



**Methane to Markets**



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

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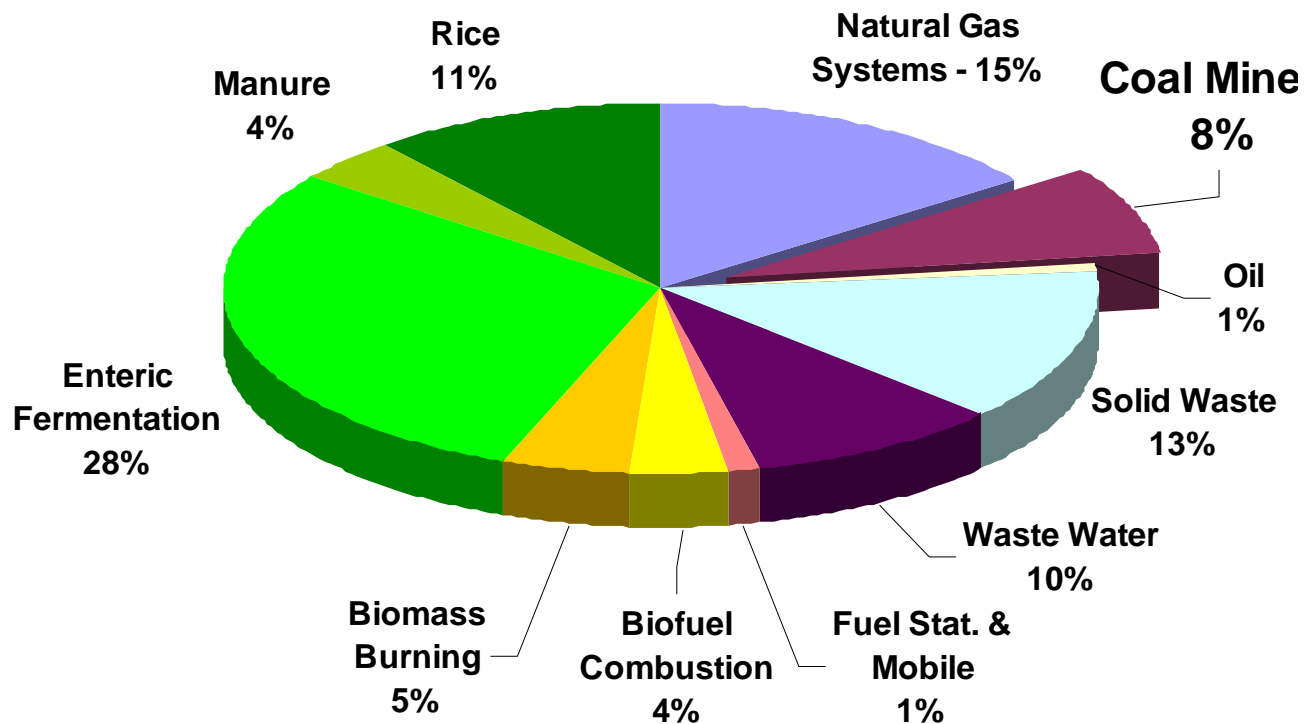
*Methane to Markets Partnership Expo  
October 30, 2007  
Beijing, China*



# Global Methane Emissions

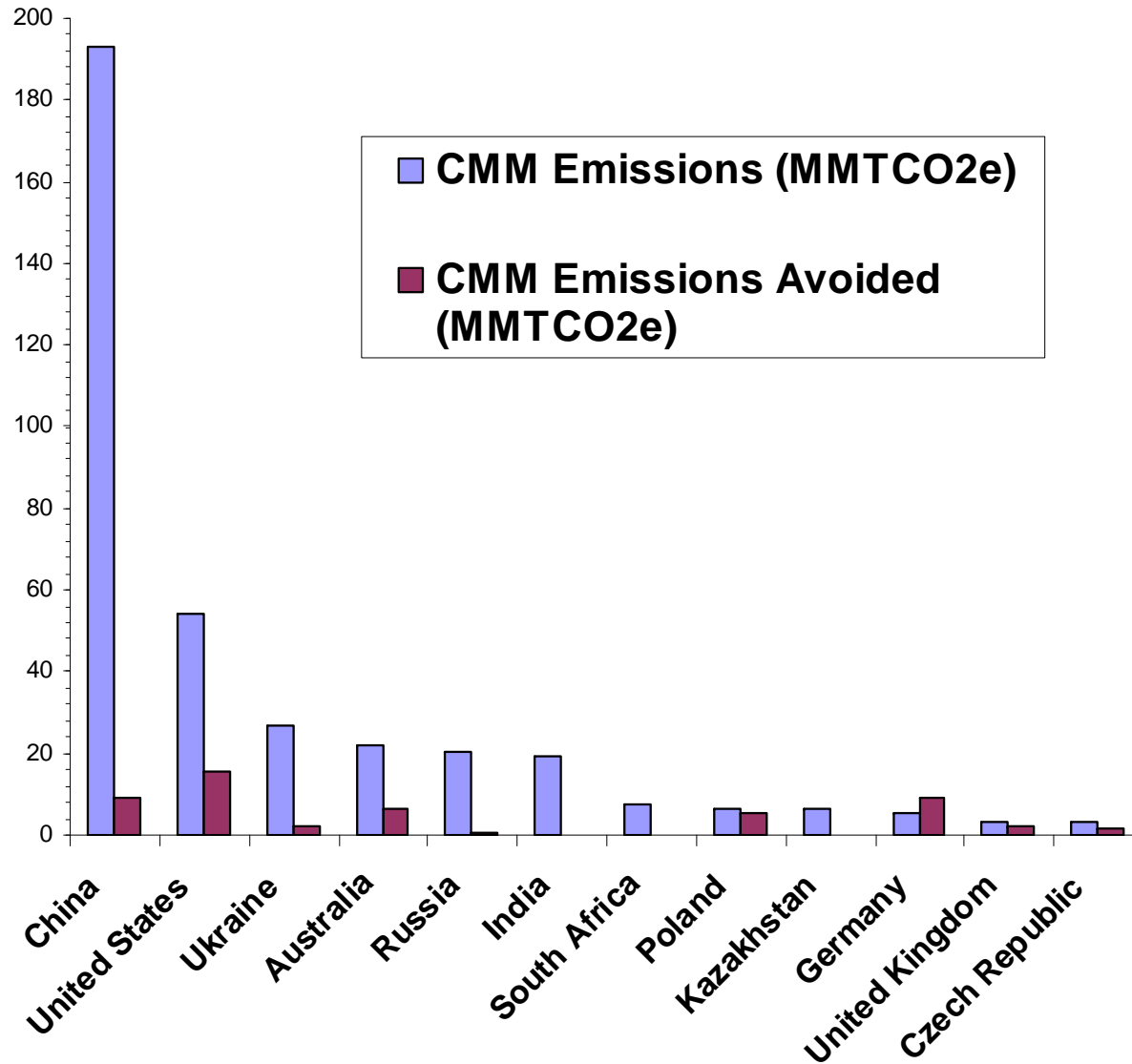
Total Global Methane Emissions (2000)

= 6020 MtCO<sub>2</sub>e (422 billion cubic meters)

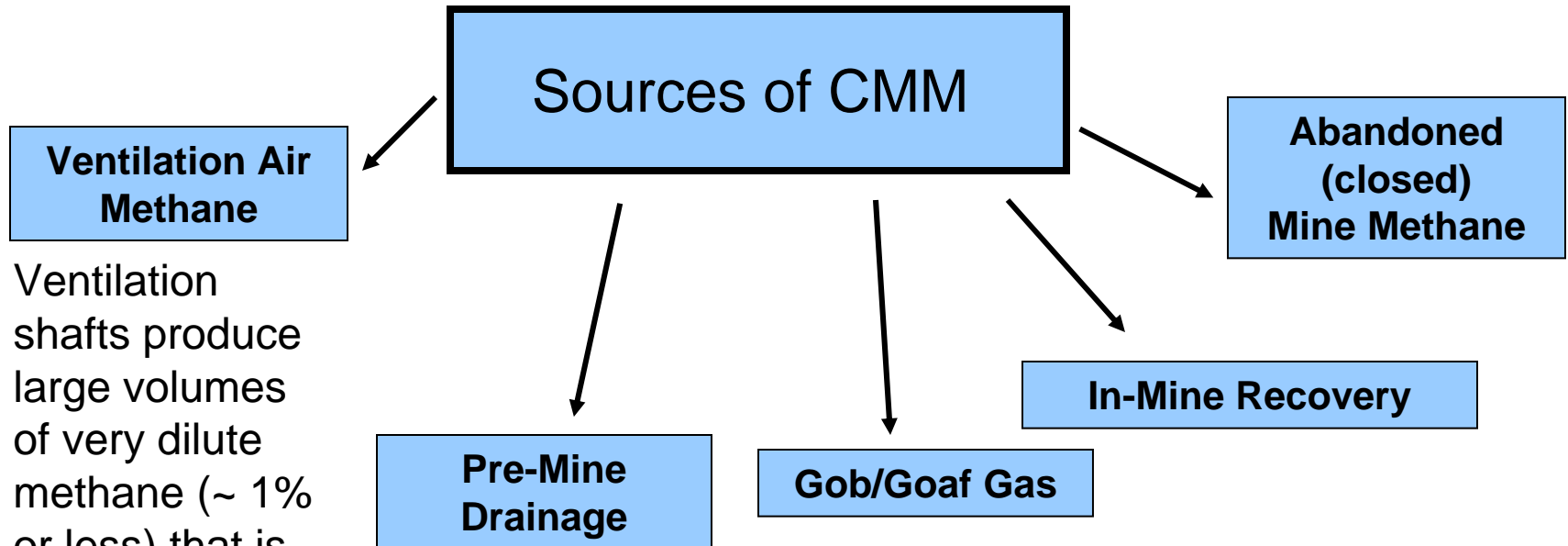


**Coal mine methane (CMM) emissions are about 8% of global anthropogenic methane emissions**

# Global Emissions of Coal Mine Methane (CMM)



# Potential Sources of CMM for Recovery & Use Projects



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



“**Drainage**” of CMM from active or closed mines yield gas streams quality ranging from low to high concentrations of methane



## 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

- 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*

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- 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*

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- 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)*

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- Ventilation systems are most significant source of CMM emissions
  - Account for 50% of global CMM emissions
  - 230 MMTCO<sub>2</sub>e (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)*

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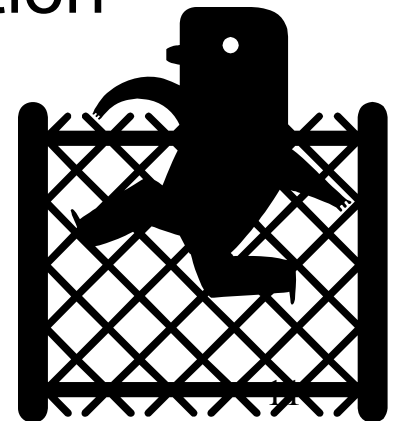
- Technological advances:
  - Oxidation technology has been demonstrated
  - Other technologies under development
- Global interest in mitigating and recovering VAM emissions
  - 5 demonstration projects underway in Australia, China, USA



# *Global Challenges to CMM Project Development*

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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*

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- 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
  - Successful workshops in Beijing (2005), Geneva (2006), Brisbane (2006)

- 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*

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- **CMM emissions: 1<sup>st</sup> globally**
  - Nearly 200 MMTCO<sub>2</sub>e in 2004 (~ 14 billion cubic meters)
- **1<sup>st</sup> 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*

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- 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



# China: CMM project profile

- 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*

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- **CMM emissions: 2<sup>nd</sup> globally**
  - 56 MMTCO<sub>2</sub>e of CMM emissions in 2003 (~ 4 billion cubic meters)
- **2<sup>nd</sup> 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*

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- ~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*

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- **CMM Emissions: 3<sup>rd</sup> globally**
  - 27 MMTCO<sub>2</sub>e of CMM emissions in 2001 (about 1.9 billion cubic meters)
- **11<sup>th</sup> 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*

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- **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*

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- **CMM Emissions: 4<sup>th</sup> globally**
  - ~ 21 MMTCO<sub>2</sub>e of CMM emissions in 2003 (~ 1.4 billion cubic meters)
- **5<sup>th</sup> 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*

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- **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*

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- **CMM Emissions: 5<sup>th</sup> globally**
  - 22.6 MMTCO<sub>2</sub>e of CMM emissions (estimated, 2005), ~1.6 billion cubic meters
- **4<sup>th</sup> in global coal production**
  - NSW: 59% from underground mines
  - 340 million tonnes produced (2004)
- **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*

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- **CMM emissions: 6<sup>th</sup> globally**
  - 14.3 MMTCO<sub>2</sub>e (estimated 2005), ~ 1 billion cubic meters
- **3<sup>rd</sup> 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*

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- **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.

- 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



Methane to Markets

# Thank you! Xie xie!

[www.epa.gov/coalbed](http://www.epa.gov/coalbed)

[www.methanetomarkets.org](http://www.methanetomarkets.org)



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