REVIEW OF THE UNDP/GEF PROJECT
IND/98/G34
COAL-BED METHANE RECOVERY AND COMMERCIAL UTILIZATION

FINAL VERSION
31/11/2004

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International consultant      National consultant
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>BCCL</td>
<td>Bharat Coking Coal, Ltd.</td>
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<td>CBM</td>
<td>Coal-bed methane</td>
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<td>CDM</td>
<td>Clean Development Mechanism</td>
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<tr>
<td>CIL</td>
<td>Coal India Ltd.</td>
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<tr>
<td>CH₄</td>
<td>methane</td>
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<td>CMRI</td>
<td>Central Mining Research Institute</td>
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<tr>
<td>CO₂</td>
<td>carbon dioxide</td>
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<tr>
<td>CMPDI</td>
<td>Central Mine Planning and Design Institute, Ltd.</td>
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<tr>
<td>DGMS</td>
<td>Directorate-General of Mines Safety</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<tr>
<td>GHG</td>
<td>greenhouse gas</td>
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<td>GoI</td>
<td>Government of India</td>
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<td>ISM</td>
<td>Indian School of Mines</td>
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<td>Ltd.</td>
<td>Limited</td>
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<tr>
<td>MOC</td>
<td>Ministry of Coal</td>
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<tr>
<td>MW</td>
<td>megawatt (1 million Watt)</td>
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<td>ONGC</td>
<td>Oil and Natural Gas Corporation, Ltd.</td>
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<td>PIR-APR</td>
<td>Project Implementation Report – Annual Progress Report</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<td>UNIDO</td>
<td>United Nations Industrial Development Organization</td>
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<tr>
<td>UNDP</td>
<td>United National Development Programme</td>
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<tr>
<td>USD</td>
<td>United States dollar</td>
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EXECUTIVE SUMMARY

This is a mid-term Evaluation Report of the project Coal-Bed Methane Recovery and Commercial Utilisation in India (project number IND/98/G34. It was prepared by Mr. Jan van den Akker and Dr. A.K. Dube. It is based upon review of the documentation developed under the project and interviews with staff of the multilateral agencies involved (UN Development Programme, UNDP and the UN Industrial Development Organization, UNIDO, the Indian project leadership (Ministry of Coal and Coal India Ltd.) and the project implementing agencies (Central Mine Planning and Design Institute, CMPDI and Bharat Coking Coal, BCCL). The project is being funded by the Global Environment Facility (GEF), UNDP and the Government of India with a budget of USD 15 million. The main objective is the reduction of methane emission by demonstrating and developing the capabilities in India to effectively capture and utilise coal-bed methane (CBM).

The project document was signed in June 1998. According to GEF regulations, an external review is needed during the course of the project to assess the progress of project implementation, the impacts and relevance of the project as well as lessons, if any, to be learned. To this end, a comprehensive Terms of Reference was drawn up and an evaluation mission was fielded to India and Vienna in October 2004. The first part of the report of the evaluation team concerns the findings regarding project design and execution, and the second the conclusions and recommendations.

Regarding project execution, the project has had long delays, mainly due to the procurement of the drilling and gas recovery equipment. The project effectively started in September 1999 when it was officially sanctioned by the Government. Initially foreseen to end by September 2004, the bulk of activities, especially the vertical well and horizontal underground drilling, gas recovery and its subsequent utilisation on-site as fuel, still had to be implemented to date. A number of factors have caused this, including (1) delays in project initiation (time needed to subcontract UNIDO to provide technical backstopping and equipment procurement services as well as drawing up specifications and packages for the equipment to be tendered), (2) gaps in project design as given in the UNDP-GEF project document (the equipment, estimated at USD 8 million, turned out to cost USD 12-13 million and the gap was met by securing additional funds, downsizing the project and budget adjustments) and (3) time over-run in the tendering and procurement process (flexibility to react to changing circumstances has at time been slow as UNIDO has to follow its own procurement and contracting regulations, while their has often been low response to tenders by equipment providers.

With most of the essential drilling and gas recovery equipment purchased or being processed, this main hurdle has now been removed, and, with the first sites being prepared, the project appears ready to start the drilling operations (at the Moonidih and Sudamidih mines in the state of Jharkand, nearby its capital Ranchi). Given the fact that project partners CMPDI and BCCL are enthusiastically working, together as well as with the external partner Oil and Natural Gas Corporation (ONGC), and given the fact that project is actively supported by the UNDP Country Office and the Ministry of Coal, the evaluation team believes that the long delay in project initiation and equipment procurement, should not overshadow the project’s implementation in the years to come and the project should be extended by three years (2005-2007). The project’s objective remain valid, especially in the light of interest shown by Indian private sector in CBM project development and the expected entry into force of the Kyoto Protocol will raise interest in CBM internationally as an investment opportunity under its Clean Development Mechanism.

In principle, the project budget appears to be adequate currently, but looking at the forthcoming events and the contingencies for a complex project like this one, more funds may be needed at some stage in the later years in order to achieve its planned outputs. There is an urgent need therefore to prepare a detailed work plan and budget for the remaining part of the work with a logical framework of time-planned activities and critical assumptions, indicating the resources needed and budget available.
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1. INTRODUCTION

1.1 Background

Methane and coal are formed together during coalification, a process in which plant biomass is converted by biological and geological forces into coal. Methane is adsorbed in coal seams and the surrounding strata and released during coal mining. Deeper coal seams contain much larger amounts of methane than shallow seams. Small amounts of methane are also released during the processing, transport, and storage of coal.

The knowledge of methane occurring with coal beds is as old as the mining itself. However, initially it was treated more as a hazard than a resource. Being highly explosive in certain proportions, coal mines have faced many explosions in the past due to this gas, due to lack of proper ventilation in mines. High capacity fans are used to dilute the gas during mining and the mixture is released into the atmosphere. Thus, the resource is not only lost, being a greenhouse gas, it contributes to the global warming. Although the volume of methane (CH$_4$) contribution to the world’s greenhouse gas (GHG) emissions is three times smaller than that of carbon dioxide, at the same time, methane is a particularly strong GHG, its greenhouse potential is 21 times higher than that of carbon dioxide CO$_2$. Coal mining is reported to be contributing about nine percent of the total methane emissions.

If captured, methane forms a remarkably clean fuel when burnt, the combustion process of methane produces no particulates and only about half of the carbon dioxide associated with coal combustion. Coal-bed methane (CBM) extraction involves drilling wells down to target coal beds. Methane recovery technologies include vertical wells drilled from the surface or boreholes drilled from inside of the mines. Depending on gas quality, methane recovered from underground mines may be sold to natural gas companies, used to generate electricity, used on-site as fuel for drying coal, used to run vehicles or sold to nearby industrial, domestic or commercial facilities. Experts feel that if suitably harnessed, CBM associated with coal reserves could be a significant potential source of energy. In the U.S.A., for example, coal-bed methane accounts for between 3 and 4 percent of all gas production in the country. Thus, CBM can 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. Open-cast production accounts for 74% of the total output and the remaining 26% is met by underground mining. Especially, the underground coal reserves of the eastern belt are highly gassy. As per a geological assessment of coal/lignite basins in India, carried out by Reliance Gas, around 20,000 square kilometres of area has been identified as prospective for CBM exploitation. Recoverable CBM reserves are estimated at 800 billion cubic metres with gas production potential of 105 million cubic metres a day over a period of 20 years.

1.2 Project description and objectives

Investigation on CBM for its commercial exploitation is a comparatively recent phenomenon in India. It was mooted by the Ministry of Coal, Government of India, way back in 1994.

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1 Various underground mines are listed as Degree III mines, where the rate of emission exceeds 10 m$^3$/tonne of coal output.
2 The Hindu, 14 January 1999
when several companies from India and abroad showed keen interest in the subject, such as Reliance Gas (P) Ltd, Modi McKenzie and Amoco. However, though the blocks were allotted to some of them by the Ministry of Coal, it was discovered that the resource came under the authority of the Ministry of Petroleum and Natural Gas (MoPNG). Finally, the MoPNG was entrusted with the responsibility of framing the policy for the development and use of CBM in India. However, collieries under which there are prospects of CBM exploitation fall under the Ministry of Coal and the Coal India Ltd. (CIL). In the period 1997–2000, the Oil and Natural Gas Corporation (ONGC) drilled some test holes and found substantial amount of gas in state of Jharkand, in the Parbatpur block. The boreholes were capped after flaring of the gas for some time and search started for the technology for its exploitation and customer for its utilization.

In the mean time, a CIL subsidiary, the CMPDI (Central Mine Planning and Design Institute), sought the necessary permission from the government to start off a demonstration project on ‘CBM recovery and commercial utilization’ with assistance from the United Nations Development Programme (UNDP) and Global Environment Facility (GEF). The project document was prepared by a group of consultants in 1997 – 98 and was approved by UNDP in April 1998. The purpose of the project is to demonstrate the commercial feasibility of recovering and utilizing methane recovered from coal strata, before, during and after coal mining. The project became operational in September 1999 with an envisaged duration of five years. It has three budget components:

- UNDP USD 1,210,000
- GEF USD 9,198,000 (including USD 82,633 of preparatory assistance)
- Government USD 4,544,000 (in cash)
- Government USD 2,321,000 (in kind)
- TOTAL: USD 17,273,000

The emphasis of the project is put on four objectives:

1. Capability building of relevant institutions to develop and support CBM recovery and utilisation projects
2. Investigation and demonstration of CBM recovery at the Moonidih and Sudamdih coal mines located in the Jharia coalfield in Jharkand, using different drilling technologies
3. Demonstrate the utilisation of the recovered gas for energy purposes, i.e., electric power generation and vehicle refuelling
4. Development and adoption of an action plan for replication and setting up of a CBM clearinghouse.

1.3 Review method

The project work started in early 1999, but than has faced serious time constraints due to delay in equipment procurement and budget problems that will be detailed in the next chapter. The activities have been scaled down and the actual extraction process may start only by early 2005, more than half a year after the project was supposed to end. The Programme Rules of the GEF (Global Environment Facility) require a mid-term evaluation, under the responsibility of the implementing agency, in this case the United Nations Development Programme (UNDP). In order to evaluate the progress made and to make recommendations

3 Later, ONGC made an additional contribution of USD 2.69 million, bringing the total finance to USD 19.96 million.
for future action, an external review of the project’s design, implementation and its relevance for coal-bed methane development in India was deemed to be the appropriate step.

During the mission, the external evaluation mission drew up a table of contents (ToC) that covers the issues to be addressed as mentioned in its Terms of Reference (see Annex A) and follows the structure of this report:

- Introduction (project description and background)
- Findings on project progress
  - Implementation in terms of achieving objectives, inputs, activities, outputs, outcomes and impact and measurement against indicators (as set in the project document and the National Steering Committee of the project), especially the processes/procedures explaining the delays in equipment procurement
  - Utilisation of resources (inputs, human as well as financial) towards producing outputs, in particular regarding the selection of equipment and equipment budget
  - Appropriateness of the institutional arrangement
  - Assessment of project objectives, expected outcome and impacts of the project, taken into account sustainability and replicability issues
  - Relevance of the CBM project in terms of replicability and commercial viability, interest in the private sector and of contribution to GEF’s overall objective of greenhouse gas emission reduction
- Conclusions and recommendations
  - Conclusions and lessons learned
  - Recommendations

During the mission’s 15-day travel to Delhi, Ranchi, Dhanbad, Calcutta (India) and to Vienna (Austria), extensive interviews and discussions were held with all the relevant project partners and, where appropriate, requests for relevant documents and missing information were made. We also requested (via e-mail) additional information. The mission took place from 1-10 October (India) and 11-14 October (Vienna). The envisaged presentation and discussions of the draft mission report with government officials and project staff during 14-15 October had to be postponed due to unavailability of the responsible government officials. The mission’s schedule is detailed in Annex C. For this purpose, a second mission took place on 9-11 November 2004.

1.4 Project set-up and project partners

The Ministry of Coal (MOC) has the responsibility for the exploration and development of coal and lignite resources in India, and for all matters relating to production, supply and distribution of coal. The Ministry has under its administrative control the Coal India Limited (CIL), which has seven coal producing subsidiaries and the Central Mining Planning and Design Institute (CMPDI). The CIL and its producing subsidiaries account for about 88 percent of coal production in the country. Project management and implementation involves a number of executing and implementing agencies, as described in figure 1 and whose roles are summarized in the text below:

- The Global Environment Facility (GEF) and the United Nations Development Programme (UNDP), as the GEF Implementing Agency, are the collaborators of the project with the Government of India (GoI). UNDP provides overall management and guidance from its New Delhi country office and is responsible for monitoring and evaluation of the project as per normal GEF and UNDP requirements.
The (CMPDI), a subsidiary of the public sector company Coal India Ltd. (CIL) is the main implementing agency. CMPDI has formulated and coordinated the project from its inception. CMPDI works under the leadership and supervision of the Ministry of Coal.

Bharat Coking Coal Ltd (BCCL), a coal-producing CIL subsidiary, is the co-implementing agency. BCCL participated in the project formulation process as well and plays a major role in implementing field trials at the two specific mine sites at Moonidih and Sudamdih.

After project inception, an agreement was reached in February 2000, involving United Nations Industrial Development Organisation (UNIDO) in the execution of the project, providing technical supervising (international experts) and equipment procurement services (from the UNDP/GEF budget). UNIDO contracts the Chief Technical Advisor (CTA) and other international experts that have assisted in preparing the various tender packages and technical specifications for equipment and in the evaluation of bids.

The project partners rely on variety of universities and technology institutes of repute to perform part of the study, research and engineering work, including the Indian School of Mines and the Central Mining Research Institute (CMRI), both based in Dhanbad.

Also, the Oil and Natural Gas Corporation (ONGC), a public sector company, has been involved at a later stage by providing additional budget and support for equipment procurement and support when the drilling and gas recovery operations will start.

A National Steering Committee is set up under the chair of the Ministry of Coal, providing guidance and supervision on the project implementation. The Committee is convened by the Additional Secretary who is the Project Director, responsible for monitoring and adherence of the project’s work plan. The Committee has met four times so far; its last meeting was in May 2004. The Project Director is assisted by the Project Advisor (CBM) to carry out coordination with various government ministries and agencies, provide guidance to the project team, to coordinate with UNDP and UNIDO, to review reports and to look after administrative arrangements required under the GoI, UNDP and UNIDO procedures.

Two other Committees provide a forum for programming, review and measures on operational issues:

- The Operational Executive Steering Committee, convened by the Chief Project Manager and consisting of representatives of the implementing agencies (CMPDI and BCCL) and the Directorate General of Mines Safety (DGMS) for reviewing the work progress on a regular basis,

- The Policy Advisory Committee is a forum to discuss broader policy issues and also to seek inputs from other organisations, besides the institutions involved in the project.
GEF implementing agency: United Nations Development Programme (UNDP)

National Steering Committee:
- Chair: Secretary, MOC
- Members:
  - Res Rep. (UNDP)
  - Jt. Secr. (MOEF)
  - D.G. (Mines Safety)
  - Chair (Coal India)
  - C.M.D. (CMPDIL)
  - C.M.D. (BCCL)
  - Jt. Secr. (DEA)
- Convener: National Project Director, Project Advisor

Executing Agency: Government of India Ministry of Coal Coal India Ltd.

Project Advisor CBM

Local Implementing Agencies:
- Central Mine Planning & Design Institute Ltd. (CMPDIL)
- Bharat Coking Coal Ltd. (BCCL)

Project Management Cell

Chief Technical Advisor (CTA)

Chief Project Manager (CPM)

- Manager CMPDIL
- Manager BCCL Moonidih mine
- Administrative and Finance Manager
- Manager BCCL Sudamdih mine

International consultants

National consultants

Operational Steering Committee
- Chair (by rotation): C.M.D. (CMPDIL), C.M.D. (BCCL)
- Members:
  - Dr. (CIL)
  - D.G. (Mines Safety)
  - Project Advisor ONGC
- Convener: Chief Project Manager, Meeting monthly

Policy Advisory Committee
- Chair: Project Advisor
- Members:
  - C.M.D. (CMPDIL)
  - D.G. (Mines Safety)
  - C.M.D. (BCCL)
  - Dr. (CIL)
  - Central Mining Research Institute
  - Indian School of Mines
  - ONGC
  - FICCI
  - CII
  - CSIR
  - ASSO
  - Local and regional groups
  - State and local officials
  - Chief Technical Advisor
- Convener: Chief Project Manager

Oil and Natural Gas Corporation (ONGC)

United Nations Industrial Development Organizations (UNIDO)

Figure 1 Project implementation arrangements
2. FINDINGS

2.1 Implementation: outputs, activities and accomplishments

For each of the four project objectives, as mentioned in paragraph 2.1, this section assesses the implementation of the project, in terms of achieved outputs, activities finalized, inputs used and planned activities for 2004-2007.

Objective 1 Strengthen and increase capacity of CMPDI, BCCL, CMRI, MOC, CIL and other relevant organisations

Expected outputs (as defined in the 1998 UNDP project document):

<table>
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<tr>
<th>Output</th>
<th>Description</th>
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<tr>
<td>1.1</td>
<td>Members of CMPDI and BCCL trained in reservoir modelling and prediction of gas production parameters</td>
</tr>
<tr>
<td>1.2</td>
<td>Team members trained in latest vertical well drilling technology (including equipment specification to be purchased)</td>
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<tr>
<td>1.3</td>
<td>Team members trained in latest underground directional drilling (including equipment specification)</td>
</tr>
<tr>
<td>1.4</td>
<td>Team trained in use of CBM gas for power generation (including equipment specification)</td>
</tr>
<tr>
<td>1.5</td>
<td>Team trained in use of CBM gas in vehicle internal combustion engines (including equipment specification)</td>
</tr>
<tr>
<td>1.6</td>
<td>Team members trained to develop safety protocols on the technologies mentioned in 1.2-1.5</td>
</tr>
<tr>
<td>1.7</td>
<td>Team members CMPDI and ISM trained in the financial-economic assessment of CBM</td>
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Only three trainings have been carried out so far:
- Vertical drilling study tour to USA (March 2004, 2 weeks, 6 participants; output 1.2 in the UNDP project document)
- Training on laboratory coal testing in India, at OGNC (March 2003, 8 participants, 2 weeks; output 1.2)
- Training on mud chemistry at OGNC (November 2003, 2 weeks; output 1.2)
- Training of Surface Drilling (Class Room & Onsite) at ONGC for 2 weeks (November 2003)

The training activities in the project had to be rescheduled and reprogrammed for the following reasons. It turned out that CBM vertical and underground drilling technologies are quite specialised for which no ‘off-the-shelf’ courses are available. Most training has to be undertaken by the equipment providers. In addition, it has not been proven feasible to train staff in such a short period that they can confidently draft specifications for the drilling equipment. In most cases, the project’s international experts, together with the project management and staff, have made the terms of references and specifications for the equipment bidding packages (as is detailed further under “objective 2”).

Budget
Of the budget for available for group training (UNDP contribution, USD 180,000), some one-third was spent during 1991-2003 (see table 1 in paragraph 2.2.2)

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4 Training periods as projected in the project document in the form of study tours abroad would be too short for providers even to allow participants to touch the expensive drilling equipment, while staying longer abroad would have exhausted the budget
Future activities
Hence, the training remaining will have a strong ‘on-the-job’ component and partly be done as part of the equipment packages bids of the vertical and underground drilling and gas recovery exercises. In chronological order:

- Electric power generation study tour and training and natural-gas-fuelled vehicle training (end 2004, output 1.4)
- Safety trainings on vertical wells and underground drilling (output 1.4; mid-2005)
- Safety trainings on drainage and recovery system, compressed gas fuelling and internal combustion engine power generation (outputs 1.5 and 1.6)
- Reservoir modelling and training (output 1.1; mid-2005)
- Financial and economic assessment and modelling (output 1.7)

**Expected outputs (as defined in the 1998 UNDP project document):**

1.8 CBM Information System (library, Internet Gateway) installed at CMPDI
1.9 CMPDI, CIL, MOC Intranet installed at CMPDI
1.10 CBM Clearinghouse established

The activities are under implementation by CMPDI, i.e., the establishment of the Information System is under way (activity 1.10.1). A scheduled visit to China is under reconsideration, as the China Clearinghouse appears not be functioning anymore (activity 1.10.2).

**Objective 2  Prepare and execute CBM gas recovery demo projects on in the Jharia coalfield**

**Expected outputs (as defined in the 1998 UNDP project document):**

2.1 Fully equipped and trained unit for vertical well drilling
2.2 Plan for vertical well drilling into coal seams and advance of mining strata (Moonidih: 9; Sudamdidh: 8 wells)
2.3 Fully equipped drilling camp
2.4 Vertical wells located and drilled
2.5 Plan for vertical well drilling into sealed gob areas (10 wells)
2.6 Vertical gob wells drilled
2.7 Oxygen and CO monitoring system installed
2.8 Fully equipped and trained unit for underground directional drilling
2.9 Plan for directional drilling
2.10 Fully equipped centre of operations
2.11 Directionally drilled boreholes

Essentially, two important changes have occurred regarding the procurement of equipment and the drilling plan; the project has been downsized and there have been huge delays (of four years) in the procurement of equipment.

**Project methodology**
The project concept is to effectively capture methane in working coal mines. Two mining sites were identified by the two UNDP consultants that wrote the project document, Moonidih and Sudamdh in the Jharia coalfield of BCCL, located in the state of Jharkand. For developing the coal-bed methane, it has been proposed in the project document to:

- Pre-drain the gas in virgin coal seams by vertical well drilling (outputs 2.1-2.4)
- Recover gas from surface by vertical drilling in gob areas (outputs 2.5-2.6)
- Recover gas in-seam by long-hole underground directional drilling (outputs 2.8-2.11)

**Downsizing of the demonstration component of the project**
The first major change in the scope of the project relates to the physical and technical constraints at the two mining sites and subsequent reduction in the number of drilling sites:
• Vertical wells will be reduced from 17 to 7 (two at Sudamdih and 5 at Moonididh)\(^5\)
• Only one GOB well will be drilled (at Moonididh), instead of the envisaged ten (many areas have been stowed)
• There will be one underground drilling site at Moonididh and 2 sites at Sudamdih

Executing the project with the originally defined number of boreholes has not been practically feasible, due to the following reasons:
• Many areas are heavily built up and with ownership titles not belonging to the mine, which sets a limit on the sites that can be developed
• Underestimation of the budget needed for drilling equipment, as discussed in the next paragraph. Since only one vertical and one horizontal drilling systems were purchased instead of the original two per system, this has reduced the number of holes that can be drilled within the project period by half, and this ‘period’ has been reduced anyway from 2001-2004 to 2005-2007.

To our opinion, the project downsizing in terms of number of wells drilled should not affect the overall objectives, provided that the drilling proceeds as planned during 2005-2006 and that the wells actually produce the desired quantities of gas. The cost-benefit analysis might result to be less satisfactorily since fewer wells will be developed in view of the high investment cost in drilling equipment, but, such analysis would be preliminary anyway given the demonstration nature of the gas recovery operations.

**Budget for equipment**

A second major change concerns the budget for procurement of equipment. After the project inception, a field visit of the international expert team\(^6\) for drawing up the specifications of the equipment and for detailing the cost estimates. This clearly revealed that there was gross underestimation of the budget for equipment, estimated at around USD 13.87 million; in contrast, in the UNDP-GEF project document, the budget line available for UNIDO procurement of equipment was only USD 8.578 million\(^7\). To reduce the cost, it was decided to use one vertical drill rig instead of two\(^8\), one underground drill instead of two and leave out non-essential equipment (mud-logging system and two-phase testing tool), which yielded a cost reduction of USD 1.5 million. However, this still left a gap of USD 3.795 million, which was closed:

• In September 2002 an agreement was signed between ONGC and CMPDI & BCCL to co-share the cost of certain equipment, (although the funds were only repatriated to UNIDO by April 2003), adding a ONGC contribution of USD 2.698 million
• The remaining shortfall in funds of USD 1.097 million has been met by re-appropriation in the budgets, of which the Government of India will provide USD 1.049 million\(^9\), which was approved in May 2003.

It is important to mention that without the ONGC contribution of 2003 and without the budget re-appropriation of 2004, no sufficient budget would have been available for UNIDO.

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5. At Sudamdih the gas recovered from the vertical wells and underground systems will be piped to one collection centre at the mining site, where it will be fed into a compression unit. At Moonididh the vertical well and underground systems each will have their collection point.

6. CTA, Surface Drilling Expert, Underground drilling expert and Laboratory Expert

7. To illustrate this, the vertical drilling rig, estimated at USD 800,000, was purchased at USD 2.4 million; the hydrofracturing equipment, estimated at USD 700,000, was costing USD 4.4 million (see Annex B for a detailed list of equipment and its procurement progress

8. The first drill can also drill GOB wells, instead of using an additional lighter-weight drill, also in view of the fact that the number of planned GOB sites had been reduced in number from 10 to 1

9. GoI (cash): USD 1.049 million out of budget line 3a. (CBM utilization), UNDP-India, USD 0.043 from budget line 17 (national consultants) and UNDP-GEF: USD 0.005 from budget line (miscellaneous); see also table 1. In July USD 1.03 million from the GoI budget was transferred to UNIDO.
to continue the bidding process of the equipment (described in the next section), thus stalling project implementation. UNIDO’s regulations require sufficient funds to be in its bank account before it can tender and purchase equipment.

Procurement and acquisition of the equipment

The equipment procurement has been hampered by much delay. To get more insight in the causes of this delay (discussed further in paragraph 2.2.1), the following chronological order of events is important:

- Four packages\(^{10}\) were made initially to be tendered and the request for expression of interest was published in January 2001. However, few offers were received and those were not technically acceptable, often because no supplier could provide fully the equipment specified in each package (1\(^{st}\) round of tendering)
- UNIDO and the project partners than decided to organise a second round of tendering with of smaller packages, 26 to be tendered by UNIDO, 4 by CMRI and 5 by the Project. After redefining the packages, a global tender for the 26 packages of equipment was floated by UNIDO in November 2001. A description of the packages is given in Annex B. The evaluation was done during November 2001-January 2002 (2\(^{nd}\) round)
- Given the non-response and technical evaluation considerations, 14 packages had to re-issued by UNIDO in March-May 2002. Offers were received for 13 packages, whose evaluation was done in July 2002. Of these, one package had to be re-tendered and was evaluated November 2002 (3\(^{rd}\) round).
- The successful bidder in the 3\(^{rd}\) round for package #11 (vertical drilling rig), with a value of USD 2.4 million, declined, early June 2003 and re-bidding was initiated in July 2003. A total of 10 other packages were affected by the fact that they took longer to process than the 120 days validity period. According to UNIDO’s Contract Committee, extension of validity was not possible under UNIDO regulations, which led to another bidding process, initiated in December 2003. Of the 12 packages left, six packages (mainly surface equipment) were re-tendered in December 2003 (4\(^{th}\) round of tendering)
- Three packages were re-tendered in March 2004 and two packages were redrafted with new specifications. Of these five, offers were received for only three packages. Of these, two have bee finalised and awaiting placement to order, while the third package (package 4) is to be re-tendered by UNIDO. The other two packages, along with the one remaining package, i.e., packages 9, 10 & 24 are to be tendered, after the necessary funds of USD 1.03 million (mentioned before under ‘budget for equipment’) were received by UNIDO in July (5\(^{th}\) round of tendering).

Future activities

In total 9 packages have been purchased up to now (October 2004) at a total value of USD 7.8 million, including the two most expensive packages, the hydraulic fracturing (USD 4.4 million) and the vertical drilling rig (USD 2.2 million). Seven packages have been tendered and ordered by UNIDO since December 2003, but are awaiting supply (total value of USD 1.8 million), while the last 6 packages will be re-tendered in the coming months.

Most of the essential equipment (for starting the vertical drilling operations) has now been purchased and delivered (output 2.1). The last pieces of equipment to arrive will be the drill pipes, after which operations can start, presumably by January/February 2005. Since only one vertical drilling system and one horizontal drilling system have been supplied (instead of the original two sets of systems each), vertical drilling will start first at Moonidih, while underground drilling operations will start simultaneously at Sudamdih. One reason also to start with underground drilling at Sudamdih, is that these coal seams are reportedly to be very

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\(^{10}\) 1. Underground drilling and completion, 2. Underground gas collection equipment, 3. Surface drilling and completion equipment and 4. Laboratory equipment
gassy, in fact so gassy that in the eastern part of some seams mining operations were stopped after an explosion occurred. To minimise risks, these seams have to be degasified before, extraction of coal can (re-)start.

With most of the equipment having arrived on-site, site preparation and civil works have started in one vertical site at Moonidih and in one underground drilling site at Sudamdih (outputs 2.1 and 2.3)\(^{11}\). At both Moonidih and Sudamdih, a small centre of operations will be established from which the drilling teams and international experts can monitor drilling and gas recovery operations (output 2.10). Other sites will be prepared in the months to come accordingly to the vertical and underground drilling plans (outputs 2.2, 2.5 and 2.9). The drilling (outputs 2.4, 2.6 and 2.11) is planned to proceed as follows:

- **Phase I** (about 10-12 months\(^ {12}\)) - Drilling of three vertical wells (from the surface to the virgin, ahead of mining, coal seams at Moonidih and one underground drilling into the virgin top coal seam at Sudamdih
- **Phase II** (about 8-9 months) – Drilling of two vertical wells and drilling of GOB well at Moonidih and the second underground drilling at Sudamdih
- **Phase III** (about 7-8 months) – Underground drilling at Moonidih and drilling of two vertical wells at Sudamdih.

Based on the duration of drilling operations of 24 months, the Chief Project Manager estimates that the project could finish January/February 2007 earliest. However, this assumes that all drilling operations are implemented without any delay, so the evaluation team suggests that a period of up to 30 months is more likely, meaning that the project would finalise its operations by mid-2007, assuming that the first vertical drilling operation can start by January/February 2005.

**Objective 3  Use CBM gas recovered from above-mentioned wells for vehicle refuelling and power generation**

*Expected outputs (as defined in the 1998 UNDP project document)*:

<table>
<thead>
<tr>
<th>Output</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>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 Moonidih and Sudamdih respectively</td>
</tr>
<tr>
<td>3.2</td>
<td>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 Moonidih and Sudamdih</td>
</tr>
<tr>
<td>3.3</td>
<td>Surface gas gathering systems designed and connecting each of the underground borehole manifolds to a surface pipeline that will deliver the gas to a central location at Moonidih and Sudamdih</td>
</tr>
<tr>
<td>3.4</td>
<td>A small gas blending plant located at each of coal mines at which gas from the various wells is blended to meet end-use requirements</td>
</tr>
<tr>
<td>3.5</td>
<td>An internal combustion (IC) stationary engine generator set with 1 MW installed capacity at Moonidih mine</td>
</tr>
<tr>
<td>3.6</td>
<td>A fully equipped and functional compressed methane fuelling station located at Sudamdih, used to refuel coal dumper trucks, powered by engines that have been converted to operate on methane</td>
</tr>
</tbody>
</table>

In accordance with the change in the number of wells, output 3.2 has been merged with 3.1. The methane recovered from the various wells and underground systems will be piped and blended at a central collection point at each of the two mines, to be used subsequently in a...
1MW stationary engine generator set for power generation (at Moonidih) and for fuelling 10-tonne\textsuperscript{13} trucks (Sudamdih). The following activities have been initiated and are still ongoing:

- Design of the surface gathering and pipeline systems for the vertical wells and underground systems as well as procurement of materials (outputs 3.1-3.3)
- Design of a low-cost gas blending station (output 3.4)
- Design of the gas refuelling station (compressor and dispenser; output 3.6)

In terms of gas production, a first rough estimate gives gas production of 3,000-3,500 m\textsuperscript{3} per day per vertical well or underground system. This gives a production of around 18,000-21,000 m\textsuperscript{3} per day at Moonidih and 12,000-14,000 m\textsuperscript{3} at Sudamdih. The expected gas usage of the 1-MW generator is 9,000 m\textsuperscript{3} per day. Assuming a gas usage of 300 m\textsuperscript{3} per truck, the gas usage of the fleet of 10 dumper trucks with conversion kits installed, its daily gas usage will be 4,500 m\textsuperscript{3} per day. This implies that of the combined gas production of 30,000-34,000 m\textsuperscript{3}, only 13,500 m\textsuperscript{3} will be utilized. In line with the environmental objective of the project, the surplus methane gas either has to be flared or alternative uses have to be found. BCCL is therefore contemplating installing more generation sets, a second compressor and dispenser unit (for fuelling the trucks) or piping the gas to nearby communities. BCCL would pay for the additional equipment out of its own budget.

**Budget**

The gas utilisation equipment will cost about USD 860,000 to be paid out the Government of India’s cash budget (see also table 1 in paragraph 2.2.2). Power generator sets: USD 310,000, gas compressor and dispenser unit: USD 320,000, conversion kits for 17 dumper trucks: USD 182,000 and unforeseen USD 48,000. The equipment for gas utilisation will be purchased locally as all equipment is available on the Indian market.

**Future activities:**

- Procurement, testing and commissioning of the power generation facility (output 3.5)
- Procurement, testing, commissioning and construction of refuelling station (output 3.6)
- Tendering, procurement and installation of the truck compresses gas conversion kits as well as training of drivers and refuelling station operators (output 3.6)

**Objective 4  Action plan for replication and CBM clearinghouse**

**Expected outputs (as defined in the 1998 UNDP project document):**

<table>
<thead>
<tr>
<th>Expected output</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Report presenting methane production and cost-benefit analysis and recommendations for future activities</td>
</tr>
<tr>
<td>4.2</td>
<td>Action plan adopted by MOC to promote CBM methane recovery</td>
</tr>
<tr>
<td>4.3</td>
<td>A CBM clearinghouse located at CMPDI</td>
</tr>
<tr>
<td>4.4</td>
<td>Additional courses on CBM added to ISM curriculum</td>
</tr>
</tbody>
</table>

Awaiting the recovery and utilisation of CBM gas, the following activities remain pending:

- Analysis of production data and estimates of methane gas content in the coal seams of Moonidih and Sudamdih, as well as cost-benefit analysis and impact analysis, including greenhouse gas emission reduction estimates (output 4.1)
- Development of an action plan for upscaling of CBM-activities in the project areas and replication to other areas, including involvement of private sector (output 4.2)
- Dissemination of project results (publications, workshops; output 4.3)
- Integration of CBM in mining engineering course materials (output 4.4)

\textsuperscript{13} The project document mentions the use of 50-tonne trucks. In practice, 10-tonne trucks will be fitted with a compressed gas conversion kit, based on the fact that these are readily available in India, which has a large compressed gas in buses programme.
2.2 Implementation: assessment of the evaluation team

2.2.1 Assessment of the implementation strategy in achieving the identified objectives, inputs, activities, outputs and outcomes

(Issue 1 in the evaluation team’s Terms of Reference (ToR), see Annex A)

A major problem that has occurred is the long delay in the procurement of equipment, delaying the date of initiation of the drilling operations. Until the equipment essential to start the drilling of wells, most of the other activities of objectives 1 and 2 (training, recovery of gas and its subsequent utilization) and all activities of objectives 3 and 4, have been put on hold. The first drilling operations are now planned for June 2005, implicating a delay of 69 months, since September 1999, when the project became operational.

The causes of this time over-run of 64 months are (Issue 8 in the evaluation team’s ToR, Review the process/procedures explaining time over-run):

- **Delays in project initiation** (18 months), from project approval by Government of India in September 1999, through the finalization of the agreement with UNIDO to provide technical advisory and equipment procurement services in September 2000, to the definition of the equipment packages of the first round of tendering by January 2001

- **Lack of details regarding equipment specification in the project design**, leading to a time gap (10 months) between the initial tender of four packages of equipment and the re-definition in 24 smaller packages (October 2001). To the opinion of the mission team, this should have been part of an expanded preparatory phase and the delay cannot particularly be attributed to UNIDO’s procurement process, which is the next point.

- **Delays in equipment procurement** (an estimated 31 months), talking from the call for expression of interest for the four equipment packages in January 2001 (as formulated by the team of experts) to the expected delivery of drill pipes by end of 2004. This delay is itself caused by the budget problems mentioned in the previous paragraph, the lengthy tendering procedures of UNIDO and the non-response to tenders. UNIDO has gone through 5 rounds of bidding now to get the equipment purchased.

- **Delays in securing the additional funding** necessary to purchase the demonstration project equipment, requiring an additional USD 2.7 million (from ONGC funds) and USD 1.03 million (through budget re-appropriation), causing an estimated total of 10 months of delay. For more details on the budget gap, the reader is referred to paragraph 2.1 (Issue 12 in the Terms of Reference, Provide specific commentary on the equipment selection, the global equipment scenario and the adequacy of the equipment budget).

With respect to the project design, the evaluation team has the following comments:

- There is not much fault in the project’s setup as such. The objectives of this project are to control greenhouse gas emissions and demonstrate the economic viability of harnessing coal-bed methane, an important greenhouse gas, in the Indian coal mining sector. The full project is intended to build national capabilities in the field of coal-bed methane recovery and utilisation. As such, objectives, outputs, and most of activities are clearly formulated.

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14 The project was approved by the GEF Council in July 1997, while the UNDP project document was finalized in April 1998

15 Estimated made by the evaluation team, based on time difference between UNIDO’s invoice at the end of the 3rd round of tenders (July 2002) and receipt of ONGC share of funds (USD 2.7 million) in April 2003 (after which the 4th round could start, plus the time difference between the end of the 4th tender (June 2004) and the receipt of additional funds (USD 1.03 million from re-appropriation) in July 2004). The delay in equipment procurement is then: total time lapse September 1999-January 2005 (64 months) = delay in project initiation (18 months) + delay due to project design faults (10 months) + delay in securing sufficient funds for procurement (10 months) + delay in equipment procurement process itself (26 months).

16 Affecting packages 1,3,4,9,10,24 (see Annex B)
are achievable and are still standing today (Issue 5 in the evaluation team’s ToR, Review if the project objectives are clear)

- Unfortunately, the devil has been in the lack of detail of the inputs;
  - Giving the size of the project and the large equipment component, the project
document has been less clear on inputs needed to carry out the activities, produce the
outputs and reach the objectives in a timely manner. In this sense, the project
document is very conceptual in nature and lacks many essentials, namely a detailed
list of equipments, equipment technical specification and a description of the
equipment supply market.
  - The costing of equipment in the project document has proven to be very unrealistic,
  constraining the project’s progress. Also, the specification of training needs should
  have been more sharply focused on what type of training (study tours, class-room
  training and on-the-job training) can actually be given and what is basically needed to
  be able to perform drilling and gas recovery operations
  - The selected drilling sites were described in very general in nature and later proved to
  be difficult for operations as most of the areas are heavily built up by houses.

- In addition, the project document lacks a good project logical framework (as is customary
to add to GEF project documents), which clearly links outputs with budgeted inputs and
includes indicators (together with baselines, targets and key assumptions and risks
analysis). Currently, it is difficult, for example, to fill out properly the yearly Annual
Project Report (PIR-APR) formats and also to monitor progress. (Issue 2 in the
evaluation team’s ToR, Verify achievements against indicators in the project document)

- Given the budget available for project preparation17 and the formats for GEF and UNDP
project documents, the team of two consultants that designed the project probably did
what was in their terms of reference. With hindsight, we can say that this apparently has
been sufficient to prepare a project framework and document, but a larger preparatory
phase would have allowed a more detailed reality check of training needs and
possibilities, to have a more detailed description of the project sites and to have detailed
specifications of the equipment needed and listing potential equipment suppliers. Having
these basics would have helped in speedier execution of the full project.

With respect to the delays in equipment procurement, the evaluation team has the following
observations:

- Questions have been raised about, UNIDO’s tendering and contracting process and
  procedures being flexible to be able to purchase this type of equipment:
  - Procedures do not allow for re-validation of the bids by the bidder after the tender
    period expires (after 120 days), while in various occasion it has proven to be difficult
to conclude the tendering process within this timeframe
  - The contracting does not include a penalty clause in the form of an earnest money
    deposit, forfeited if the selected bidder suddenly withdraws from the project. There
    have been various instances of bidders backing out of the supply order, making re-
    tendering necessary
  - UNIDO’s regulation will only permit the start of the tender and contracting process,
    if and when sufficient financial resources (from the project) have been transferred
    into its bank account. Since the budget for equipment was insufficient, additional
    funds had to be secured in 2002 (from ONGC) and in 2004 (re-appropriation of the
    budget).

While acknowledging that such UNIDO’s rules have slowed down the tender process, the
evaluation team likes to point out that these type of rules are typical for both multilateral
and national government procurement, where transparency and impartiality has to be
maintained over commercial responsiveness.

17 USD 82,633 from GEF and disbursed through IND/97/G31 Preparatory Assistance (executed by UNOPS)
Regarding UNIDO’s backstopping function\(^{18}\), UNIDO apparently did not have previous experience in providing this type of specialised equipment for CBM projects. This means that it had to go through a learning curve of five consecutive rounds of defining, specifications of equipment, tendering and evaluation of bids to arrive at the optimal equipment packages\(^{19}\). The mission team likes to point to the fact, that UNIDO actively sought information from a twin project on CBM in China\(^{20}\) on the nitty-gritty details on equipment procurement and on the project results in general, but was not given the required information, despite repeated requests.

- The non-response by equipment providers to the tenders can be attributed to the fact that the market for CBM equipment appears to be a seller’s market\(^{21}\), under which conditions a UN agency might find difficulties in negotiating with the bidding companies and on the other hand maintaining transparency and legal correctness.

### 2.2.2 Assessment of the utilization of resources (including human and financial) towards producing the targeted outputs

*(Issue 3 in the evaluation team’s Terms of Reference)*

Table 1 on the next page provides an overview of the budget allocation per budget line and co-financer. Budget for equipment and training had seriously been underestimated in the UNDP project document, as we discussed extensively in paragraph 2.1, but budget shortage issues have largely been resolved during 1999-2003 by a mix of measures, including downsizing, redefinition of training needs and opportunities as well as obtaining additional financial and in-kind support from ONGC and re-appropriations within the existing GoI, UNDP and GEF budgets.

According to reports and papers received by the evaluation team, *the project budget appears to be adequate currently but looking at the forthcoming events and the contingencies for a technical and complex project like CBM, the project may feel the need of more funds at some stage in the later years*, based on the following observations per budget line:

- **Consultants.** International consultants have, so far, mainly been used as advisors on the preparation (equipment specifications) and technical evaluation of the bids\(^{22}\). Now most the procurement has been done (outcome 2), their participation will shift to the activities of outcomes 3 and 4. Sufficient funds appear to be available in the budget for consultants and their travel for the remainder of the project, as well as for hiring national consultants.

- **Group training.** According to the Chief Project Manager, the UNDP-GEF budget remaining available for training is appropriate to carry out the planned study tours and class-room training in 2004-2006, given the fact that the emphasis in drilling and gas recovery has shifted towards on-the-job training, as part of the equipment tender package or as in-kind support from ONGC. In conclusion, while funds for training abroad were

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18 Although UNIDO’s has had four backstopping officers for the project, Mr. Hassan Nazimi (mid-2000), John Topper (2000-2001), M. Oprisan (2001-2003) and Enver Khan (since 2003), continuity has been there in the form of their chief, Mr. Cahit Gürkök, and the contracts officer, Ms. M. Letrich.

19 Evidence of a learning curve is provided by the vertical rig package, the first round of tendering lasted 15 months (from 03/2002 to 05/2003, while the second round was much faster (3 months, from 07/2003 to 11/2003)

20 CPR/92/G31 Development of Coal-bed Methane Resources in China.

21 Apparently, the 1990s have seen a boom in coal-bed methane development in countries, such as the U.S.A. and Australia, in which situation equipment providers may have found it hard to keep up with the rising demand for equipment.

22 Currently, the experts are Mr. Hilmer von Schollenbach (drilling and gas collection expert, budget lines 11.02, 11.03 and 11.04), Mr. Pete Soot (gas plant, 11.05). Other experts to be hired are the reservoir modelling (11.06), laboratory (11.07) and economic modelling experts (11.08). The information system expert (11.09) will be cancelled, as CMPDI will provide this service.
Table 1  Project budget, financing and utilisation of funds

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>GoI (cash)</td>
<td>GEF</td>
<td>UNDP</td>
</tr>
<tr>
<td>11</td>
<td>International consultants (UNIDO)</td>
<td>515</td>
<td>515</td>
<td>140</td>
</tr>
<tr>
<td>15 &amp; 16</td>
<td>Travel (UNIDO/NEX)</td>
<td>111</td>
<td>30</td>
<td>245</td>
</tr>
<tr>
<td>17</td>
<td>National professionals (NEX)</td>
<td>270</td>
<td>50</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>Group training (UNIDO)</td>
<td>84</td>
<td>169</td>
<td>169</td>
</tr>
<tr>
<td>45</td>
<td>Equipment</td>
<td>4,350</td>
<td>8,578</td>
<td>195</td>
</tr>
<tr>
<td>- UNIDO</td>
<td></td>
<td>8,109</td>
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<td>8,263</td>
</tr>
<tr>
<td>- NEX</td>
<td></td>
<td>358</td>
<td>159</td>
<td>517</td>
</tr>
<tr>
<td>50 &amp; 80</td>
<td>Miscellaneous</td>
<td>237</td>
<td>36</td>
<td>273</td>
</tr>
<tr>
<td></td>
<td>Grand total</td>
<td>4,545</td>
<td>9,115</td>
<td>1210</td>
</tr>
</tbody>
</table>

Notes:
- Figures are in ‘000 US dollars
- The amount on UNDP and GEF funds spent on equipment (budget line 45) does neither include the additional contribution by ONGC of USD 2.69 million in 2003, nor the USD 1.03 million added through re-appropriation (of which USD 1.49 million comes out of the GoI budget line for equipment and the remainder out of other budget lines of the UNDP and GEF budgets). When added, the percentage of UNDP and GEF money spent on equipment during 1999-2003 goes down to 46% (of USD 12.4 instead of USD 8.4 million). By October 2004, an amount of USD 7.8 million had actually been spent on equipment, while another USD 1.8 million of equipment had been ordered, but was awaiting supply (see Annex B)

inadequate, these training parameters were redefined and should not result in inadequate human resource development.

- Equipment – UNDP & GEF funding
  - Procurement by UNIDO. After long delay, the essential equipment will have arrived by the end of 2004, so that the first (vertical) drilling operations can start by early 2005. Nine of the UNIDO-procurement equipment packages (for drilling and gas recovery) have been supplied, seven are being ordered and six packages are being processed.23 The total cost expenditure is equivalent to about USD 11 million, as detailed in Annex B. By adding ONGC funds and budget re-appropriation (see also bullet point ‘equipment – GoI’) the necessary funds have now been secured, as discussed earlier.
  - National procurement (NEX). Laboratory equipment to be procured by CMRI will cost an estimated USD 261,706, of which details are presented in Annex B. Locally procured equipment (by the project) includes workstations, computer equipment, modelling software, transportation equipment, a photocopier and air conditioners at a total value of USD 182,000. Adding the two components gives a total of around USD 440,000, for which sufficient funds will be available

- Equipment – GoI
  - Of the cash contribution of the Government of India (GoI) of USD 4.35 million, USD 1.03 million was re-appropriated for equipment procurement by UNIDO. The remainder will be used for the acquisition of gas utilisation equipment (outcome 3), an estimated USD 860,000, and for operating expenses (manpower, materials, insurance) of camp and well site preparation, gas recovery as well as gas utilisation.

We feel that the difficult exercise to re-appropriate funds and arranging co-funding has saved the budget from collapsing and it appears to be on track at the present time. However, in

23 Of the 26 packages to be procured by UNIDO, four shifted to procurement by CMRI (see Annex B)
some cases spare parts have not been procured as part of the procurement packages, while in practice needed to be able to operate equipment. Also, it is not likely that from now on everything goes well, e.g. with no equipment may break down during operation. In addition, more funds will be needed if the project wants to expand the gas utilization equipment by acquiring more generator sets or adding a second compressed gas refueling station.

In practice, an extra contingency budget for equipment will be needed. Also, additional budget may be needed to cover:
- Cost of salaries of project personnel beyond the original five year period up to mid-2007
- Terminal evaluation of the project (around USD 30,000).

The implementing agencies should look into this issue by carefully assessing cost estimates and contingencies in a detailed work plan for 2005-2007 to implement fully the field work.

2.2.3 Review of the appropriateness of the institutional arrangement
(Issue 7 of the evaluation team’s Terms of Reference)

We discussed the institutional set-up and arrangements in paragraph 1.4. Although the set-up, as depicted in figure 1, appears to be complex at first glance, such a structure is inevitable, given the fact that various multilateral bodies are involved as (UNDP as GEF implementing agency and UNIDO as contracted party), various sources of funding (GEF, UNDP, India), two main implementing agencies (Coal India through its two subsidiaries CMPDI and BCCL) as well as, as well as other local public organisations (ONGC, CMRI, ISM, DGMS).

It is the opinion of the evaluation team that, despite its complexity, the set-up actually works quite well:
- There is a close collaboration not only between the two implementing parties, CMPDI and BCCL, but also with ONGC. The fact that ONGC has supported with both large cash (USD 2.7 million) as well as in-kind on-the-job support is, to our opinion, indicative for the “ownership” by the Indian counterparts of the project. The project is a good example of collaborations between government agencies and with UN officials to jumpstart a complex programme of common interest in close consultation with relevant agencies and organisations.
- With budget and equipment procurement issues settled, the perceived complexity of the institutional arrangement will be of less importance as the emphasis in project activities will shift to the on-the-ground operations, under the responsibility of the project staff in the field of the two implementing agencies, BCCL and CMPDI.

2.2.4 Assessment of the expected project impacts, keeping in mind sustainability and replicability issues
(Issue 4 of the evaluation team’s Terms of Reference)

Outcomes of the project
Since the demonstration part, i.e., actual well and underground drilling and the subsequent, gas recovery and utilisation, is yet to be completed, it would be premature to assess its impacts, which should be addressed in a final project evaluation:
- Strengthening of capabilities (training a core group of mine planners, engineers)
- Institution building (geologists; strengthening institutional collaboration on CBM)
- Bringing, through technology transfer, state-of-the-art CBM gas recovery and resource assessment techniques
• Demonstrating a variety of methane utilisation possibilities and demonstrating their commercial viability
• Dissemination of the result (by transferring information within India and to other coal-producing countries of the world)

Although the number of wells and underground systems have been reduced on one hand, the first estimates on CBM availability at Moonidih and Sudamdih indicate that, on the other hand, the amount of gas extracted may well exceed the envisaged utilisation demand (as discussed in paragraph 2.1). Therefore, to our opinion, the scaling down in procurement and site activities will not in any way affect the target of the proposed demonstration projects and the relevance of the project in general.

One issue to look into further is the functioning of the CBM Clearinghouse after the project’s end, as part of CMPDI or outsourced, in terms of continuation of permanent staff and funding through government (coal institutions) and/or private sector contributions.

Relevance of the CBM project

(Issue 9 of the evaluation team’s ToR, Assess the possible replicability and commercial viability of the technology and whether the project has been able to evoke interest from the private sector)

The Government of India has been supportive of initial moves to develop and recover methane by providing working blocks in coal areas for bidding, and some of these have already been awarded. However, these are in areas that are planned not to be mined, hence, are outside the scope of climate change abatement (not being mined, means that the methane gas would not have escaped into the atmosphere). While national and multinational private sector enterprises have expressed interest in harnessing coal-bed methane in India, but little progress has been made, due to the fact that private sector enterprises face a multitude of barriers in terms institutional problems (regarding resource ownership), high capital investment cost and uncertainty on its profitability. The successful demonstration of CBM recovery and utilisation and the effective dissemination of the project results are therefore likely to attract investors that are now awaiting a ‘proof-of-concept’ activity under Indian conditions.

It should be noted that the project is already influencing a closer cooperation between Indian public sector companies, as the project partner CIL will conclude a joint-venture with ONGC regarding future CBM development and recovery activities.

Contribution of the project to the GEF’S overall objectives of greenhouse gases emission reduction

(Issue 10 of the evaluation team’s Terms of Reference)

The direct impact on climate change of the project will be in terms of emission reduction of methane into the atmosphere and its replacement of coal-based power and diesel fuels. Box 1 gives a quick overview of how the climate change impacts can be calculated.

Since the project is a pilot scheme, its real importance will lie in the increased opportunities for future replication of the project concept, which can only be assessed at the end of the implementation of the project in 2007
Box 1 GHG emission reduction estimate due to project operations

Assuming that the gas recovery systems at Sudamdh and Moonidih (7 vertical wells, 1 gob well and 3 underground systems), produce 32,000 m³ of gas per day.

- At an annual basis this is about 11.52 million m³ or 7,626 tonnes of gas per year. Because methane (CH₄) is a more potent gas (21 times more than CO₂), this is equivalent to 160,151 tonnes of CO₂. Thus, just burning off the captured methane (flaring) would reduce annual GHG emissions with 150,525 tCO₂-eq, assuming that otherwise all this methane would have escaped to the atmosphere, due to the mining operations (A)
- If the recovered gas would be used as fuel this gives a greenhouse gas reduction in terms of fossil fuel use avoided. For example:
  - 1 MW diesel generator sets, using 9,000 m³ of gas daily, replacing 8,750 litres of diesel and thus avoiding 8,585 tCO₂ annually (B, C)
  - 15 compressed-gas fuelled trucks, using 4,500 m³ of gas daily, replacing 4,380 litres of diesel and thus avoiding 4,292 tCO₂ annually (C)

Thus, annual CO₂ reduction can be roughly estimated at about 180,000 tonnes of CO₂. At this stage of the project, its economics of the project is difficult to estimate. In a commercial project, the costs would be comprised of:

- Initial project cost (costs of drilling the first wells and gas recovery, including investment cost in drilling equipment, piping and collection station) and cost of drilling additional wells over the project’s lifetime
- Initial cost of gas utilisation (gas compression and refuelling station, truck conversion kits, power generator and interconnection cost)
- Standard operating costs of gas recovery and utilisation (labour, insurance, maintenance, spare parts)

The project yields benefits in terms of the purchases of diesel and electricity avoided from the energy companies. In addition, if CBM projects could be developed under Clean Development Mechanisms of the Kyoto Protocol, this could give additional benefits in the order of at least USD 5-6 per tCO₂ reduced, depending on how the CO₂ price will settle, once the Protocol enters into force.

(A) Please note that, methane recovery in areas that will not be mined does not contribute to greenhouse gas reduction
(B) Assuming 1 litre of diesel is equivalent to 1 m³ of methane in terms of heating value; 350 days of operation in a year and a CO₂ factor of 0.0028 tonnes per litre of diesel.
(C) Under these estimates more gas will be recovered than will be utilised, implying that the rest needs to be flared to avoid bits release into the atmosphere
3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

The following summarises the findings of the evaluation. Each of the points identified is discussed in the previous chapter 2. Apart from drawing conclusions on the project design and execution, want to end with one basic question underlying the ToR, which is “despite the delays in project execution, especially regarding equipment procurement, can the project objectives still be achieved in a reasonable timeframe?”

3.1.1 Project design and execution

On project execution, we ask: “Has the project been well implemented?”

We notice that project has not been without problems. Huge delays of a couple of years in the implementation of activities have occurred, due to a number of reasons:

- Delays in project initiation, as time was needed to contract a third party, UNIDO for the provision technical advisory and equipment procurement services and to organise the tendering process (detailing equipment specification and bidding packages)
- Delays in effecting budget adjustments and in securing the additional funding necessary to due to a severe underestimation in the project document by 60% of the real cost of equipment for the drilling and gas recovery systems
- A delay in equipment procurement, due to non-response to tenders by the equipment providers and strict adherence to UNIDO’s tendering procedures (forcing re-tendering in a number of cases).

Despite the delays in equipment, we feel that project execution by UNIDO has approximated what in retrospect could reasonably have been achieved under the circumstances of a seller’s market of CBM equipment and the limitations posed by the project design. Regarding implementation by the Indian project partners BCCL and CMPDI it is too early to tell and the proof will be in the pudding when drilling, gas recovery and utilisation operation will start in 2005.

On project design, we ask: “Was the project appropriately designed for the perceived needs?”

As such, the conceptualisation of the programme as captured in the project document proves to be appropriate, as the basic design of outputs and activities still holds with some modifications. Its objectives, to control greenhouse gas emissions by demonstrating the economic viability of harnessing coal-bed methane and building technical capabilities among the project participants, are valid.

But what has clearly been lacking has been a detailed design of training activities, analysis of the equipment provider market and detailed listing and costing of equipment. Much of the delays mentioned before could have been avoided if, from the onset, it would have been clear, what equipment to procure and which cost, who would procure the equipment and where to procure and if training needs and opportunities for the operation of equipment would have been clearly defined. This level of detail could have been obtained by having a much larger, one-year, preparatory phase, before embarking on the full project. In addition,
the project document has been lacking a good logical framework with outputs and indicators, making monitoring and evaluation difficult.

3.1.2 The way forward: can the project meet its objectives?

(Issue 6 of the mission’s Terms of Reference)

The delay in project implementation has been such since the approval of the project by the Government of India in September 1999, most of the project activities are still about to be started. The first drilling of the vertical well and underground systems is expected to start early 2005 (after all the equipment and spare parts necessary has been secured. However, the downscaling of project activities will actually created one year of extra time, i.e. the work plan attached to the UNDP project document foresees a period of 3.5 years from the start of the first drilling to gas subsequent utilisation and dissemination activities, while the current planning is closure to be likely at around mid-2007, under the assumption that drilling operations start by early 2005.

While both project design and execution have not been without problems, it is our opinion these should not overshadow the project’s implementation in the years to come:

- Apart from drill pipes and some spare parts, the equipment necessary to start drilling has been purchased or about to be ordered. With this main hurdle taken and the first drilling sites under preparation, the project can now take off.
- We noticed however, that there is close collaboration between the two implementing agencies, the project has received substantial financial and in-kind support from ONGC, an enthusiastic core team of technical experts has been formed, while, given the equipment supply constraints, the project as has been well-managed by the Project Advisor and Chief Project Manager with active support from both the multilateral agencies involved (UNDP and UNIDO) as well the Government of India (Ministry of Coal)

Therefore, the evaluation team is confident that the project can achieve its objectives. We recommend therefore a project extension with 3 years until the end of 2007, although under the critical assumptions that no further delays will occur, that the core technical teams at BCCL will receive sufficient on-the-job training to complete successfully the vertical and underground drilling operations and that sufficient budget will be (made) available for equipment contingency and other cost items (project staff extension, terminal evaluation).

It is expected that this project will generate useful data on coal-bed methane (CBM) recovery and, after successful completion, would generate more confidence in prospective public and private sector investors in India to replicate CBM gas recovery from gassy underground mines and its subsequent use as fuel substituting coal or diesel. With the Kyoto Protocol to come in force soon (which Russia ratified recently), it is likely that international project developers will be interested to invest in CBM as a Clean Development Mechanism activity, in return for the greenhouse gas emission reduction credits. In this respect, it is worth mentioning that CIL and ONGC have formed a joint venture to develop future CBM activities. CMPDI, through its CBM Clearinghouse, could help in replication by providing consultancy services, based on the knowledge obtained in this project.
3.2 Lessons learned and recommendations

(Issue 11 in the evaluation team’s Terms of Reference, Assess what are the important lessons, if any, that can be drawn from the project. In particular, what has worked well and can be applied to other projects and what has not worked so well and should be avoided in future)

Based on the facts and findings presented in this report, the following recommendations are offered:

3.2.1 Project-specific

Given the fact that most drilling equipment has been ordered nowe drilling sites are being prepared and the continuing counterpart support (evidenced for example by ONGC’s contributions), the evaluation team recommends extension of the project beyond 31-12-2004 with a period of 3 years and making available the UNDP, GEF and GoI balance budget available.

To be able to monitor and evaluate the project more effectively (for the period 2005-2007), we recommend that the project management (and implementing agencies) draws up a detailed work plan of activities for 2005-2007 (to be endorsed by the project’s National Steering Committee) containing:

- A qualitatively and quantitatively detailed description of activities to be carried out:
  - Training programme (indicating clearly the shift towards on-the-job training as part of the equipment operation, rather then study tour and class-room instruction and its impact on the capacity building objective of the project)
  - Drilling and gas recovery operations at Moonidih and Sudamdih (with a clear timeline),
  - Gas utilisation for power generation and dumper truck fuelling (indicating also if more equipment, and thus budget, may be appropriate than originally foreseen in the project document, and also if other uses, such as piping gas to nearby communities, could be considered)
  - Knowledge dissemination and action plan for future replication (including the sustainability of the CBM Clearinghouse after the project’s end)
- A radically improved project logical framework (logframe) with project progress indicators and analysis of critical assumptions and bottlenecks that may hinder project progress. An example of such a logframe (based on the format used nowadays in GEF project proposals) is given in the Annex D.
- Inputs needed and available
  - Human resources to be deployed (paid for by the project, GoI as well as in-kind)
  - Realistic cost estimates and budget available for the remaining part of the work, indicating where in future bottlenecks may occur (based on the critical assumption analysis in the logframe) and the need for budget contingencies.

Since most of the project operations still have to start, it is difficult to draw any lessons from the project execution itself at this stage. The final evaluation at the project’s end should provide lessons learned regarding technology transfer, capability building, awareness creation as well as on the potential and profitability of CBM as a greenhouse gas mitigation activity. With respect to the CBM recovery at the two mining sites, the project will yield useful data on gas recovery rate and the reservoir potential in this type of gassy mines. In addition, an analysis should be made on the impact of hydrofracturing on coal, which may affect future mining operations as well as on the possibility of CBM recovery associated with mining at larger depths.
3.2.2 Generic

One general lesson learned is that large and complex technology transfer projects need to be designed properly, based on a thorough review of the issues and options. Outputs need to be based on on-the-ground realities and activities need to be designed in such a way that they can deliver the outputs within a reasonable timeframe using realistically estimated inputs, in terms of human and financial resources. Sufficient time and resources should be used to have a solid preparatory phase to realistically draw up the project document that not just follows the design formats used by the funding agency, but that has sufficient detail regarding inputs needed for specific activities to be able to successfully execute the project. It is more common now than a decade ago for large GEF projects to have an extended preparatory phase, supported by GEF’s PDF A and PDF B funding, and the history of the India CBM project only underlines the rationale for good project preparation.

The equipment needed as part of the demonstration component of ‘first-of-a-kind’ projects, should be adequately budgeted. The budget should not only be sufficient to cover the purchase and operating cost of the technology, but should include a contingencies to provide for spare parts, changes in foreign exchange rates and price increases over the project’s lifetime.

Regarding procurement and administrative procedures in the UN, the evaluators believe that transparency and competition for equipment and services is important. However, this can make the procedures cumbersome and slowing down the response in the procurement process. We recommend that the procurement agency, whether multilateral or governmental, is to be involved in the project design stage as well to see if its procedures are flexible and responsive enough to provide the services required in a particular project setting. UN organisations, such as UNIDO, may in this respect want to address their procurement regulations to find a right balance between accountability and speediness in equipment procurement and to address current procurement practices, i.e., how and through which media prospective bidders are informed about procurement announcements.

Projects developed with public funds, whether multilateral, bilateral or national, should have a policy of active dissemination of project results. The India CBM project would have clearly benefited in its design stage from information made available from the earlier China CBM project, but such information was not made available or not easily accessible. Dissemination should not limit itself to ‘information’ (e.g. making available the project document and a list of project results), but be extended to ‘knowledge’ (e.g., how was the project implemented, what problems were encountered, what worked and what did not?).
ANNEX A. THE EVALUATION MISSION’S TERMS OF REFERENCE AND WORK SCHEDULE

A.1 Terms of Reference for the review Of UNDP/GEF Project
IND/98/G34 - Coal Bed Methane Recovery And Commercial Utilization

BACKGROUND:

The above is a pilot demonstration project of five-year duration and became operational on 15 September 1999. It has three budget components (from UNDP, GEF and the Government of India).

An Agreement reached between the Government of India and UNIDO spelling out UNIDO’s role in project operations (4 February 2000) forms an integral part of the project document. A copy of the Agreement and the Project Document are enclosed.

PURPOSE OF THE REVIEW:

The purpose of this review is to evaluate progress made to date and to make recommendations for future actions.

ISSUES TO BE ADDRESSED:

1. Assess the implementation strategy in achieving the identified objectives, inputs, activities, outputs, expected outcomes and impact;

2. Verify achievements against indicators (in the project document and as set by the National Steering Committee);

3. Assess the utilization of resources (including human and financial) towards producing the targeted outputs;

4. Assess the contributions of the project and document the expected impacts keeping in mind sustainability and replicability issues.

5. Review if the project objectives are clear;

6. Review how the project can meet its objectives;

7. Review the appropriateness of the Institutional arrangement;

8. Review the processes/procedures explaining delays in equipment procurement;

9. Assess the possible replicability and commercial viability of the technology and whether the project has been able to evince interest from the private sector;

10. Assess how far the project will be able to contribute to the GEF’s overall objectives of Greenhouse Gases Emission and act as a demonstration project; and

11. Assess what are the important lessons, if any, that can be drawn from the
project. In particular, what has worked well and can be applied to other projects and what has not worked so well and should be avoided in future.

12. As equipment procurement has been a major component of the project, a specific commentary may be provided on the equipment selection, the global equipment scenario and the adequacy of the equipment budget.

SCHEDULE AND DURATION OF THE REVIEW:

The total mission is expected to last ten days, excluding travel time.

The consultant/s will be provided with a schedule that will include five days visit to project sites, i.e. Dhanbad & Ranchi and New Delhi. This visit will also include meetings with the officials of the Implementing Agency (at Ranchi), Local Implementing Agency (at Dhanbad), staff of Oil & Natural Gas Commission (who are the joint-owners of a part of the equipment) and the staff of Coal India Limited.

The schedule will also include two days visit to UNIDO, Vienna.

After the briefing by UNIDO, the consultant/s will meet with the National Project Director, his staff at the Ministry of Coal, the Project Advisor-CBM and the Implementing Agencies.

REPORTING:

At the end of the visits (one day before), the consultant/s will submit and present a draft report to the National Steering Committee.

After incorporating the comments made in the meeting, the consultant/s will submit the final report to UNDP, before leaving Delhi.

The report should be with clear recommendations, with crisp points and preferably not exceeding ten pages in total.

CONSULTATIONS:

Throughout the period of the review, the consultant/s will liaise closely with the UNDP Resident Representative's office, the UNIDO office, the concerned agencies of the Government, any national and international experts working on the project and the counterpart staff assigned to the project. The consultant/s can raise or discuss any issue or topic it deems necessary to fulfill its task, the consultant/s, however, is/are not authorized to make any commitments to any party on behalf of UNDP or the Government.
## A.2 ITINERARY OF THE EVALUATION MISSION

### First mission (01-14 October 2004)

<table>
<thead>
<tr>
<th>Date</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-09, Thursday</td>
<td>Arrival from Amsterdam of Mr. Jan van den Akker with flight KL 871</td>
</tr>
<tr>
<td>01-10, Friday</td>
<td>• Courtesy call to Mr. Maurice Dewulf (Deputy Resident Representative, UNDP) at UNDP Country Office, Delhi</td>
</tr>
<tr>
<td></td>
<td>• Meeting with Mr. Anil Arora (Assistant Programme Officer, UNDP) at UNDP Country Office, Delhi</td>
</tr>
<tr>
<td></td>
<td>• Courtesy call to Mr. Pradeep Kumar (Additional Secretary and Project Director) at Ministry of Coal, Delhi</td>
</tr>
<tr>
<td></td>
<td>• Meeting with Mr. N.N. Gautam (Project Advisor) at UNDP Office, Delhi</td>
</tr>
<tr>
<td></td>
<td>• Meeting with Ms. Neera Burrah (Assistant Resident Representative, UNDP) at UNDP Office, Delhi</td>
</tr>
<tr>
<td></td>
<td>• Meeting with Mr. George Assaf (Regional Director, UNIDO) at UNIDO Office</td>
</tr>
<tr>
<td>02-10 Saturday</td>
<td>Public holiday; first reporting</td>
</tr>
<tr>
<td>03-10 Sunday</td>
<td>Reporting; departure for Ranchi with flight IC 809</td>
</tr>
<tr>
<td>04-10 Monday</td>
<td>• Meeting and discussions with Mr. N. Prasad (Chief Project Manager) at CMPDI, Ranchi</td>
</tr>
<tr>
<td>05-10 Tuesday</td>
<td>• Courtesy call to Mr. M.N. Jha (Chairman-cum-Managing Director, CMPDI) at CMPDI, Ranchi</td>
</tr>
<tr>
<td></td>
<td>• Departure from Ranchi and arrival at Dhanbad (by train)</td>
</tr>
<tr>
<td>06-10 Wednesday</td>
<td>• Meeting with Mr. S.B. Chakravarty (Chief General Manager) at Moonidih mine, Dhanbad</td>
</tr>
<tr>
<td></td>
<td>• Visit to project site</td>
</tr>
<tr>
<td></td>
<td>• Courtesy call to Mr. P.S. Bhattacharya (Chairman-cum-Managing Director, BCCL) at BCCL Office, Dhanbad</td>
</tr>
<tr>
<td></td>
<td>• Meeting with Mr. Man Mohan Sharma (Deputy Director General) at DG of Mines Safety, Dhanbad</td>
</tr>
<tr>
<td>07-10 Thursday</td>
<td>• Meeting with Mr. Agarwal (Chief General Manager) at Sudamidih mine, Dhanbad</td>
</tr>
<tr>
<td></td>
<td>• Visit to project site</td>
</tr>
<tr>
<td></td>
<td>• Meeting with Mr. Ajay.K. Singh (Head, Methane Emission and Degasification) at CMRI, Dhanbad</td>
</tr>
<tr>
<td></td>
<td>• Departure from Dhanbad and arrival at Calcutta (by train)</td>
</tr>
<tr>
<td>08-10 Friday</td>
<td>• Meeting with representatives from ONGC, Mr. Yash Malik (Dy. Gen. Mgr. Production), Mr. D.K. Agarwal (Finance Coordinator), Mr. Das at ONGC Office, Calcutta</td>
</tr>
<tr>
<td></td>
<td>• Departure for Delhi with flight IC 201</td>
</tr>
<tr>
<td>09-10 Saturday</td>
<td>Reporting</td>
</tr>
<tr>
<td>10-10 Sunday</td>
<td>Reporting</td>
</tr>
<tr>
<td>11-11 Monday</td>
<td>• Departure from Delhi and arrival in Vienna with flights OS 34 (Mr. Dube) and KL 871 – KL 1839</td>
</tr>
<tr>
<td></td>
<td>• Meeting with Mr. C. Gürkök (Director, Energy and Cleaner Production Branch) at UNIDO Headquarters, Vienna, Austria</td>
</tr>
<tr>
<td>12-11 Tuesday</td>
<td>• Meeting with Mr. Gürkök and Ms. M. Latrech (Contracts Officer, Purchase and Contracts Section) at UNIDO</td>
</tr>
<tr>
<td>13-11 Wednesday</td>
<td>Reporting</td>
</tr>
<tr>
<td>14-11 Thursday</td>
<td>• Final meeting with Mr. Gürkök; departure of Mr. Van den Akker with KL 1848</td>
</tr>
<tr>
<td>15-11 Friday</td>
<td>• Departure for India of Mr. Dube by flight OS 33</td>
</tr>
</tbody>
</table>
Second mission (November 2004)

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>08-11 Monday</td>
<td>Arrival of Mr. Van den Akker from Amsterdam with flight KL 871</td>
</tr>
<tr>
<td>08-11 Tuesday</td>
<td>Internal discussion evaluation report by consultants</td>
</tr>
<tr>
<td>09-11 Wednesday</td>
<td>Presentation of the report to UNDP and GoI</td>
</tr>
<tr>
<td>10-11 Thursday</td>
<td>Discussion and finalisation of evaluation report; departure of Mr. Van den Akker</td>
</tr>
</tbody>
</table>
ANNEX B. EQUIPMENT

B.1 Equipment as listed in the UNDP project document

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Amount (USD’000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vertical drilling rig 1</td>
<td>800</td>
</tr>
<tr>
<td>2. Mudlogging unit 2</td>
<td>150</td>
</tr>
<tr>
<td>3. Vertical drilling rig 1</td>
<td>650</td>
</tr>
<tr>
<td>4. Completion equipment</td>
<td>400</td>
</tr>
<tr>
<td>5. Directional (horizontal) drill 1</td>
<td>300</td>
</tr>
<tr>
<td>6. Horizontal drill 2</td>
<td>1,000</td>
</tr>
<tr>
<td>7. Drilling accessories</td>
<td>150</td>
</tr>
<tr>
<td>8. Geophysical logger 1</td>
<td>900</td>
</tr>
<tr>
<td>9. 2-Phase well testing tool</td>
<td>200</td>
</tr>
<tr>
<td>10. Hydro-fracturing unit</td>
<td>700</td>
</tr>
<tr>
<td>11. High-capacity pumps (16)</td>
<td>140</td>
</tr>
<tr>
<td>12. Adsorption systems</td>
<td>100</td>
</tr>
<tr>
<td>13. Gas chromatograph</td>
<td>75</td>
</tr>
<tr>
<td>14. Lab peneameter</td>
<td>14</td>
</tr>
<tr>
<td>15. Field work station</td>
<td>70</td>
</tr>
<tr>
<td>16. Hqr. Field station</td>
<td>65</td>
</tr>
<tr>
<td>17. Modelling software</td>
<td>50</td>
</tr>
<tr>
<td>18. Data processing and mapping systems</td>
<td>50</td>
</tr>
<tr>
<td>19. Portable cabins</td>
<td>6</td>
</tr>
<tr>
<td>20. Air conditioning and furniture</td>
<td>14</td>
</tr>
<tr>
<td>21. Transport (truck)</td>
<td>139</td>
</tr>
<tr>
<td>22. Procurement and transportation cost</td>
<td>70</td>
</tr>
<tr>
<td>23. Gas collection systems</td>
<td>330</td>
</tr>
</tbody>
</table>

6,373

B.2 Status of UNIDO procurement of equipment for drilling and gas recovery, November 2004

<table>
<thead>
<tr>
<th>#</th>
<th>Package name</th>
<th>Cost [USD]</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Underground drill bits</td>
<td>18,100</td>
<td>Supplied in July 2002</td>
</tr>
<tr>
<td>6</td>
<td>Surface exhausters</td>
<td></td>
<td>Four exhauster units have been supplied, except for the methane sensors (specs did not conform the ToR specs)</td>
</tr>
<tr>
<td>17</td>
<td>Cementation equipment</td>
<td>880,600</td>
<td>Supplied in May 2003. Procured under 50:50 cost-sharing with ONGC</td>
</tr>
<tr>
<td>20</td>
<td>Hydraulic fracturing</td>
<td>4,359,254</td>
<td>Supplied in May 2003. Procured under 50:50 cost-sharing with ONGC</td>
</tr>
<tr>
<td>22</td>
<td>Well head, tub. head and frac.</td>
<td>105,727</td>
<td>Supplied in May 2003</td>
</tr>
<tr>
<td>No.</td>
<td>Equipment</td>
<td>Cost (INR)</td>
<td>Status/Remarks</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------</td>
<td>------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>23</td>
<td>Echometer</td>
<td>20,444</td>
<td>Supplied in November 2002</td>
</tr>
<tr>
<td>25</td>
<td>Whole core permeameter</td>
<td>158,635</td>
<td>Supplied in December 2002</td>
</tr>
<tr>
<td>26</td>
<td>Equilibrium moisture apparatus</td>
<td>10,595</td>
<td>Supplied in January 2003</td>
</tr>
<tr>
<td>11</td>
<td>Vertical drilling rig</td>
<td>2,241,821</td>
<td>The availability of ONGC funds (April 2003) paved the way for issuance of contract to GEFCO, the selected bidder. However, GEFCO withdrew and the package had to be re-tendered in July 2003. Contract was issued to Crown Energy Technologies (November 2003) and equipment supplied during July/August 2004</td>
</tr>
<tr>
<td></td>
<td>TOTAL (1)</td>
<td>7,777,076</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipment packages finalised and ordered by UNIDO, awaiting supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Pumping equipment</td>
<td>524,323</td>
<td>Re-tendered on December 2003 (validity extension by selected party was not possible)</td>
</tr>
<tr>
<td>12</td>
<td>Drill pipes</td>
<td>139,487</td>
<td>Procurement affected for the same reason as #21. Re-tendered and purchase order were issued to two parties. One party (Woodhouse) withdrew because of quoted steel price increase of 37%, forcing re-tendering under UNIDO rules (August 2004). Evaluation should be finalised in November. When pipes are delivered, the first vertical drilling operations can start (January-February 2005)</td>
</tr>
<tr>
<td>13</td>
<td>Drill bits (surface)</td>
<td>126,181</td>
<td>Procurement affected for same reason. Re-tendered and purchase order issues in April ’04.</td>
</tr>
<tr>
<td>7</td>
<td>HDPE pipe collection system – UG and surface</td>
<td>160,208</td>
<td>Procurement affected for same reason. Re-tendered and purchase order issues in April ’04.</td>
</tr>
<tr>
<td>8</td>
<td>Fusion machine</td>
<td>46,850</td>
<td>Procurement affected for same reason. Re-tendered and purchase order issues in May ’04.</td>
</tr>
<tr>
<td>19</td>
<td>Geophysical logger services</td>
<td>651,700</td>
<td>The package provides for services rather than equipment. Equipment affected for same reason. Re-tendered and contract issued by UNIDO on July ’04.</td>
</tr>
<tr>
<td>18</td>
<td>Casing</td>
<td>180,199</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL (2)</td>
<td>1,828,948</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipment packages re-tendered (cost figures are indicative)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Long hole drill (UG-underground)</td>
<td>927,000</td>
<td>Procurement affected for same reason as #21 and was re-tendered. Expected date of purchase end of 2004. Expected supply time: 4-10 months. Two bids were evaluated; one combined with #4 (which part did not qualify, making re-tendering possible)</td>
</tr>
<tr>
<td>3</td>
<td>Down-hole motor</td>
<td>82,400</td>
<td>Procurement affected for same reason as #21 and was re-tendered. Expected date of purchase end of 2004. Expected supply time: 6 months.</td>
</tr>
<tr>
<td>4</td>
<td>Steering tool</td>
<td>360,500</td>
<td>Procurement affected for same reason as #21. Re-tendering but only one bid (combined with #1, which did not qualify). Re-tendering is being done (closing date Nov’ 04)</td>
</tr>
<tr>
<td>#</td>
<td>Package name</td>
<td>Estimated cost [USD]</td>
<td>Comments</td>
</tr>
<tr>
<td>----</td>
<td>----------------------------------</td>
<td>----------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>10</td>
<td>Safety devices</td>
<td>26,900</td>
<td>Procurement affected for same reason as #21. specs were revised and re-tendering was done in March 2004, but no bids were received. expected date of re-tender in October 2004; UNIDO may request to bid for all three packages</td>
</tr>
<tr>
<td>24</td>
<td>Gas gathering collection system</td>
<td>47,500</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Well head assembly</td>
<td>85,900</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL (3)</td>
<td>1,530,200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GRAND TOTAL (1+2+3)</td>
<td>11,136,224</td>
<td></td>
</tr>
</tbody>
</table>

Out of the original 26 packages to be tendered by UNIDO, four (mostly laboratory equipment) have shifted to CMRI procurement. This gives a total of nine packages under procurement by CMRI and the project, as mentioned below (with the four UNIDO-shifted given first):

<table>
<thead>
<tr>
<th>Status of equipment supplied</th>
<th>#</th>
<th>Package name</th>
<th>Estimated cost [USD]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Adsorption isotherm apparatus upgrade</td>
<td>94,600</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Field desorption apparatus</td>
<td>53,000</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Mobile field desorption laboratory</td>
<td>35,000</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Gas chromatography</td>
<td>16,900</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Blow-out preventor</td>
<td>1,050</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Water tanks &amp; flow traps</td>
<td>10,500</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>MS pipes</td>
<td>14,700</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Well site electrical parts</td>
<td>61,400</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Meter run</td>
<td>17,600</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>304,750</td>
</tr>
</tbody>
</table>
### ANEX C. REVISED PROJECT LOGICAL FRAMEWORK

The following table gives an example of a project logical framework. We recommend that project management completes such a logical framework as part of the work plan for 2005-2007 to be able to draw up an overview of bottlenecks and critical assumptions as well as to facilitate the final evaluation at the end of the project.

<table>
<thead>
<tr>
<th>Objectives and outputs</th>
<th>Indicators and [verifiers]</th>
<th>Critical assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective 1</strong> Strengthen and increase capacity of CMPDI, BCCL, CMRI, MOC, CIL and other relevant organisations</td>
<td>CBM units or sections institutionalised to undertake further activities on CBM after project’s end (Commitment in non-project budget to CBM-relevant activities; plans for CBM activities beyond the project)</td>
<td>Management of these organisations is interested in CBM development for safety, energy or other purposes</td>
</tr>
<tr>
<td>1.1 Members of CMDIL and BCCL trained in reservoir modelling and prediction of gas production parameters</td>
<td>About x members from CMPDIL and y members trained (where?) by quarter (Q) a of year (yr) b [Training materials; timesheets or activity reports of training]</td>
<td></td>
</tr>
<tr>
<td>1.2 Team members trained in latest vertical well and underground directional drilling technology</td>
<td>About x technical staff of BCCL trained (abroad / classroom and/or on-the-job) by Q a of yr b [Training materials; timesheets or activity reports of training]</td>
<td>Relevant personnel is willing to participate in training and in applying the know-how for their respective organisation; Necessary skills and training can sufficiently be provided within the project’s timeframe</td>
</tr>
<tr>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4 Team trained in use of CBM gas for power generation</td>
<td>About x technical staff of CMPDIL and y staff from BCCL trained (abroad, classroom, on-the-job) by Q a of yr b [Training materials; timesheets or activity reports of training]</td>
<td>Relevant personnel is willing to participate in training and in applying the know-how for their respective organisation</td>
</tr>
<tr>
<td>1.5 Team trained in use of CBM gas in vehicle internal combustion engines</td>
<td>About x technical staff of CMPDIL and y staff from BCCL trained (classroom and/or on-the-job) by Q a of yr b [Training materials; timesheets or activity reports of training]</td>
<td>Relevant personnel is willing to participate in training and in applying the know-how for their respective organisation</td>
</tr>
<tr>
<td>1.6 Team members trained to develop safety protocols on the technologies mentioned in 1.2-1.5</td>
<td>About x technical staff of CMPDIL and y staff from BCCL trained (classroom and/or on-the-job) by Q a of yr b [Training materials; timesheets or activity reports of training]</td>
<td>Relevant protocols (by-laws) are approved by DGMS</td>
</tr>
<tr>
<td>1.7 Team members CMPDI and ISM trained in the financial-economic assessment of CBM</td>
<td>About x staff of CMPDIL and y staff of ISM trained (classroom, on-the-job) by Q a of yr b [Training materials; timesheets or activity reports of training]</td>
<td>Relevant personnel is willing to participate in training and in applying the know-how for their respective organisation</td>
</tr>
<tr>
<td>1.8 CBM Information System (library, Internet Gateway) installed at CMPDI</td>
<td>Library is functional by (start / mid / early) year Z. Intenet Gateway installed at CMPDI by Q a of yr b [CMPDI staff and visitors are using library and gateway]</td>
<td>There is continuous demand for these services</td>
</tr>
<tr>
<td>1.9 CMPDI, CIL, MOC Intranet installed at CMPDI</td>
<td>Fully functioning intranet is operationalised by (start / mid / early)</td>
<td>There is continuous demand for these services</td>
</tr>
<tr>
<td>Objectives and outputs</td>
<td>Indicators and [verifiers]</td>
<td>Critical assumptions</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>CBM Clearinghouse established</td>
<td>Fully functioning library is operationalised by (start / mid / early) year Z. Internet Gateway installed at CMPDI by Q a of yr b [Researchers, scientist, officials and private sector using library and gateway]</td>
<td></td>
</tr>
<tr>
<td>Objective 2 Prepare and execute CBM gas recovery demo projects in the Jharia coalfield</td>
<td>Gas is recovered from vertical, gob and underground systems and collected [Published drilling and gas recovery results]</td>
<td></td>
</tr>
<tr>
<td>2.1 2.8</td>
<td>Equipment procured and delivered by Q a of yr b [Documentation of equipment proposals, approved bids, procurement, shipment, delivery and physical presence at project sites]</td>
<td>Equipment arrives without further delays; Co-financing is secured for spare parts, where necessary</td>
</tr>
<tr>
<td>2.2 2.9</td>
<td>A suitable plan for drilling operations agreed by Q a of yr b: • Phase 1: 3 vertical wells (Moonidih) and 1 UG system (Sudamdih) • Phase 2: 2 vertical well and 1 gob well (Moonidih) and 1 UG system (Sudamdih) • Phase 3: 1 UG system (Moonidih) and 2 vertical wells (Sudamdih) [Documentation of the plan]</td>
<td></td>
</tr>
<tr>
<td>2.3 2.10</td>
<td>Civil engineering and support facilities completed by Q a of yr b [Documentation of the designs and facilities; actual inspection of erected facilities]</td>
<td></td>
</tr>
<tr>
<td>2.4 2.6 2.11</td>
<td>Vertical, gob wells directional boreholes located and drilled at Moonidih Number of systems in place: • 5 vertical well sites • 1 gob well site • 1 underground system [Documentation of drilling operations and technical services provided]</td>
<td>Relevant personnel has sufficient knowledge and skills (acquired in activities 1.1-1.6 or otherwise) to carry out drilling and gas recovery tasks;</td>
</tr>
<tr>
<td>2.4 2.11</td>
<td>Vertical, gob wells directional boreholes located and drilled at Sudamdih Number of systems in place: • 2 vertical well sites • 2 underground systems [Documentation of drilling operations and technical services provided]</td>
<td>Relevant personnel has sufficient knowledge and skills to carry out drilling and gas recovery tasks</td>
</tr>
<tr>
<td>2.7</td>
<td>Oxygen and CO monitoring system installed</td>
<td>Oxygen and CO monitoring system installed</td>
</tr>
<tr>
<td>Objective 3 Use CBM gas recovered from wells for vehicle refuelling and power generation</td>
<td>Gas is utilised for on-site power generation and truck fuelling [Published gas demand and utilisation results]</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Surface gas gathering</td>
<td>Equipment installed and operating by Q a</td>
</tr>
<tr>
<td>Objectives and outputs</td>
<td>Indicators and [verifiers]</td>
<td>Critical assumptions</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------</td>
<td>----------------------</td>
</tr>
</tbody>
</table>
| 3.2 3.3 system designed and connecting the vertically drilled (and gob) wells and the underground borehole manifolds to pipelines that will deliver the gas to a central location at Moonidih and to one at Sudamdih | of yr b  
[Documentation of equipment proposals, procurement, delivery and physical presence at project sites] | |
| 3.4 Small gas blending plant located at each of the two coal mines sites at which gas from the various wells is blended to meet end-use requirements | Equipment installed and operating by Q a of yr b  
[Documentation of equipment proposals, procurement, delivery and physical presence at project sites; gas recovery reports] | Equipment arrives without further delays; Co-financing is secured for spare parts, where necessary |
| 3.5 Internal combustion (IC) stationary engine generator Moonidih mine | Equipment installed and operating by Q a of yr b  
[Documentation of equipment proposals, procurement, delivery and physical presence at project sites; electricity production reports] | Equipment arrives without further delays; Co-financing is secured for spare parts, where necessary |
| 3.6 A fully equipped and functional compressed methane fuelling station located at Sudamdih, used to refuel coal dumper trucks, powered by engines that have been converted to work on gas | Equipment installed and operating by Q a of yr b  
[Documentation of equipment proposals, procurement, delivery and physical presence at project sites; compressed gas production and truck fuel consumption reports] | Equipment arrives without further delays; Co-financing is secured for spare parts, where necessary |
| Objective 4 Action plan for replication; CBM clearinghouse | Published demonstration site results, gas production potential estimates and techno-economic analysis  
[Documentation] | Government, public and private sector is interested in further CBM development |
| 4.1 Report presenting methane production and cost-benefit analysis and recommendations for future activities | Comprehensive results of the analysis by Q a of yr b.  
[Documentation of assessment methodology, of magnitude of gas production, reservoir potential, of costs and benefits and greenhouse gas reduction potential] | Data on technical and economic characteristics of the demo sites are sufficient to make techno-economic analysis |
| 4.2 Action plan adopted by MOC to promote CBM methane recovery | An action plan is agreed by Q a of yr b  
[Documentation and official publication of the plan] | Sufficient CBM resources exist that can be extracted economically for large-scale development |
| 4.3 A CBM clearinghouse located at CMPDI | CBM Clearinghouse established  
[Documentation on official inauguration of the Clearinghouse]  
An average of X guests served in yr a  
[Guestbook, internet logins, record of services provided] | Public and private sector is interested in CBM activities |
| 4.4 Additional courses on CBM added to ISM curriculum | CBM training course started by Q a - yr b  
[Course materials; documentation on provision and completion of the course; number of participants] | |