process of mining. This is diluted by ventilating air, which in turn releases it to surface atmosphere. At times, the ventilating air may not be able to dilute it to safe limits. This may result in risk of methane ignition and/or explosion. Capture and recovery of methane in working gassy coal mines will eliminate/reduce GHG emissions, and improve/increase safety as well as production and productivity etc.

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- Addition to the resources of the coal mine and its economics.
- Availability of additional power thus reducing power shortage in industry and local community.
- Increase in local employment opportunity by use of methane as fuel/ substitute to diesel in transport vehicles and further future likely use as piped gas or bottled gas for local use.

B. Project Purpose:-

In brief the purpose of the project is to demonstrate commercial feasibility of recovering and utilizing coal mine associated methane with benefits to coal mines , community, local regional and national environment and global climate change.

C. Task/Scope of Work:-

1. Provide assistance and advice to Chief Project Manager and, and when required, to Project Advisor (CBM), National Project Director, and National Steering Committee in executing the work plan consistent with the project document for:-

a) Strengthening and increasing capacity of Executing and Implementing Agency(ies) to develop and support the project in identification, design, and implementation in a safe , cost effective and environmentally acceptable manner.
b) Establishment of an integrated CBM information system.
c) Preparation and execution of the Project for methane capture and recovery
d) Use of Gas recovered for Electric Power Generation and for use as Vehicle Fuel in Dump Trucks as substitute to diesel

2. Carry out interactions with various implementing and supporting Agencies for effective inter-institutional coordination and for efficient execution. Analyze the report prepared by National Project Director that presents analysis and recommendations for future activities based on the analysis of the economic, environmental and safety impacts of the technology and approach used in the demonstration project.

3 Based on the above report, assist in preparation of recommendations and its analyses for future replication of the projects. .

4. Assist in technical monitoring, and reviewing of the project activities.

5. Participate in the periodic reviews.

6. Carry out joint field and site tours with the Chief Technical Advisor and assist him in the project consultancy work.

7 Interact with the international and national experts, engaged for specific expertise job/activity.

8. Carry out suitable periodic field inspections and provide consultancy to implement out various tasks

D. QUALIFICATIONS AND EXPERIENCE:

(a) Qualifications:- Graduate in Mining Engineering and a Certificate of Competency to Manage a Coal Mine

(b) Experience :- At least 25 years of experience in operation, management, planning and design of coal mines, planning, development, management, gas assessment, drilling, production practices, and economic and financial evaluation-techniques. International experience of working in gassy mines, project planning, development, exploration, drilling and economic and financial

evaluation is essential. Out of the above at least 10 years experience must be in planning and design, project planning and development, drilling, and financial and economic evaluation. Should have worked at senior level technical and managerial positions.

TERMS OF REFERENCE

PROJECT ADMINISTRATION AND FINANCE MANAGER

Project No.	IND/97/631
Project Title	Coal Bed Methane Recovery and Commercial Utilization India
Post Title	Project Administration and Finance Manager
Period	5 Years
Duty Station	Ranchi

A. Background:-

The proposed project is for capturing, recovery and the use of methane, a green house gas being released during the process of mining and its commercial utilization as a cleaner primary source of energy for generation of (i) Electrical Energy through stationary 1 M.W. internal combustion engines and (ii) as substitute to diesel in engines of 50 ton Dumpers.

Normally in gassy coal mines, methane, causes safety hazard by initiation and explosion when present in certain percentage in mine air and is emitted, during the process of mining. This is diluted by ventilating air, which in turn releases it to surface atmosphere. At times, the ventilating air may not be able to dilute it to safe limits. This may result in risk of methane ignition and/or explosion. Capture and recovery of methane in working gassy coal mines will eliminate/reduce GHG emissions, and improve/increase safety as well as production and productivity etc.

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- Utilization of a cleaner primary source of energy reducing coal or diesel and to that extent providing local, regional and national environmental benefits.
- Addition to the resources of the coal mine and its economics.
- Availability of additional power thus reducing power shortage in industry and local community.
- Increase in local employment opportunity by use of methane as fuel/ substitute to diesel in transport vehicles and further future likely use as piped gas or bottled gas for local use.

B. Scope of work

1. The Project Administration and Finance Manager will be responsible for carrying out total finance management work of the project.

1. The preparation of activity-wise annual action plan and related budget.

1. Preparation of the budget and carry out the certification and financial concurrence for all purchases, procurements, award of contract or work order for all items in line with UNDP guidelines.

1. Will release of all funds and payments, and their proper record .

1. Will keep all accounts and their audit by appropriate authorities.

1. Providing necessary assistance to the Chief Project Manager, Local Implementing Agency, various committees and participating institutions in financial matters related to the project.

1. Providing necessary information and reports to be required by the implementing agencies from time to time.

C. QUALIFICATIONS AND EXPERIENCE:

(a) Qualifications:- Charted Accountant/Cost Accountant/M.Com. (Accounts) or equivalent qualifications.

(b) Experience :- At least 5-7 years of experience in financial management and accounting. Experience in operation and management of coal projects will be preferred.

TERMS OF REFERENCE

THREE COMMITTEES

I. National Steering Committee:

The National Steering Committee will be established with the following composition, and will meet on a **quarterly** basis:

1.	Secretary, Ministry of Coal	**Chairperson**
2.	Additional Secretary, MOC,	**NPD & Convenor**
3.	Resident Representative, UNDP)	Members
4.	Joint Secretary (Climate Change), MOEF)	
5.	Director General of Mines Safety)	
6.	Chairman, Coal India Ltd.)	
7.	Chairperson-Managing Director, CMPDIL)	
8.	Chairperson-Managing Director, BCCL)	
9.	Joint Secretary (DEA), Min. of Finance)	
10.	Project Advisor (CBM)	

The Committee will be chaired by the Secretary, Ministry of Coal. The National Project Director (NPD), who will be the Additional Secretary dealing with subject matter in MOC, will the Convenor. The members include the UNDP Resident Representative and the Heads of the implementing agencies, and those cooperating organizations/institutions which have a direct bearing on the successful implementation of the project.

The Committee will be responsible to:

- Review policy issues related to coal mine methane development. Pre-eminent on the list of responsibility is the transfer from abroad and dissemination throughout the country, of appropriate technology for drilling and production of methane, and its transport and utilization.
- Lay down policies defining the functions, responsibilities and delegation of powers for the local implementing agency and the Operational Executive Steering Committee.
- Coordinate and manage the overall project activities and the budget.
- Review the project activities, and their adherence to the workplan set forth in the project document.
- work to foresee major problems before they are encountered and when consulted by the local implementing agency.

- Take decisions on the issues brought to its notice by UNDP and other cooperating institutions, and advise regarding efficient and timely execution of the project.

- Initiate remedial action to remove impediments in the progress of project activities which were not envisaged earlier.

- Final selection and approval of the senior project officials such as Project Adviser (CBM), Chief Technical Advisor, Senior National Technical Consultant, Chief Project Manager, and Administrative & Finance Officer.

2. Operational Executive Steering Committee

This Committee will be at local implementing agency level, and will comprise of:

1. Chairperson-Managing Director, CMPDIL *
2. Chairperson-Managing Director, BCCL *
3. Director (Technical), Coal India Ltd.) Members
4. Representative of Director-General) Mines Safety
5. Project Adviser (CBM)
6. Chief Project Manager Convenor

*** Chairperson of the Committee by rotation**

The Committee will be meet on a **monthly** basis, and the Chairpersons of CMPDIL and BCCL will chair the committee by rotation to ensure better linkage and work coordination.

The Committee will be responsible for:

- All operational details not delegated to Chief Project Manger or his technical team leaders.

- Carry out all functions of approval of purchase proposals, award of contracts, work orders, etc. for equipment items, contracts and work orders beyond the value which have not been delegated to Chief Project manager.

- Lay down system of purchase, financial concurrence, etc. for the project, purchase, procurement, award of work, which should be on competition basis and in line with GOI/UNDP guidelines.

- Provide coordination among local implementing agencies and the various institutions and agencies involved in the implementation of the project to ensure speedy, timely and safe implementation.

- review and approve annual workplan and budget of the project for timely submission to NPD and the National Steering Committee.

- Monthly programme review of project activities with Chief Project Manager and technical team leaders.

- Suggest and initiate remedial action to avoid delays in project implementation, and to bring delayed activities back on schedule.

3. Policy Advisory Committee

The function of the policy advisory committee will be primarily to provide a forum to a wide range of stakeholders and participating institutions for seeking their inputs on policy issues including socio-economic and environmental issues. This Committee will network and effectively utilize the knowledge of cooperating institutions and agencies such as Indian School of Mines, Central Mine Research Institute, etc. and also to take advantage of earlier work done, and available database concerned with the activities of the project.

In principle, the functions and responsibilities of the Advisory Committee will be to help lay the ground work for future development and replication of the successful elements of the demonstration project. It is important to have a forum to discuss the technical and social issues that will arise during the course of the demonstration project. Inputs from the local administration and State Government officials, allied industry and consumers will aid in determining the appropriate course of action to ensure sustainability of this initiative.

The committee will comprise of the following members:

1.	Project Adviser (CBM)	**Chairperson**
2.	CMD, CMPDIL	) Members
3.	CMD, BCCL	)
4.	DG. Mines Safety (Representative	)
5.	Director, Central Mining Research Inst.	)
6.	Director, Indian School of Mines	)
7.	Director (Tech.), Coal India	)
8.	General Manager (Project & Planning), BCCL	)
9.	General Manager, Moonidih Area	)
10.	General Manager, Sudamdih Area	)
11.	Chief Technical Adviser	)
12.	Senior National Technical Consultant	)
13.	FICCI Representative	)
14.	CII Representative	)
15.	CSIR Representative	)
16.	ASSO Chem. Representative	)
17.	Local & Regional Consumer Groups	)
18.	State and local officials	)
19.	Chief Project Manager Member/Secretary and Convenor)	

JUSTIFICATION FOR THE USE OF UNDP/GEF RESOURCES FOR THE EQUIPMENT TO BE SUPPLIED BY UNDP/GEF

1. The justification to use UNDP/GEF resources for procuring equipment is under the project provided in this note.

2. List of equipment proposed to be procured under UNDP/GEF input is given in Annex 5.

3. Equipment to be procured are:

- surface and subsurface drilling equipment, and transports;
- equipment to measure the amount of methane gas desorbed from coal samples in the field;
- laboratory equipment to measure the methane adsorptive capacity of coal samples and their permeability;
- downhole equipment to log and evaluate the methane production potential of boreholes;
- computing and graphics equipment to model methane production character of the reservoirs;
- equipment to complete and produce methane gas from underground and surface wells;
- surface pipeline for a gathering system for bringing gas from different gas wells i.e. gas wells ahead of the coal face in virgin areas, gas wells into old gobs and from underground inseam boreholes bringing gas to a central point on the surface;
- safety equipment to monitor gas composition in the gob areas of mines; and
- a gas collection system to transport methane from the central point on the surface where the gathering system ends to end-use site of power generation by IC engine or compressed methane plant end use point.

4. The Government shall make budget provisions (as GoI's contribution in cash) to buy the end use equipment which would include:

- a 1 MW IC engine generator set which will be fueled by methane gas produced from this project;
- equipment for construction and operation of a compressed methane vehicle refueling station;
- kits to convert 50 ton mine-owned coal haulage trucks from diesel fuel to bi-fuel methane/diesel;
- ancillary drilling equipment and supplies;
- project site staging and crew accommodations;
- and surface pipeline for a distribution system.

5. The project is intended to contribute to the promotion of increasing self reliance in regard to management and implementation of, exploration, production, use of methane in a commercially viable and environmentally beneficial manner; further and strengthen capacity for technical research; and expand experimental and administrative capabilities of the Government and of the institutions concerned. In addition, under the arrangements agreed by the Government with the

- Appropriate buildings with adequate space complete with all services and infrastructure and civil engineering works etc., must be made available for accommodating the various equipment professionals and workmen.

12. The Government will make all necessary infrastructure and services available. Necessary provision has been made in the Government input for the provision of the above infrastructure and services.

13. Only routine maintenance and servicing facilities are required for the above equipment, which can be handled by the two technical institutions, and no special facilities are therefore needed in this regard. The cost of maintenance and servicing facilities will be borne by the Government.

14. Initially a supply of spare parts will be procured along with the main equipment from the UNDP/GEF funds. During the life of the project, additional needs will be met from project and/or national funds. The Government has undertaken to provide necessary funds for the procurement of spare parts replacement of depreciated items and supply of consumable, after the completion of the project.

15. Concerning the expertise required to manage and operate the equipment, the Government has at its disposal the necessary technical personnel to manage and operate the equipment. In addition, specialized training to these technical staff covering operation and maintenance of equipment, and safety will be provided during the course of the project, under fellowship training for which necessary provision has been made in the UNDP/GEF input. The trained personnel will be available to continue proper operation and maintenance of the equipment after the termination of the UNDP/GEF assistance and arrangements will be made by the Government to ensure continuity of competency of staff in future.

16. The equipment will operate at or near the capacity for which it was designed.

List of Main Equipment to be supplied by UNDP/GEF

	Description	Costs (in US $)
1.	Vertical drilling rig 1	800,000
2.	Mudlogging unit 2	150,000
3.	Vertical drilling rig 1	650,000
4.	Completion equipment	400,000
5.	Directional drilling	300,000
6.	Horizontal drill 2	1,000,000
7.	Drilling accessories	150,000
8.	Geophysical logger 1	900,000
9.	2 Phase well testing tool	200,000
10.	Hydro-fraturing unit 1	700,000
11.	High capacity pumps -16	140,000
12.	Adsorption systems	100,000
13.	Gas chromatograph	75,000
14.	Lab permeameter	14,000
15.	Field work station	70,000
16.	Hqr. field station	65,000
17.	Modeling software	50,000
18.	Data processing, mapping and illustration systems	50,000
19.	Portable cabins	36,000
20.	Air conditions (6), furniture (computers/lab)	14,000
21.	Transports : 3 trucks and 7 WD/suv	139,000
22.	Procurements and costs for transporting the equipment from port landing to site	70,000
23.	Gas collection system for compressed methane and electric power generation systems	330,000

DESCRIPTION OF MAIN EQUIPMENT TO BE SUPPLIED BY UNDP/GEF

Equipment	Units	Physical Description
Vertical Drilling Rig	1	truck mounted, top drive, mast for double drill pipe lengths, depth capacity to 1500 meters, 35000 lb. hook load, equipped for wireline retrieval, mud system including tanks, pumps, and shaker screens, 4500m drill pipe.
Mudlogging Unit	2	FID detector chromatograph, drilling fluid agitator system and gas sampling pumps, computerized system, log plotting equipment, sample examination microscope, telecommunication system for transmittal of data, installed in portable cabin.
Vertical Drilling Rig	1	truck mounted, top drive, mast for double drill pipe lengths, depth capacity to 1000 meters, 25000 lb. hook load, equipped for wireline retrieval, mud system including tanks, pumps, and shaker screens, 3000m drill pipe.
Completion Equipments		High pressure-high volume pumps, inflatable packers, mechanical packers, casing perforator guns, perforator loads.
Directional Drilling Rig		Two downhole mud motors, measurement while drilling (MWD) equipment, bent subs, cross-overs, down hole survey tools.
Horizontal Drill	2	horizontal drilling system, thrust capacity sufficient for drilling ahead up to 500m, equipped with downhole mud motor, single shot survey system, 1500 m drill pipe, coring capable.
Drilling Accessories		assorted drill bits designed for horizontal and directional drilling, diamond core bits, plastic and glass bead proppants, wireline retrieveable core barrel, split core tube, inner barrel, crossovers, subs.
Geophysical Logger	1	truck mounted wireline system for geophysical logging, computerized recording and plotting system, sondes including: sonic, gamma-ray, compensated neutron density/porosity, resistivity, SP, cased hole tools, cement bond tools, caliper.
Two phase well testing tool	1	downhole pressure transducers, inflatable packers, drill stem test and sample capable.
Hydro Fracturing Unit	1	truck mounted hydrofracturing system, including high pressure pumps and piping with connectors valves and subs, capable of delivering and monitoring downhole fluid displacement pressures, four fracc tanks.
High Capacity Pumps	16	high capacity pumps, downhole progressive cavitation for dewatering.
Adsorption System		high pressure volumetric & gravimetric adsorption system including: analog to digital computerized recording system, sample preparation equipment, ASTM temperature and humidity control system, canisters, pressure transducers, flow meters, and thermocoup.
Gas Chromatograph		laboratory grade FID, sample injection ports, reporting software and printer.
Lab Permeameter		permeameter capable of testing with single or multi-component gases, capable of adsorption capacity determination, cable of application of in situ vertical and horizontal stresses, at constant reservoir temperature.

Field Work Station		UNIX based multi platform workstation equipped with advanced versions of geological database, mapping, crossection and analytical software. Telecommunication via modem and compatible with satellite uplink, fully surge. protected and custom UPS system installed. Compatible and linked with Intranet.
H.Q. Work Station		UNIX based multi platform workstation equipped with advanced versions of geological database, mapping, crossection and analytical software. Telecommunication via modem and compatible with satellite uplink, fully surge protected and custom UPS system installed. Compatible and linked with Intranet.
Modeling software		multi-platform compatible reservoir modeling software, finite volume capable of modeling multi-phase fluid migration through coal seams and sandstone reservoirs simultaneously, must be able to model gob areas, virgin unmined areas and movement of gases through ventilation system, cable of prediction of borehole and ventilation gas production.
Data Processing and Technical Illustration:		
		* A-4 size plotter with drives for field
		* 132 col. DMP for field
		* Digitizer AO size with drivers
		* Color scanner AO size with drivers
		* Plotter (AO design) with color and driver software
		* Pentium with 1 GB RAM 200MHZ with DMP laser writer, printer and copy jet/color ink jet printer
		* Latest version AutoCAD software
		* Generator/UPS
Portable Cabins		dual axle, insulated, cooking, restroom facility and sleeping compartment.
Air conditioners (6), furniture (computers and lab)	6	refrigerated air conditioners, humidity controlled, desks chairs, drafting and printer tables.
Transports: 3 trucks and 7 4WD/SUV		4 wheel drive/ All wheel drive- automatic transmission and pick-up and sports utility vehicles, cellular phone equipped.
Gas collection system for compressed methane and electric power generation sites		API grade piping, valves, flanges, gas analyzers and flowmeters installed and connected to wellheads.

USAGE OF EQUIPMENT TO BE SUPPLIED BY UNDP/GEF :

1. Vertical drilling rig
The vertical drilling rig will be used to drill boreholes/gas wells in virgin coal mines much ahead of working coal faces for proving and establishing the quantum of methane emission, and the subsequent extraction/recovery of CBM from virgin coal. These boreholes are expected to be deep i.e. about 1000 meters and above.

2. Mudlogging Unit
The mudlogging unit (equipment) will be used for logging of the boreholes/wells drilled with the mud flushing which is likely to be necessary in the strata to be dealt with during the drilling operations. The mudlogging unit will provide information on geological strata/horizons.

3. Vertical drilling rig
The usage of this vertical drilling rig will be same as that of vertical drilling rig at S.No.1 except for the fact that this rig will undertake medium depth drilling of boreholes/well for tapping methane from existing gobs (i.e. less than 1000 meters). The quantum and nature of work requires both types of vertical drilling rigs.

4. Completion equipment
The completion equipment is used after drilling of boreholes/wells as they have to be sealed/completed by cementing, casing and installing liners. This step will ensure maximization of gas recovery.

5. Directional drilling unit
In underground drilling of mines, directional drilling by horizontal drills will be required to tap methane from the coal seam and the surrounding strata. This equipment will be required for the above purpose as a support/auxiliary equipment to the horizontal drills.

6. Horizontal drill
The horizontal drill will be used for drilling from underground mine coal faces.

7. Drilling accessories
Drilling accessories are various accessories to vertical and horizontal rigs and drills.

8. Geophysical logger
The geophysical logger is required to carry out geophysical logging of the strata drilled and find out the various geological horizons/strata, and thereafter determine promising geological horizons for methane capture and recovery.

9. Two Phase well testing tool
The Two Phase well testing tool is a testing tool for boreholes/wells to find out the probable/estimated methane yield.

10. Hydro-fracturing unit
The hydro-fracturing unit is required for fracturing coal seams and strata around it to increase and maximize the liberation of methane gas.

11. High capacity pumps

The high capacity pumps (total no.16) will be required to pump water at high pressure to liberate methane from pores where it is absorbed/adsorbed.

12. Adsorption systems

Adsorption systems are required to study the methane adsorption capacity of coal seam/seams and surrounding strata in various locations in the field.

13. Gas chromatograph

The gas chromatograph will be required to study the gas contents and concentration.

14. Lab permeameter

The lab permeameter is used for the testing permeability of strata.

15 and 16. Field work station and Hqr. field station

Field work station and headquarters field station are workstations to be put at field site and field headquarters for coordination and implementation of various functions and field activities including data recording of drilling, logging, field listing for gas yield study and production etc.

17 and 18. Modeling software and Data processing, mapping and illustration systems

Modeling software and data processing, mapping and illustration systems will be used during the planning phase as well as during the field activities including drilling of boreholes/wells from surface and underground geological and geophysical logs of strata, and collection of related data, e.g. on permeability of various rocks and strata over- and underlying coal seams, adsorption/absorption capability of coal seams and strata yield of gas etc. Based on the collected data, reservoir modeling for methane availability and modeling for likely yield under similar geological set up will be undertaken. Appropriate computer software for this purpose will be procured to suit the Indian geological set up. Choice of appropriate software will be feasible after training of various teams and in consultation with relevant experts as provided in activity 1.1.1, 1.2.2, and 1.2.3 etc.

19. Portable cabins

Six portable cabins will be provided for housing drilling site offices, and stores for various items. These portable cabins will be modular units of about 400 sq.ft. area each which can be joined to increase or reduce the spaces as per the field site requirements.

20. National Procurement ($ 469,000)

National procurement would include part drilling accessories, work stations, portable cabins, air-conditioners, and costs for transporting the equipment from port landing to site, etc.

Annexure 6A

Economic Viability of CBM Recovery and Utilization Project in India

The project's sustainability in the long run will be determined by the future costs of gas extraction, and the potential revenue streams. Once the GEF initiative is completed, these are anticipated to be very favorable. The scope of the coal-bed methane resource in India is significant on both a national and global scale.

Potential for Cost Reductions in Gas Extraction:

The post-GEF phase costs of the project are expected to be lowered quickly and considerably in comparison to the demonstration phase, on three counts:

- The **" finding costs"** (term used in the CBM literature) go down as improved data base provides a exploration guide, identifying a set of "recognition" criterion for areas with good prospects of finding gas and it is recovered by running fewer tests than the initial years. With the back up data and built up information base, the frequency of ending up with dry spots reduces and finding sweet spots go up. The training and the skill formation goes a long way in ensuring more refined capability of turning gas reserves to resource. International experience has shown finding costs to drop on an average within a period of five years by more than $15 per mt drilled. The mix of output from horizontal, gob and vertical wells will determine the actual costs.

- The **capital costs** per m3 of gas recovered will also be lowered. Because of the geophysical log information built up over the years, and the tabulation of fraccing results, not only does the number of holes drilled per unit of gas recovered go down, the cost per drill hole goes down too. Instances like losing the entire bore hole or the equipment become far and few. This reduces the capital cost. Experiences at successful sites within the USA has shown the cost of drilling wells to have reduced by 50% of the original cost in a 5 year period. While the finding costs in the US are currently in the range of 90 cents per thousand cubic ft, the cost per ton of carbon avoided is currently stabilized at $2.5 to $3.

- Once experience and technical expertise in the operation of CBM drilling rigs has reached a sufficient threshold size, the **productivity** of the drilling teams will be substantially increased, thereby decreasing further the operating costs. This will result in the development of commercial drilling operations whose overall productivity will be higher than that achievable in a demonstration-project context.

The following cost and output mixes are envisaged in the present exercise. The costs are drawn on the total meterage to be drilled i.e. approximately linear 42000 mts. The final column provides an estimate of what the eventual extraction cost might be after project success. Although we do not expect these cost reductions to be achieved within five years (as was the US case), we would expect them to be eventually achieved within the lifetime of the project. The current price of gas stands at $85.50 Mm3 (HBJ pipeline, charged by GAIL from consumers other than the fertilizer industry). As shown in the table below, 73% of the output in the present exercise is from sites where extraction costs are already below the price received by the primary producer and distributor of gas.

Drilling Method	Output Mm3	Cost Range $/Mm3	Expected Extraction Costs $/Mm3
Vertical well	36	130 to 132	~65
Gob Well	68	44 to 46	~22
Horizontal well (Virgin Coal)	30	58 to 70	~29

Potential for gas recovery:

As explained, the capital costs of recovering gas declines with time as **larger volume of gas is recovered** per drill hole. The demonstration sites of the present project assesses the potential for gas recovery by taking the most conservative estimate from deploying 3 drills.(Of the schedule of holes per drill, we assumed at least 45% will fail to begin with) and is expected to give 134 million m3 of gas from an area of 5km * 15km. Gas content data and an Isotherm index in the region (covering 10 times the surface area) indicated 6-8 billion m3 of gas resources. Even if the ratio of the RRR (resource recovery rate) to reserve is assumed to be 10%, the potential for gas recovery ranges up to 600 million m3, in the neighborhood of the sample sites.[2]

Thus, lowering of costs is matched by an increasing revenue stream from harvesting of gas, as higher mine depths encounter increasingly gassy seams. For the sample mines in the present study, it is expected that once the year beyond which the concentration of methane in ventilation air has reached its maximum (at 2%), it is necessary for a higher volume of gas to be harvested.

Potential Revenues

On a very conservative note, the project shows a **net revenue of $ 1.96 million** on the basis of the savings enjoyed by the sample mines if the gas recovered is predominantly used for producing their own power from fuel cell and IC engine generators. As a demonstration of gas being used for bi-fuel systems, a fleet of representative size dumpers will be converted from the diesel system, using 3% of the gas. The diesel displaced is valued at the international price and the so is the well head gas price. It is interesting to note in columns two and three **(see Annex 6B)** the scale advantages lowering the cost of carbon saved, due to increase in the size of dumpers. With increased thrust on opencast mining, the industry is preparing to move towards fleet conversion to larger size and the reduction of cost of carbon avoided due to scale, adds to the

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2 For the sites examined time series of ventilation data, methane concentration data and bore hole data from premining areas were put together. The in situ gas content in the region under study is known to be 14 standard m3/tonne (10 makes it gassy of degree three), where as the specific emission is as high as 29 m3/tonne(Moonidih). This is evident among the underground mines in the eastern region of the country, rich with superior grade prime and medium coking coal. The underground mines contribute
43% of the coal output in this region as against 26% of the national average. In comparison to the UG mines in the region the average gas content for non coking coal strip mines is as low as 3-5 m3.

sustainability of the project. The costs of trying out this particular end use option was included since the conversion technology is not currently available in the country and there exists a strong possibility of public-private sector partnership collaboration in developing it. While the cost of installing the fueling station is borne by the Govt. of India ($1.89 million), the conversion cost of $300 thousand is expected to be borne by GEF resources.

During the demonstration phase it is felt that most of the gas will be used for on site and near-site power generation not requiring major infrastructural support. The benefit stream of power is calculated on the basis of avoided cost (i.e., the NPV of the price at which the mine will be able to buy and sell power, $0.04/kWh). Currently electric utilities in the state produce or purchase power at two and a half cents per kWh and sell it at an average of four cents per kWh. The NPV has been calculated on the basis of these prices. In several neighboring states, the purchase prices negotiated with IPP's have gone up to 7.5 cents. If similar prices are put in place in Bihar (which is expected because of the acute power shortage), the profitability of the activity increases even more.

If gas were to be piped and consumed by the industries concentrated heavily in the area, the current sale price of $0.026 cents per '000 cubic feet offered by GAIL (i.e., equivalent to $0.0225/kWh) approximates the avoided cost of two and a half cents per kWh. The GAIL however has expressed a firm commitment to enter into negotiated price regime with individual consumers, in the event enhanced scale of operation dealing with methane gas matures. This is well in line with IPP agreements for the electricity sector..

Potential Profitability

Table 3 in the text presents 4 different scenario cases demonstrating the potential profitability of the project. **Case 1** in the table corresponds to the situation being presented by this project. Learning costs are high and all capital and recurrent costs are met by project funds. The net present value of the project under these assumptions are a $(-) 11.9 million, roughly equivalent to the gross incremental cost presented in Annex 1. As a result, the initial profitability is low. **Case 2** corresponds to a case where the learning costs are still high, but all drilling services are obtained from a leasing company which charges only recurrent costs, including a fee for the amortization of the drilling equipment. Profitability under these assumptions is still very weak, and the incremental costs would also be negative. **Case 3** represents the post-project situation, where sufficient training and institutional capacity-building has occurred to lower the finding costs (i.e., fewer unsuccessful wells will be drilled). As a result of the national capacity being built up by the project, the gas yields (and therefore the revenues from CNG substitution and electricity generation) are considerably higher than in Cases 1 and 2. Profitability is therefore much higher, with a NPV of approximately $5.3 million. **Case 4** includes both the drilling/leasing company and the post-project situation to demonstrate approximately the commercial viability of the coal-bed methane enterprise. The NPV of this future enterprise-- which is able to take advantage of higher skills and the economic advantages of leasing services-- is estimated at over $10 million.

TABLE 3: NET CASH FLOW SCENARIOS

SCENARIO DESCRIPTION	PRESENT VALUE OF COSTS		PRESENT VALUE OF REVENUES		NET PRESENT VALUE
	Capital Costs	*Recurrent Costs*	*From Electricity*	*From Gas*	
CASE 1 - PROJECT CASE Project pays for full capital and recurrent costs for drilling--Relatively low yields and returns from electricity and CNG use due to high learning costs	($6,053,571)	($7,883,081)	$1,462,023	$495,744	($11,978,885)
CASE 2 - LEASING COMPANY CASE Project pays for only recurrent costs of drilling-leasing subcontractor provides service--Low yields due to high learning costs, same as in Case 1	$0	($8,868,466)	$1,462,023	$495,744	($6,910,699)
CASE 3 - INCREASED YIELDS: COMMERCIAL OPERATION Commercial viability achievable even if project must account for all capital and recurrent costs following the completion of the GEF project as improved training and skill levels will lead to higher yields (lower search costs).	($6,053,571)	($7,883,081)	$14,737,187	$4,461,700	$5,262,235
CASE 4 INCREASED YIELDS AND LEASING COMPANY- -Recurrent costs only as leasing company covers capital costs. Higher yields due to higher skill levels as in Case 3.	$0	($8,868,466)	$14,737,187	$4,461,700	$10,330,421

Carbon Emissions Avoided

	1000 m^3 CH_4 Recovered	Density of CH_4 in t/m^3	% of C in CH_4	Tons of Carbon	Radiative Forcing Index	CH4 Converted as a 100% Substitution for Coal, %0 for Diesel 50 t Dumper Tons of Carbon Equivalency using the RFI Index for CH_4	CH4 Converted as a 97% Substitution for Coal, 3% for Diesel 50 t Dumper Tons of Carbon Equivalency using the RFI Index for CH_4	CH4 Converted as a 93% Substitution for Coal, 7% for Diesel 85 t Dumper Tons of Carbon Equivalency using the RFI Index for CH_4	CH4 Converted as a 87% Substitution for Coal, 13%for Diesel 120 t Dumper Tons of Carbon Equivalency using the RFI Index for CH_4
	134,000	0.662	75%	66,531	21	1,397,151	1,397,151	1,397,151	1,397,151
Assume combustion efficiency of methane at 100% equivalence of methane recovered in power at 9.31 MWh/ MMm3=					1,246,200				
Assume combustion efficiency or coal at 95% Equivalent of tons of coal for energy conversion 8.14 MWh/ton of coal =					145,441		140,399	135,615	135,615
Tons of carbon avoided by using methane substitute for coal with 88% fixed carbon						127,988	123,551	119,341	119,341
Tons of carbon avoided by using methane substitute for diesel @ 0.001608 tCO_2/t of diesel							2.59	5.04	9.74
Tons of carbon released as methane if coal is mined containing $13m^3/t$						20,652	19,937	19,257	19,257
Tons of carbon released during combustion of methane =						(66,531)	(66,531)	(66,531)	(66,531)
						(939)	(939)	(939)	(939)
					Net Carbon Avoided	1,478,321	1,473,171	1,468,284	1,468,288
					Estimated Alternative Cost	$10,880,000	$10,880,001	$10,880,002	$10,880,003
					Net Present Value of Revenues for Power Projects	$1,507,240	$1,462,023	$1,401,733	$1,311,299
					Net Present Value of Savings for CNG Project		$495,744	$966,147	$1,865,649
					Total Savings		$1,957,767	$2,367.880	$3,176,948
					Net Incremental	$9,372,760	$8,922,234	$8,512,122,	$7,703,056
					Cost per ton of Carbon	$6.34	$6.05	$5.79	$5.24
					Increase in Cost due to increase in Diesel Substitution		-4.5%	-8.6%	-17.3%

Annexure 7

INCREMENTAL COSTS

1.1 Broad Development Goals:

The broad development goals being pursued by this project is the provision of capacity building and technical assistance to India to enhance coalbed methane recovery and utilization opportunities. This will provide additional energy resources to the economy where approximately 16% of the energy demand is unsatisfied. The generation of energy will be achieved in a decentralized manner which will avoid the current problem of transmission and distribution loss faced by the conventional grid based electricity. Such a goal can only be achieved if the coal industry in the country adopts methane recovery as a by product of coal production activities and uses the energy source efficiently. The private sector has shown keen interest in the resource but has not met with success yet Mobilizing them to ensure productive end use of the methane recovered will ensure the success of the development goal.

1.2 Baseline:

Under the baseline, the coal mining industry, which is largely nationalized will undertake some mining operations that are common to the processes relevant for producing coal alone or producing coal as well as methane. These will include standard drilling activities and maintenance of degasification operations necessary for mine safety. However the mine safety regulations do not need as much drilling initiative in terms of skill number of boreholes and drilling techniques as needed for the economic recovery of in seam methane Therefore the necessary resources and the effort needed to achieve the later will not be forth coming from the nationalized coal company which is focused primarily on increasing mine production.

Some aspects of training and skill formation is regularly undertaken in the mining industry, but this too is not guided towards the very specific skills and expertise needed for methane recovery. Under this projects UNDP IPF resources are to be funding the special capacity building needs in the project as part of its country programme initiative.

1.3 Global Environment Objectives:

The global environment objective being pursued is the reduction of GHG emission under the short term category where the cost effective GHG reduction option of methane recovery is currently not undertaken primarily due to the lack of skill, training and access to relevant technology .The capacity to assess and access the maximum quantity of the inseam gas without damaging coal resource is not available in the country. As a mitigation option it is attractive because of the low $ cost of carbon saved if only the resource could be harnessed. Even in the case of sites where coal resources are exhausted, harnessing of methane will stop it from slow escape into the atmosphere

Since the potential options for the recovered gas are very high, the capability to recover it will ensure cost recovery of such initiatives. In the long run mines will find it an asset to generate revenue from this additional energy resource hitherto allowed to go to waste.

Since the project is cost effective and is a priority in the national mitigation strategy with a high probability of success (methane recovery has worked in a commercial basis in countries like the US and Australia), it is considered consistent with the GEF short-term projects concept.

1.4 GEF Project Activities

The GEF project activities are described in detail in the following table. They have been designed to provide for activities that are specific to technology transfer and their application in the context of mining characteristics commonly found in the eastern region of the coal fields in India .Two specific mine fields have been selected for this purpose after screening nine candidate fields. The screening criterion consisted of geological characteristic of the seam, mining technique currently being applied, the permeability of the coal, the expected life of the mine area, the depth of the seam, the gaseousness of the seams and the locational advantages for the end users. The gas recovery techniques are different depending on the stage of mine life. viz. recovery prior to mining, during mining and after mining. The GEF funds will be accessed to demonstrate recovery of gas from all three categories.

1.5 System Boundary:

The project is being discussed in the context of the Indian economy and its energy system. The incremental cost table represents the costs of undertaking a technical assistance cum demonstration project that will show the complete process of coal bed methane harnessing activities and its successful utilization possibilities.

1.6 Incremental Cost Matrix:

As shown in the incremental cost matrix the baseline project costs are funded by the Government of India ($4.544 million) and UNDP resources to the tune of $1.214 million. The cash resources from the GoI are also complemented by in-kind contribution worth $2.321 million. The UNDP resources cover for typical capacity building activities like training, information base, and laboratory facilities. The GoI will provide for the regular drilling operations' expenses, wages and salaries and training expenses of the project personnel. Any incremental effort needed for the recovery of the CBM and not covered by the revenue stream from the project will be funded by the GEF. The following table illustrates itemized allocation of total project resources in cash and kind. The net revenue generated from the production and sale of electricity and substitution of diesel by CNG in the dumper fleet has been deducted from the funding request made of the GEF.

Incremental Cost Matrix

COMPONENT	BASELINE	ALTERNATIVE	INCREMENTAL
Global Environmental Benefits	• Increases willingness and preparedness to utilize methane as a potential source of clean fuel.; • lowers CO2 emissions	• Increases awareness of global consequences of CBM emissions as well as opportunities for its utilization; • Affords synergistic approach to common problems in recovery and use of CBM; • New technology to improve gas yields; • Lowers emissions of coal-bed methane; • Lowers CO2 emissions and increases power generation efficiency; • Lowers CBM emissions which may in the long run lower CO2 emissions; • Increases energy supply ,encourages fuel substitution; and • Develop skills for lowering CBM emissions and recovering more CBM	• New technology use to improve yield of gas. • Lowers emissions of coal mine methane to the atmosphere • Lowers CO_2 emissions and increases power generation efficiency.; • Lowers CBM emissions and in the long run lowers CO_2 emissions; • Increases energy supply and encourages fuel substitution. • Contributes to development of skills that lower the present level of CBM emissions and prepares India to recover additional quantities of methane as mining depths increase.
Domestic Benefits	• Increases CBM resources development skills and encourages use of gas. • CMPDIL Center better able to carry out development and use of CBM; • Links India to world body of knowledge on CBM; • Expanded info & experience re: CBM leading to resources development skills • Encourages the development of comprehensive resource utilization plan • Recovers wasted resources, increases mine safety • Improves fleet efficiency, therefore mine output • Limited substitution of gas for diesel • Increases probability of sustainable CBM development • Encourages information exchange and introduces potential investors to India's CBM resource. • Increases capacity for development of clean burning indigenous resource, recovers wasted resources and increases mine safety.	• Expanded info & experience re: CBM leading to resources development skills • Encourages use of gas • Improves upon existing mine safety conditions; • Encourages the development of comprehensive resource utilization plan • Improves upon existing mine safety conditions. • Encourages the use of a clean burning fuel for transports; • Substitutes gas for low quality coal used for power generation. • Lowers particulates. • Increases power generation efficiency and provides decentralized power. • Encourages information exchange and introduces potential investors to India's CBM resource.	• Expanded info & experience re: CBM leading to resources development skills and encourages the use of gas

Incremental Cost Matrix (continued)

COSTS (US$000)	BASELINE COSTS	ALTERNATIVE COSTS	INCREMENTAL COSTS
Activities 1.1 & 1.2: Train CMPDIL cell in for development/ use of CBM & establish CBM Info System	424 (UNDP) 14 (GOI cash) 221 (GOI in-kind)	424 (UNDP) 14 (GOI cash) 221 (GOI in-kind)	NONE
Activities 2.1 and 2.2 Choose & train members of CBM Project Team and Plan & Apply best strategies for CBM dev't	420 (UNDP) 70 (GoI cash) 300 (GOI in-kind)	360 + 420 (UNDP) + 70 (GoI cash) + 300 (GoI in-kind)	360
Activities 3.1; 3.2; & 3.3 Drill vertical wells ahead of mining; Drill vertical wells into gob in mined-out areas; and Drill horizontal drainage boreholes into coal seams and overlying strata	2,470 (GOI cash) 500 GOI in-kind)	8,270 + 2,470 (GoI) + 500 (GoI in-kind)	8,270
Activities 4.1 & 4.2 Collect, transport, and compress high heating value gas from wells drilled in Activity 3.1 for use as vehicle fuel and Collect & transport med. heating value gas produced in Activity 3.2 to stationary IC gensets	900 (GOI in-kind) 1,990 (GOI cash) 330 (UNDP)	900 (GOI in-kind) 1,990 (GOI cash) 330 (UNDP)	NONE
Activities 5 & 6 Develop & adopt action plan for replication of demonstration project and Establish CBM clearinghouse to disseminate info & facilitate cooperation	40 (UNDP) 400(GOI in-kind)	2,250 40 (UNDP) 400(GOI in-kind)	2,250
Totals	4,544 (GOI cash) 2,321 (GoI In kind) 1,214 (UNDP)	10,880 4,544 (GoI Cash) 2,321 (GoI in-kind) 1,214 (UNDP)	10,880
LESS: Revenue from sales of electricity and diesel substitution			(1,960)
Net incremental costs			8,920
Plus: Executing Agency Support Costs (3%)			267.6
Incremental Request from GEF			9,187