METHANE TO MARKETS CONFERENCE
NEW DELHI

POTENTIAL FOR CMM / AMM / CBM IN INDIA

By

Prem Sawhney, Sr. Vice President (CBM)
Reliance Industries Limited

February 22, 2007
OUTLINE

- CH₄-Valuable energy resource
- CMM
- AMM
- Possibilities for CMM / AMM in India
- Carbon Credit Potential
- Path forward
- Conclusions
CH$_4$ - A valuable energy resource gets generated during the process of coalification and remains adsorbed in the coal seams. This resource is being commercially harnessed in many countries using following techniques:

- CBM - To exploit commercial value of gas ahead of mining and make the coal mining safe
- CMM - To realize the commercial value from methane production during coal mining operations. Adds value and avoids accidents
- AMM - To tap the remaining commercial value from residual methane gas from abandoned mines
### CH₄ - VALUABLE ENERGY RESOURCE

#### TYPICAL CBM CONCENTRATIONS AND FLOWS FROM VARIOUS SOURCES

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Methane Concentrations (%)</th>
<th>Pure Methane Flow, m³/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM</td>
<td>&gt;95</td>
<td>4000-10000</td>
</tr>
<tr>
<td>CMM</td>
<td>35-75</td>
<td>6000-194000</td>
</tr>
<tr>
<td>Ventilation Air</td>
<td>0.05-0.8</td>
<td>4000-130000</td>
</tr>
<tr>
<td>AMM</td>
<td>35-80</td>
<td>11000-86000</td>
</tr>
</tbody>
</table>

*Source: Technology status report, DTI, 2001*
METHANE GAS – EXTRACTION & UTILIZATION

1. Improves safety & productivity
2. Power generation
3. Power transmission
4. Fertilizer / petrochemical manufacture
COMMERCIAL METHANE SOURCES FROM COAL IN UK, USA & CHINA

CH$_4$ - VALUABLE ENERGY RESOURCE
### INDIA’S CMM EMISSIONS (MILLION CUBIC METRES)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CMM Emissions (no utilization)</td>
<td>763*</td>
<td>957.3</td>
<td>959*</td>
<td>1106*</td>
<td>1363 *</td>
</tr>
</tbody>
</table>

Data provided in gigagrams has been converted to million cubic meters where 1MCM =0.679 Gg

Source: UNFCCC(1994);   * USEPA (2006)
CBM / CMM / AMM: INDIA

- CBM: DGH has awarded 26 blocks for extraction of CBM from virgin seams from 3 bid rounds, thus far

- UNDP/GEF/GOI collaboration Project: Under development in one of CIL's companies to demonstrate the commercial feasibility of utilizing methane gas

- AMM projects yet to be taken up
METHANE EXTRACTION BY JIM WALTERS RESOURCES, INC., USA

- Jim Walter Resources, Inc (JWR) operates underground mines in Black Warrior & other basins in USA

- Methane drainage techniques developed for mining of coal from highly gassy seams

- Methane extraction and utilization added commercial value to coal mining
  - Methane drainage started in 1979 and commercial sales started in 1982
Methods adopted for methane drainage:

- **Ahead of Mining**: VCBM
  - Hydraulically stimulated vertical wells

- **During Mining**: CMM
  - Horizontal methane drainage boreholes

- **After Mining**: CMM
  - Gob wells to remove methane released from strata above and below the coal bed which also prevents overflow of methane from gob into mine ventilation system
  - Gob wells are drilled and made ready for production in advance of longwall mining
  - Gob wells are high gas production wells

METHANE EXTRACTION BY JIM WALTERS RESOURCES, INC., USA

CMM - CASE STUDY
METHANE EXTRACTION BY JIM WALTERS RESOURCES, INC., USA

GOB WELL CAPTURE EFFICIENCY

LONGWALL NO. 1

FACE 12%

BLEEDERS 26%

GOB WELLS 62%

LONGWALL NO. 2

FACE 9%

BLEEDERS 34%

57% GOB WELLS
METHANE EXTRACTION BY JIM WALTERS RESOURCES, INC., USA

Brookwood coal degasification field, Black Warrior basin, USA

Gob gas plant

Gas compression Station
Gas remaining in the disturbed unmined coal in an abandoned mine represents the AMM reservoir.

Sealing of air leakage from surface to avoid dilution of the gas in the mine is important in AMM Projects

Rising water levels in the workings reduce and isolate the volume of coal available for gas extraction

AMM projects are in operation in countries like UK, Germany & USA
AMM APPROACH

Extraction Unit

Old pit head

Extraction Unit

No Gas Vented

Local Works
(No Imported Fuel)

Usable Gas

Abandoned Mine Workings

Methane in Fractured Strata

Unworked Coal Seams

Methane extraction using disused/unfilled mine shaft
POSSIBILITIES FOR CMM/AMM IN INDIA

- Working and abandoned gassy coal mines in India can be ideal targets:
  - Areas where mining is planned (5-7 years ahead)
  - Active Mines
  - Abandoned Mines

- Coal companies may possibly consider developing these resources by forming an alliance with experienced operators.
POSSIBILITIES FOR CMM / AMM IN INDIA

PROPOSED ALLIANCE STRUCTURE

METAHNE ALLIANCE STRUCTURE

CMM / AMM OPERATOR

Agreement with Mine operator for CMM / AMM

Sets up system, operates and pays expenses

Sells the gas, obtains revenues & pays royalties

MINE OPERATOR

Owns coal rights

Grants leaseholds for CMM / AMM

Obtains royalties, may share expenses and revenues
CMM / AMM OPERATOR’S ROLE

- CMM / AMM Operator shall bring the following:
  - Resource modeling of coal seams under de-stressed conditions for initial gas resource and gas production estimates
  - Design and management of gas drainage systems
  - Gas clean-up techniques, gas enrichment and blending
  - Usage of gas
CARBON CREDIT POTENTIAL OF CMM / CBM

- Kyoto Protocol envisages greenhouse gas emission credits (carbon credits) for methane capture and utilization
  - Approved base line methodology for methane capture and utilization is in place for CMM projects
  - China has several CMM projects registered with UNFCC

- Revenue from a CBM / CMM could be substantially increased by sale of carbon credits
Development of coal-field specific databases & carrying out assessment of potential

Delineation of CMM / AMM blocks. Coal producing companies may carve out areas of few hundred square kms for methane drainage

The blocks so formed may be allocated to experienced operators by forming joint ventures through:
  - International competitive bidding
  - Selection from pre-qualified operators

Fiscal terms & conditions could be similar to CBM Exploration & Production Policy
CONCLUSIONS

- Indian coalfields have a potential for exploiting the valuable energy source of methane from coal

- There has been progress in CBM, but steps for developing CMM & AMM need to be taken up
THANK YOU