Coal Mine Methane Recovery & Utilization: A Global Overview of Project Opportunities

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Total Global Methane Emissions (2000) = 6020 MtCO2e (422 billion cubic meters)

Coal mine methane (CMM) emissions are about 8% of global anthropogenic methane emissions.
Global Emissions of Coal Mine Methane (CMM)

- China
- United States
- Ukraine
- Australia
- Russia
- India
- South Africa
- Poland
- Kazakhstan
- Germany
- United Kingdom
- Czech Republic

**CMM Emissions (MMTCO2e)**

**CMM Emissions Avoided (MMTCO2e)**
**Potential Sources of CMM for Recovery & Use Projects**

**Sources of CMM**

- **Ventilation Air Methane**
  - Ventilation shafts produce large volumes of very dilute methane (~1% or less) that is challenging to recover.

- **Pre-Mine Drainage**
  - "Drainage" of CMM from active or closed mines yield gas streams quality ranging from low to high concentrations of methane.

- **Gob/Goaf Gas**

- **Abandoned (closed) Mine Methane**

- **In-Mine Recovery**

*Photos Courtesy Various Sources*
CMM End-Use Opportunities

High-Quality Gas
- Natural gas pipelines
- Local distribution
- Vehicle fuel (LNG)

Medium-Quality Gas
- Power generation
- Combined heat & power
- District heating
- Coal drying
- Boiler fuel
- Industrial applications
- Fuel cells

Low-Quality Gas & Ventilation Air Methane
- Oxidation
- Combustion air
- Lean burn turbines
Global CMM Activities

- 14 countries have CMM drainage at active mines
- 12 countries have CMM recovery and utilization activities at active and/or abandoned mines
- > 200 CMM projects worldwide
- > 3.8 billion cubic meters of methane emissions avoided per year
Global Opportunities: Active mines

- Many ways to increase CMM recovery and use at active mines
  - Increasing gas drainage efficiency and recovery
    - More pre-mining and gob/goaf degasification systems
    - Integrate drainage: pre-mining and closed sections
  - Improve gas quality through upgrading / refining technologies
  - Tailor end-use technologies to utilize lower quality gas (e.g., below 50% methane)
  - Improve infrastructure (e.g., gas pipelines)
Global Opportunities: Abandoned mines

- In many countries, a relatively untapped resource
- Advantages:
  - Project is independent of mine operation
  - Great potential for emissions reductions
- Challenges:
  - Predicting gas flow and designing appropriate size project
  - Risk of flooding
  - Ownership claims can be complex
- United Kingdom, Germany are world leaders in abandoned mine methane recovery
  - Numerous projects, especially power generation
Global Opportunities: Ventilation Air Methane (VAM)

• Ventilation systems are most significant source of CMM emissions
  • Account for 50% of global CMM emissions
  • 230 MMTCO2e (16 Bcm) emitted in 2000
  • M2M Partners emit 85% of all VAM emissions

• Typically contains low methane concentrations (below 1%)
  • Presents technical, economic challenges to recover
Global opportunities: Ventilation Air Methane (VAM)

- Technological advances:
  - Oxidation technology has been demonstrated
  - Other technologies under development

- Global interest in mitigating and recovering VAM emissions
  - 5 demonstration projects underway in Australia, China, USA
Global Challenges to CMM Project Development

1. Lack of clarity about legal and regulatory issues, especially gas ownership
2. Lack of technology and technical knowledge
   - Resource assessment, technology selection, formulating feasibility studies
3. Lack of pilot projects to demonstrate site-specific economic recovery & utilization
4. Lack of financing or capacity to obtain financing
Examples of M2M Activities to Address Barriers

- Pre-feasibility and feasibility studies
  - Pre-feasibility study of VAM oxidation in Huainan, China (USEPA)
  - Feasibility studies for CMM projects in China and Ukraine (USTDA)
- Demonstration projects
  - Drilling technology in Ukraine (US AID / US Dept. of Labor)
  - Ventilation air methane technology in China (Australia CSIRO)
- Project finance capacity-building
  - USEPA – UNECE program to develop financing capacity for coal mine methane projects
- Workshops and training to increase technical knowledge
• Supporting in-country information centers
  – USEPA support for China Coalbed Methane Clearinghouse (CCII)
  – USEPA and Government of India are working to establish Coal Mine Methane / Coalbed Methane Clearinghouse

• Development of information resources
  – Methane to Markets website
  – Global Overview of CMM Opportunities
  – Global Database of CMM Projects
  – Database of Technologies to Recover and Utilize CMM
  – White Paper: Ownership and Regulatory Issues (in development)
  – White Paper on Standard Terminology for CMM and CBM
  – White Paper on CMM Flaring
China: Opportunities for CMM Projects

- **CMM emissions: 1st globally**
  - Nearly 200 MMTCO2e in 2004 (~14 billion cubic meters)

- **1st in global coal production**
  - ~90% of coal production is from underground mines
  - ~50% of large, state-owned mines are considered gassy

- **Challenges to CMM development:**
  - Most mines are not accessible to gas pipeline network
  - Limited drainage technologies/low drainage rates
  - Regulations for foreign project developers may be unclear
China: Opportunities for CMM Projects

• Over 200 mines have drainage systems (2004)
• ~ 60 CMM projects currently operating at active mines: total 240 million cubic meters/yr
  – Power generation: over 100 MW total installed capacity
  – Town gas (heating / fuel): over 500,000 households
  – Boiler fuel
  – Industrial applications
  – Vehicle fuel
• Many more CMM projects planned, under development (~240 million cubic meters/yr)
  – Power generation: Over 220 MW additional capacity
  – Town gas: 46,000 more households
  – Vehicle fuel
  – Industrial / chemical uses
Sihe Mine, Jincheng Mining Group, Shanxi Province

120 MW power generation project to use IC engines
  - World’s largest CMM power generation plant

$237 million project funding from ADB, World Bank, local entities, JBIC, US TDA
United States: Opportunities for CMM Projects

• CMM emissions: 2\textsuperscript{nd} globally
  • 56 MMTCO\textsubscript{2}e of CMM emissions in 2003 (~ 4 billion cubic meters)

• 2\textsuperscript{nd} in global coal production
  • About one-third of coal is produced from underground mines
  • Fewer than 50 operating mines are considered gassy
  • 18 underground mines conduct drainage
  • Over 400 gassy abandoned mines identified as potential project sites

• Relatively few challenges to CMM development
  • Low electricity prices
  • Methane ownership regulations can be unclear
  • Sparse natural gas pipeline infrastructure in western US
United States: Current CMM Projects

- ~10 CMM projects operating at active mines
- Most projects inject natural gas into pipeline network
- 90 MW total power generating capacity (peaking power)
- 1.1 billion cubic meters/yr emissions avoided (2005)
- About 20 projects use gas from ~ 30 abandoned mines
- Demonstration VAM oxidation project underway at a closed mine in West Virginia
  - Sponsored by US DOE, US EPA, CONSOL Energy, MEGTEC
Ukraine: Opportunities for CMM Projects

- **CMM Emissions: 3rd globally**
  - 27 MMTCO2e of CMM emissions in 2001 (about 1.9 billion cubic meters)

- **11th in global coal production**
  - Almost all coal production from underground mines, >75% considered gassy (2001)

- **Challenges to CMM development:**
  - Lack of investment in new degasification infrastructure
  - Poor degasification system maintenance
  - No competitive pricing or market system for coal or gas
  - Lack of natural gas transportation infrastructure
Ukraine: Current CMM Projects

• About 10 CMM projects operating or being developed at active mines
  • ~14% of liberated CMM is recovered and used: 178 million cubic meters avoided (2005)
  • 42 mines have degasification systems
  • CMM uses: power generation; heating / boiler fuel; industrial applications; vehicle fuel

• Noteworthy projects
  • Krasnolmanskaya Mine: US Dept. of Labor / US AID in-mine drilling project
  • Zasyadsko Mine: 131 MW generation project planned in stages (begun 2004)
  • US TDA grant for feasibility study for CBM / CMM project
Russia: Opportunities for CMM Projects

- **CMM Emissions: 4\textsuperscript{th} globally**
  - \(\sim 21 \text{ MMTCO}_2\text{e}\) of CMM emissions in 2003 (\(\sim 1.4\) billion cubic meters)

- **5\textsuperscript{th} in global coal production**
  - 44\% of mines are underground (2005); 85\% of underground mines are considered gassy

- **Coal industry was restructured and privatized (1996 – 2001)**
  - 77\% of coal now comes from independent producers

- **Challenges to CMM development**
  - Large competing natural gas resources with low, state-regulated gas sales price
  - Lack of appropriate technology
  - Complex rules on foreign investments
Russia: Current CMM Projects

- CMM utilization projects at mines in Kuzbass and Pechora Basins
  - ~ 43 million cubic meters emissions avoided, primarily in Pechora
  - Boiler fuel, power generation, mine heating projects
  - UNDP and GEF project (ongoing): remove barriers to financing and implementing CMM recovery and utilization projects
Australia: Opportunities for CMM Projects

- **CMM Emissions: 5th globally**
  - 22.6 MMTCO2e of CMM emissions (estimated, 2005), ~1.6 billion cubic meters

- **4th in global coal production**
  - NSW: 59% from underground mines

- **Few challenges to CMM/CBM development**
  - No national legislative framework for CMM (state level only)
Australia: Current CMM Projects

• About 11 CMM projects operating at active mines
  • At least 7 additional projects in development
  • 445 million cubic meters of emissions avoided per year
  • CMM projects generate 169 MW capacity

– World’s first commercial-scale VAM oxidation project operating at West Cliff Colliery (WestVAMP)
India: Opportunities for CMM Projects

- **CMM emissions: 6th globally**
  - 14.3 MMTCO2e (estimated 2005), ~1 billion cubic meters
- **3rd in global coal production**
- **About 15% of production is from underground mines**
  - ~24 underground mines classified as “Degree III” gassy mines
- **Challenges to CMM/CBM development include:**
  - Technology development due to cost and lack of investment capital
  - Lack of natural gas transportation infrastructure
  - Ambiguous policies regarding CMM development
India:
Current CMM Activities

• Currently no CMM projects operating, but some drainage in place

• Noteworthy projects / activities
  • Global Environment Fund project: to demonstrate commercial feasibility of utilizing methane gas recovered before, during, and after coal extraction. CMM to be used for power generation and CNG for mine vehicles.
Conclusions

• Methane to Markets Partner countries account for majority of global CMM emissions

• Globally, enormous potential exists for CMM recovery
  • Active mines: drained gas and ventilation air methane
  • Abandoned mines

• Extensive project, technological experience can be shared to move projects forward

• CMM projects are triple winners:
  • Greenhouse gas emissions reductions
  • Source of local, clean energy
  • Economic revenues
Thank you! Xie xie!

www.epa.gov/coalbed
www.methanetomarkets.org

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