Coal Mine Methane: Reducing Emissions, Advancing Recovery and Use Opportunities

The Global Methane Initiative (GMI)

The Global Methane Initiative (GMI) is a voluntary, multilateral partnership that aims to reduce global methane emissions and to advance the abatement, recovery and use of methane as a valuable clean energy source. GMI achieves this by creating an international network of partner governments, private sector members, development banks, universities and non-governmental organizations in order to build capacity, develop strategies and markets, and remove barriers to project development for methane reduction in Partner Countries.

Launched in 2004, GMI is the only international effort to specifically target the abatement, recovery and use of the greenhouse gas (GHG) methane by focusing on the five main methane emission sources: agriculture, coal mines, landfills, municipal wastewater, and oil and gas systems. The Initiative works in concert with other international agreements, including the United Nations' Framework Convention on Climate Change, to reduce GHG emissions. Unlike other GHGs, methane is the primary component of natural gas and can be converted to usable energy. The reduction of methane therefore serves as a cost-effective method to reduce GHGs and increase energy security, enhance economic growth, improve air quality and improve worker safety.

Why Target Methane?

Methane (CH_4), the second most important manmade greenhouse gas (GHG) after carbon dioxide (CO_2), is responsible for more than a third of total anthropogenic climate forcing. It is also the second most abundant GHG accounting for 14 percent of global GHG emissions. Methane is considered a "short-term climate forcer," meaning that it has a relatively short lifespan in the atmosphere, approximately 12 years. While methane is in the atmosphere for a shorter period of time and is emitted in smaller quantities than CO_2, its ability to trap heat in the atmosphere, which is called its "global warming potential," is 21 times greater than that of CO_2.

Methane is emitted during the production and transport of coal, natural gas and oil. Emissions also result from the decay of organic matter in municipal solid waste landfills, some livestock manure storage systems, and certain agro-industrial and municipal wastewater treatment systems. Methane offers a unique opportunity to mitigate climate change and simultaneously increase available energy supply. However, without more stringent measures to reduce sources, methane emissions are expected to increase approximately 45 percent to 8,522 million metric tons of carbon dioxide equivalent ($MMTCO_2E$) by 2030. GMI Partner Countries represent approximately 70 percent of the world's estimated anthropogenic methane emissions and include the top 10 methane-emitting countries. Cumulative methane emission reductions that can be attributed to GMI total nearly 128.3 $MMTCO_2E$.

Background on Coal Mine Methane Emissions

Methane is emitted from active and abandoned underground and surface mines, and as a result of post-mining activities (including coal processing, storage and transportation). The implementation of cost-effective methane emission reduction initiatives in the coal industry can yield substantial economic and environmental benefits, such as improved mine safety, greater mine productivity, increased revenues and reduced greenhouse gas emissions. To facilitate project development, GMI is building international alliances to advance methane recovery and use at underground coal mines throughout the world.

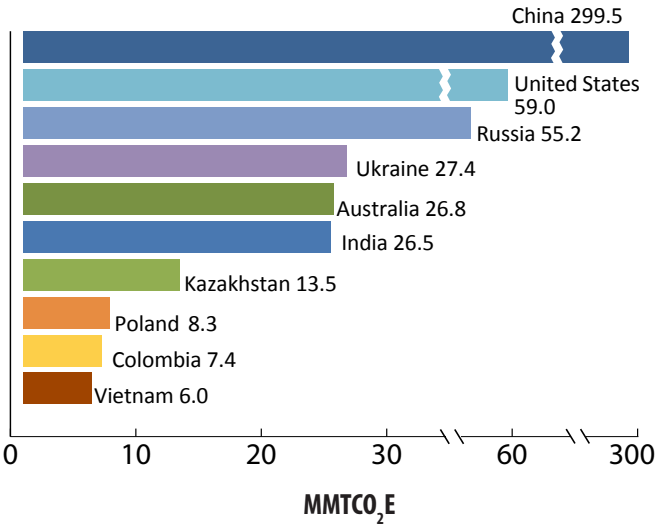
Underground mines are the single largest source of coal mine methane (CMM) emissions in most countries. For years, methane in coal mines was viewed as a nuisance and a safety hazard that had little intrinsic value. Current CMM recovery and use projects have shown that the opposite is true: CMM is a clean energy source and a commodity that, when captured, can provide many benefits to the mine; the local, regional and national communities; and the global environment.

In 2010, global methane emissions from coal mines were estimated to be approximately 584 $MMTCO_2E$, accounting for 8 percent of total global methane emissions. Figure 1 presents methane emissions from the coal mine sector in selected GMI countries.

[1] U.S. EPA, 2011. *DRAFT: Global Anthropogenic Emissions of Non-CO_2 Greenhouse Gases: 1990–2030* (EPA 430-D-11-003), www.epa.gov/climatechange/economics/international.html.

Figure 1: Estimated Global Methane Emissions From Coal Mines in Top Ten GMI Countries, 2010*

*The countries depicted in the below figure had the highest coal mine methane emissions in 2010. Total coal mine methane emissions in 2010 was 584 $MMTCO_2E$.



Recovery and Use Opportunities

At active underground mines, methane must be removed from underground operations for safety reasons. This is achieved with large-scale ventilation systems that move massive quantities of air through the mines. These ventilation systems keep mines safe, but also release large amounts of very-low-concentration ventilation air methane (VAM) into the atmosphere. In many underground coal mines, VAM is often the largest source of CMM. At some active and abandoned mines, methane is also produced from degasification systems (commonly referred to as gas drainage systems) that employ vertical and/or horizontal wells to recover methane.

There are a variety of profitable uses for CMM, and the optimal use at a given location depends on factors such as the quality of methane, availability of end-use options and project economics. The range of CMM projects includes natural gas pipeline injection, electric power production, co-firing in boilers, district heating, mine heating, coal drying, vehicle fuel, flaring, and manufacturing/industrial uses such as feedstock for carbon black, methanol and dimethyl ether production. More recent technologies can oxidize VAM to generate useful thermal energy for the production of heat, electricity and refrigeration (see "VAM Global Overview" on page 3).

Issues for Project Development

To develop successful CMM emission reduction projects, mine owners must address a range of issues from project conception through installation and operation. Successful projects require a thorough methane resource assessment and gas liberation analysis, effective integration of mine degasification and utilization with mining operations, and a ready market for the methane. Although there has been substantial progress in implementing CMM projects in recent years, project stakeholders can face a range of technical, economic and institutional issues which impede progress. Important issues for stakeholders to consider include:

- Recognizing that methane is a commodity with a practical and profitable use, rather than a nuisance and a safety hazard.
- Ensuring that coal mines and project developers have access to appropriate modern methane drainage and use technologies and training to utilize this valuable resource.
- Establishing an appropriate mechanism for the collection and dissemination of credible and unbiased data, including technical and market information.
- Clarifying the laws, regulations and policies that govern CMM capture and use and addressing any deficiencies or limitations.
- Providing access to capital markets.

Highlights of the GMI Coal Mine sector's efforts include:

- ***Country-specific strategic plans*** help Partner Countries focus on overcoming technical, financial and regulatory barriers to CMM project development. http://www.globalmethane.org/coal-mines/index.aspx
- ***International CMM Projects Database*** provides a fast overview of methane recovery and use opportunities around the world. http://www2.ergweb.com/cmm/index.aspx
- ***CMM Country Profiles,*** a publication with comprehensive profiles, summarizes the coal and CMM sectors of 37 coal-producing countries, including 29 GMI Partners and an additional eight coal-producing nations. http://www.globalmethane.org/tools-resources/coal_overview.aspx
- ***Full-scale feasibility studies*** at sites in China and Poland.
- ***Pre-feasibility studies*** at coal mines in China, Mongolia, Nigeria, Ukraine, Poland and India.
- ***Project financing sessions*** raise awareness of the economic benefits and opportunities of CMM recovery and utilization projects around the world. http://www2.ergweb.com/cmm/index.aspx

➲ The following examples showcase the types of activities undertaken by GMI and its Partner Countries.

Global VAM Projects

In the last five years, VAM projects using the thermal flow reverse reactor (TFRR) technology have been developed commercially in Australia, China and the United States. The VAM project at the West Cliff Colliery mine of BHP Billiton in New South Wales, Australia, was the world's first commercial-scale demonstration of VAM processing and power generation. The energy released when oxidizing 0.9 percent VAM generates high-grade steam designed to suit a conventional steam turbine. The project, commissioned in 2007, uses the MEGTEC Systems VOCSIDIZER™. The project handles 250,000 cubic meters (m^3) per hour of ventilation air and uses a waste heat steam turbine to generate around 5 megawatts (MWs) of electricity and more than 625,000 carbon credits. MEGTEC Systems, a GMI Project Network member, estimates that the system achieves 95 to 98 percent nominal heat exchange efficiencies. As shown in Figure 2, VAM processing fans pull the ventilation air from the evasee and push it through the TFRR. The photograph also shows the steam cycle and steam turbine hall.

Figure 2. VAM power plant at the West Cliff Colliery mine of BHP Billiton in Australia

In April 2008, GMI Project Network member Biothermica Technologies received authorization to implement a VAM oxidation project at Jim Walter Resources' Coal Mine #4 in the state of Alabama. The project, the first of its kind at an active underground coal mine in America, has been successfully oxidizing VAM since January 2009. As of September 2011, the Biothermica VAMOX system has operated for more than 17,500 hours and reduced emissions by approximately 65,000 TCO_2E. The VAMOX system can operate within a proven methane concentration range of 0.4 to 1.5 percent methane.

In 2010, the Datong mine in China's Chongqing municipality contracted with MEGTEC to build the largest plant in the world to capture and eliminate VAM. The project is a joint venture owned by Shenzhen Dongjiang Environmental Renewable Energy Company Ltd., Songzao Coal and Electricity Company Ltd. (SCEC), and the United States-based global power generation company AES Corporation. Capturing the 375,000 m^3 of air exiting the mine ventilation systems, the Datong mine project uses MEGTEC VOCSIDIZERS™ to oxidize the VAM. Some of the heat generated during oxidization is used to produce hot water for mine workers. The Datong VAM system will reduce emissions by 180,000 $MMTCO_2E$ annually.

Liquefying CMM for Energy Use in China

The Chongqing Energy Investment Group (CEIG) and its subsidiary, SCEC, are developing a project to gather, purify and liquefy as much as 130 million m^3 annually of medium-quality CMM from Songzao's six operating coal mines in Chongqing Municipality, in southwest China. The resultant liquefied natural gas (LNG) will be transported by truck for use locally and in booming natural gas consumption centers to the south and east. The provincial government owners are considering adding a second plant with an annual capacity of 40 million m^3 to purify and liquefy future increases in methane production from these mines. The project also includes the construction of a 26.9-MW internal combustion engine at the new Songzao mines power stations, which will burn an additional 38 million m^3 per year of CMM that cannot be transported economically to the LNG plant. The owners anticipate that the project will come online in 2012 and generate approximately 2.93 $MMTCO_2E$ of emissions reductions annually and 44 $MMTCO_2E$ over its 15-year lifetime.

Figure 3. Pump station in Songzao coal mining area

GMI at Work

GMI brings the collective resources and experience of partners together to facilitate technology transfer and demonstration, policy support, capacity building and market development necessary to realize implementation of CMM projects and increase CMM emission reductions. GMI works to improve awareness of emission reduction opportunities, advance technology transfer to ensure broad adoption of emission reduction technologies, improve and facilitate access to capital to support project investment, and provide legal and regulatory frameworks that encourage project development.

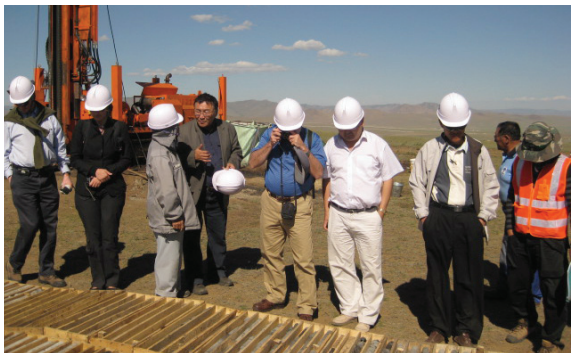
Additional Tools and Resources

- ***Coal Mine Technology Database.*** This database provides basic descriptions of several key technologies applicable to CMM recovery and utilization, including each technology's current status and commercial availability. It is intended to be a living document, which will be periodically updated to remain current. The database is an updated and revised version of the original database compiled by Australia's Department of Industry, Tourism and Resources on behalf of GMI. It is intended for informational purposes only and does not imply endorsement by GMI. http://www.globalmethane.org/tools-resources/tools.aspx#two
- ***Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines.*** This is a joint publication by the United Nations Economic Commission for Europe and GMI. The document aims to provide guidance to mine owners and operators, government regulators and policymakers on the design and implementation of safe, effective methane capture and control in underground coal mines. It is intended primarily to encourage safer mining practices to reduce fatalities, injuries and property losses associated with methane. http://live.unece.org/fileadmin/DAM/energy/se/pdfs/cmm/pub/BestPractGuide_MethDrain_es31.pdf
- ***Clearinghouses.*** Clearinghouses developed in China, India and Russia support in-country CMM and coalbed methane outreach and project development. http://www.globalmethane.org/tools-resources/tools.aspx#two

Looking Forward

The GMI Coal sector will continue to focus on site-specific assessments and technology demonstrations that result in concrete emission reductions. These activities will be supported with capacity-building workshops and trainings in Partner Countries around the world.

Coal mine methane as vehicle fuel in Ukraine



Drilling rig and coal core samples at Mongolia's Nailakh Mine

VAMOX system at Jim Walter Resources Coal Mine #4 in the United States

For additional information, please visit the GMI website
www.globalmethane.org

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