UNITED
NATIONS

E

Economic and Social
Council

Distr.
GENERAL

ECE/ENERGY/GE.4/2008/4
29 July 2008

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

COMMITTEE ON SUSTAINABLE ENERGY

Ad Hoc Group of Experts on Coal Mine Methane

Fourth session
Geneva, 16-17 October 2008
Item 5 of the provisional agenda

REPORT OF THE WORKSHOP ON NEW TRENDS IN COAL MINE METHANE RECOVERY AND UTILIZATION

Note by the secretariat*

Summary

This document provides a summary of the proceedings of the workshop on New Trends in Coal Mine Methane Recovery and Utilization, held in Szczyrk, Poland from 27 to 29 February 2008. The workshop covered a wide range of technical and financial issues relating to coal mine methane capture and use. In addition to the summary, the presentations from the workshop are available at http://www.imf.net.pl/node/28.

* This document was principally prepared by the representative of the International Energy Agency, Mr. Ming Yang.

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I. MANDATE

1. The document has been prepared in response to a request from the Committee on Sustainable Energy at its sixteenth session (ECE/ENERGY/76, para. 26(f)).

II. INTRODUCTION

2. The Central Mining Institute of Katowice, AGH University of Science and Technology and the Mineral and Energy Economy Research Institute of Polish Academy of Sciences conducted a workshop in Szczyrk, Poland from 27 to 29 February, on New Trends in Coal Mine Methane Recovery and Utilization, to assess the current global and Polish opportunities for coal mine methane (CMM) recovery and use. The workshop was held as part of the annual School of Underground Mining and the associated International Mining Forum. Around 100 experts from Canada, Czech Republic, France, Germany, Poland, Romania, Russian Federation, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and United States of America participated in the workshop which consisted of a two-day technical session followed by technical tours of the Pniowek Mine of the Jastrzebie Coal Company and the Wieliczka Salt Mine.

3. The workshop was supported by the United Nations Economic Commission for Europe, the Methane to Markets Partnership, and the International Energy Agency.

4. Introductory presentations provided an overview of opportunities to recover and use methane from coal mines. The workshop received information on many countries including Ukraine, the Russian Federation, Australia, and India, but most discussion focused on China and the United States as the largest potential markets and Poland, as the host country.

5. Globally, there are over 200 ongoing projects in 14 countries capturing 3 billion m^3 of CMM per year. China is world leader in coal production and emissions of CMM, but it is also

very active in pursuing CMM projects. In China, about 200 mines have methane drainage systems in place, with 60 of those having CMM utilization projects in place. The most notable is in Jincheng, Shanxi Province, where the world's largest CMM power plant generates up to 120 MW of electricity. Project developers in China are notable too for their willingness to look at the full range of options including CMM for power generation, town gas, chemical feedstocks, and ventilation air methane (VAM) utilization.

6. The United States ranks as the second largest emitter of CMM emissions, and has an active history of CMM utilization in the United States. Currently 14 of the 20 active mines in the United States employing methane drainage are operating CMM utilization projects. The total number of gassy coal mines in the United States is about 125, but real project potential is probably limited to 50 mines. In addition there are projects at a number of closed mines. With high natural gas prices and a very well-developed pipeline infrastructure, most CMM captured in the United States is injected into the natural gas pipeline system. Other uses, though, are being considered where pipeline access is limited or uneconomical.

7. As the host country, there was considerable focus on Poland at the workshop. There are three major coal resources in Poland: (i) the Upper Silesian Coal Basin; (ii) Lower Silesia Coal Basin (fully abandoned); and (iii) Lublin Coal Basin. At present, there are 33 active coal mines, 29 of which are classified as gassy. As in many other European countries, the number of coal mines in Poland has been decreasing over the past two decades. As a result, the actual number of gassy coal mines has also declined during this time, falling 48 per cent since 1989. However, as a percentage of all operating mines, gassy mines have increased their share.

8. Twenty of the 33 active mines in Poland are equipped with methane drainage systems, and 14 of those are using the produced CMM. Total CMM emissions in Poland were 870 million m^3 in 2006; about 30 per cent of which was captured by drainage systems and 70 per cent emitted into the atmosphere via the ventilation air. The potentially recoverable methane resources in Polish mining areas total 29.8 billion m^3, thus there remains substantial opportunity for capture and use programmes.

III. KEY ASPECTS OF A SUCCESSFUL CMM PROJECT

9. Before moving into the detailed aspects of CMM project development, the workshop first considered more broadly the components of a successful project. The lead presentation was delivered by a project developer with CMM projects in the United Kingdom and other European countries. In the United Kingdom, there are five active coal mines in operation and more than 1,000 abandoned coal mines, with a combined total of 25 projects at active and abandoned mines. With so many closed mines, there is a great potential to use CMM as a strategic local source of clean energy and to save up to 4.5 million tonnes of CO_2 emissions per annum. To succeed, however, most CMM projects must be supported by stable commodity prices, prices for renewable and/or green energy, a clear regulatory and legal framework, and reasonable access to markets.

10. As an example, participants were shown a case study. In 2004 and 2005, the wholesale electricity price in the United Kingdom fell to about £15 per MWh, and only CMM projects

already in operation were economically feasible. The typical production costs of power from CMM including capital costs are around £13 per MWh. Electricity prices began to rise in 2005, and more and more projects became economically viable. By February 2008, the electricity price had risen to over £50 per MWh giving a strong impetus to build additional CMM plants.

11. In closing, the session noted that internationally, CMM could provide a huge amount of energy with potential in excess of 1 GW of power generation. Further, the global potential for CMM projects to contribute to climate change mitigation and take advantage of the carbon markets is very strong because a reduction of one tonne of methane yields reductions of 18 to 23 tonnes of carbon dioxide equivalent (CO_2e).

IV. METHANE DEGASIFICATION

12. The workshop then focused on the principal components of a CMM project starting with the assessment of the methane resource and the degassing of the coals prior to, during and after mining.

13. Participants were introduced to the variety of technical options for degassing coals through vertical wells, gob wells, in-seam/in-mine horizontal boreholes, and cross-measure boreholes. Coals in Central and Eastern Europe have traditionally been very difficult to degas in advance of mining due to low permeabilities and a propensity for the holes to collapse. The traditional method of degassing in Europe and the countries of the Commonwealth of Independent States has been the use of cross-measure boreholes. However, new and innovative technologies such as long-hole in-mine directional drilling and horizontal wells drilled from the surface may offer more effective drainage in some cases. The meeting then received presentations on case studies including a very detailed presentation from the Jastrzebie Coal Company in Poland on its methane drainage and utilization activities.

V. VENTILATION AIR METHANE (VAM)

14. Conventional technologies employed to use drained methane such as pipeline injection and power generation are generally well understood. Therefore, for end-use options, the meeting focused on Ventilation Air Methane (VAM) which is the next frontier for CMM capture and use. The largest source of CMM emissions worldwide, VAM offers significant energy potential but its low methane concentrations, generally below 1.0 per cent make it very difficult to use. Whilst technologies for utilization of drained methane have been well understood and applied for many years, VAM use has only recently been explored. Appropriate technological solutions, however, are developing quickly. The world's first commercial project began operation in 2007, and there are currently several active and planned demonstration projects of various technologies. For carbon markets, VAM is especially attractive because all emission reductions are "additional", meaning that they are not business-as-usual and would not otherwise have occurred without the additional revenue of carbon credits. With the recent technical and market advances, coal mines, investors, and regulators are expressing great interest in VAM.

15. The workshop provided a broad overview of all VAM technologies including considerations in assessing the technical viability of siting a VAM project at a mine and updates

on the latest technical, regulatory and market developments. In addition, VAM technology suppliers were invited to give brief overviews of their technologies to the workshop participants.

16. Seventy per cent of all CMM emissions originate from mine ventilation shafts, thus VAM offers both the greatest emission reduction and energy production potential. VAM emissions are typically characterized by large airflows and low concentrations, ranging from 0.1-1.0 per cent, but more typically 0.3 to 0.5 per cent. Technical applications for VAM use include direct use as a principal energy source in oxidation units, lean-burn turbines, and kilns, where it is mixed with coal fines or other combustible materials. In addition, VAM can also be used as combustion air in internal combustion engines to supplement the natural gas or other primary fuels used for the combustion process.

17. Three oxidation systems were presented: MEGTEC's VOCSIDIZER, BioThermica's VAMOX, and the CH4MIN developed by the Canadian laboratory, CANMET, part of Natural Resources Canada. The VOCSIDIZER is a non-catalytic oxidation unit in commercial operation at the West Cliff Colliery in Australia. The VAMOX and CH4MIN are catalytic oxidizers which operate at lower temperatures, but require catalysts. Other VAM technologies include: (i) VAMCAT lean-fuel generation technology by CSIRO of Australia using VAM with 1.0 per cent concentration to generate electrical power; (ii) lean-fuel micro-turbine by Ingersoll-Rand (IR); and (iii) lean-fuel micro-turbine by FlexEnergy. Kilns are the third direct use option. COMEnergy and Torbed rotary kilns take coal dust and mix it with VAM in a fast spinning cylinder to form a combustible mixture.

18. Two technology suppliers Biothermica and MEGTEC delivered presentations at the workshop. Both systems are oxidation units with the Biothermica VAMOX using a catalyst to reduce the oxidation temperature. The MEGTEC system does not use a catalyst, and oxidizes at a higher temperature that generates steam to a sufficient temperature to supply a steam turbine, thus MEGTEC’s systems can be used for both heat and power. Currently there is a MEGTEC unit in commercial operation at the BHP Billiton West Cliff Colliery in Australia and another in field demonstration at an abandoned mine in the United States owned by CONSOL Energy. The unit in Australia also produces 6 MW of electricity through a steam turbine in addition to methane destruction. Biothermica announced in April 2008 that it will locate a commercial VAMOX unit at the Jim Walter Resources Mine in Alabama, United States.

19. The future for VAM looks very promising, although success will be dependent on adequate price signals through higher prices for carbon dioxide offsets and higher electricity prices. There are indications that additional commercial and demonstration projects are under negotiation, and the next two to three years could see substantial progress in the deployment of VAM technologies.

VI. FINANCING CMM PROJECTS

20. There were several presentations on project financing to provide participants with an understanding of the current state of the carbon markets, but also to give the mining industry some perspective on the interests and expectations of the finance community. During this

session the UNECE secretariat presented a status report of its project to support financing of CMM projects in Central and Eastern Europe and the Commonwealth of Independent States.

21. The capital markets have provided sufficient liquidity to finance CMM and other greenhouse gas mitigation projects with around US$11 billion available from carbon funds in 2007 and approximately US $70 billion in clean energy funds.

22. From the perspective of investors, CMM projects are considered to be a reasonably attractive carbon asset class. They have the ability to generate multiple revenue streams through energy production and sales, and both direct and indirect carbon emission reductions. With around 200 projects in operation worldwide, there is also a proven operational track record and considerable experience. Still, there are growing concerns in the carbon markets that some projects will not deliver their contracted emission reductions. In addition, for all the attention paid to CMM projects, new projects have been slow to develop in many countries for a variety of reasons, including limited financing options for more marginal projects.

23. Although the capital markets are prepared to finance projects, project hosts must deliver financeable projects to secure investment. To enhance the probability of securing carbon and/or institutional finance, project hosts and developers should be prepared to show that a CMM project has (i) sufficient gas resources, (ii) sufficient financial equity to support the project, (iii) permits and licence in place; and (iv) a dedicated and capable team.

24. The representative of the European Bank for Reconstruction and Development spoke on its programme for sustainable energy investments and, more generally, the market for CMM projects under the Kyoto Protocol's Joint Implementation programme to provide the perspective of international financial institutions (IFIs). Regarding the coal industry and CMM in particular, EBRD's interest was initially due to the high number of methane-related accidents in the EBRD region. The tie-in with mine safety allows EBRD to tap into its health and safety portfolio in addition to the carbon portfolio. For example, a US$100 million loan to Mittal Steel Temirtau in Kazakhstan under the health and safety portfolio includes provisions for upgrading the methane drainage and ventilation systems of its coal mines. Thus, many of the IFIs have multiple financing vehicles available for CMM projects.

25. In terms of carbon financing, EBRD and the European Investment Bank, through their Multilateral Carbon Fund, have €150 million available for investment in carbon mitigation projects, including CMM, and are interested in project opportunities. Similar funds also exist through other IFIs such as the World Bank and the Asian Development Bank offering projects an alternative financing option to private capital markets.

VII. PROJECT INTEGRATION

26. Coal mine methane projects may appear simple to implement and operate but, in fact, can be become very complex as efforts are made to integrate the CMM project with the subsurface and surface activities of mining operations. Unfortunately, this is often overlooked by project developers, mine operators and others, resulting in significant problems as projects progress. With the full range of key issues covered individually, the workshop returned to consider the

project as a whole rather than in individual parts to emphasize the importance of the proper planning and coordination necessary to deliver successful CMM projects.

27. Historically, coal mine operators have been concerned more about their core business, coal production and safety, whilst CMM project developers focus on gas quantity and quality. For both to succeed and benefit, there has to be effective coordination between the mining and CMM stakeholders. For example, lack of information on the subsurface environment may lead to under-sizing or, worse, over-sizing a CMM power plant. Alternatively, CMM project developers must understand that a mine's priority is producing coal to meet contractual demands, and that a CMM project may represent only a small share of the gross revenues originating from a mine. Throughout the process, from conceptualization to operation, there needs to be a constant and open dialogue between all stakeholders including coal company headquarters, mine staff, CMM project developers, local off-take markets such as electric utilities, and investors. The most successful projects are those where all parties recognize that working together can enhance coal mine safety, methane utilization and profitability.

VIII. BARRIERS TO CMM DEVELOPMENT

28. The workshop closed with an open discussion of barriers to CMM development, with a particular emphasis on barriers to CMM development in Poland.

29. Common problems for the global CMM industry identified by participants included the following:

(a) Surface and mineral rights may be held by multiple parties complicating or delaying project development;

(b) Existing policies and regulations make it difficult to introduce new and innovative technologies such as VAM oxidation or flaring to active mines;

(c) Although the sophistication of the coal industry in preparing investment grade documents has increased substantially in the last five years, many in the industry still remain uncertain as to the expectations of the financial community and the vehicles available for institutional and carbon-related finance;

(d) Many countries and jurisdictions fail to provide green power pricing or other incentives to encourage CMM use;

(e) Many coal companies remain indifferent to CMM projects because they are outside their core business. They also see these projects as small in both size and revenue potential.

30. Problems specific to Poland identified by participants were:

(a) Lack of government incentives/legislation to develop CMM as a clean energy source;

(b) Lack of VAM technological development;

(c) Complicated structure of electricity tariffs in Poland including the dominant role of coal as the primary fuel for power generation;

(d) Difficult geological conditions and the low-permeability of coal that necessitate new technologies to drain coal mine methane in Poland.

IX. CLOSURE OF THE WORKSHOP

31. Mr Eugeniusz Postolski, Undersecretary of State for the Ministry of Economy of Poland, delivered closing remarks. He noted that in Poland 94 per cent of power plants use coal as primary fuel because natural gas and oil resources in Poland are not sufficient to meet the demand. In 2006, domestic production of gas could only meet 40 per cent of demand; the remainder was imported from the Russian Federation. In the same year, Poland produced 783,000 tonnes of crude oil, and oil imports amounted to 19.5 million tons. The challenges are further complicated by the need to comply with the European Commission requirements on climate change. To meet these demands, Poland must eventually generate 20 per cent of its energy supply from renewable sources. Mr. Postolski emphasized the challenge for the Polish Government in addressing these needs, but also expressed its interest in capturing and using CMM and coalbed methane as an important contributor.

32. In closing, Mr. Postolski thanked all participants on behalf of the Polish Government and Polish Parliament.
