

Methane to Markets Partnership Coal Mine Methane Project Opportunities in China

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1. Summary of CMM recovery/utilization

China has rich coalbed methane (CBM). The volume of CBM resources with buried depth of 300-2,000m in onshore bituminous and anthracite coal fields is up to 31,460 billion m³. China is the biggest country with the utmost CBM emissions. 48% of the key state-owned mines are the ones with high gas concentration and gas-burst hazards.

Major emission sources in Coal Mining Areas of China mainly come from production mines, abandoned mines and process of coal treatment, storage and transportation after mining. CMM has been mainly emitted from production mines, among which ventilation air methane (VAM) in production mines accounts for 95% approximately of the total emission and emission from CMM drainage system accounts for 5%. With the increasing underground mining depth and steady growth of coal output, CMM emission has been in the upward tendency in the country. It is estimated that coal mines in China emit up to 13 billion m³ of methane to the atmosphere annually.

Methane drainage efficiency has been increased from 15% in 1998 to 26% in 2004. In China, "drainage efficiency" is defined as the quantity of methane drained from active underground mines as a percentage of the total methane liberated through drainage and ventilation systems.

Underground CMM drainage started from fifties of 20th century. Test and promotion of coal bed methane(CBM) recovery technology began in nineties of 20th century. By 2004, more than 200 mines all over the country had established underground gas drainage system with the total draining capacity of 1.926 billion m³, a rather big growth over 2003. As for CBM gas exploitation, China had drilled more than 287 wells to drain gas from virgin seams by the end of 2004 and among them unit well production of some wells reached 20,000m³/d.

China started to utilize CMM in fifties of 20th century. In 2004, CMM used in China were all recovered by methane drainage systems. To date, there has

been no attempt at recovering and using AMM, ventilation air methane (VAM) or methane from post-mining activities. Since China produces a huge volume of VAM, Coal Mining Areas in the country are very interested in utilizing VAM.

Currently, civil consumption, power generation, industrial fuels, chemical industry and automobile fuels are major ways to utilize CMM in China. Projects with representativeness are as the following: Civil CMM Utilization Project in Fushun Coal Mining Area in Liaoning Province, Northeast China; 120MW CMM Power Generation Project in Jincheng Coal Mining Area in Shanxi Province, China; CMM Alumina Roasting Project in Yangquan Coal Mining Area in Shanxi Province, China; and CMM Faku Ceramic City Project in Tiefa Coal Mining Area in Liaoning Province, Northeast China.

Table 1: CMM Emissions in China (Million m³)

Year	1987	1992	1993	1994	1995	1996	2000	2002	2003	2004
Emissions	6450	8320	8550	8950	8900	9280	9630	9871	11674	13535

Table 2: Coal Mine Methane Drainage in China (Million Cubic Meters)

Year	1997	1998	1999	2000	2001	2002	2003	2004
Drainage	760	740	790	870	980	1150	1521	1929

Table 3: Coal Mine Methane Utilization in China (Million Cubic Meters)

Year	1998	1999	2000	2001	2002	2003	2004
Utilization	361.78	362.00	318.4	458.28	455.67	629.21	603

The number of abandoned mines in China has been increasing year by year. Between 1953 and 1998, there were 459 abandoned mines among key state-owned mines. More than 30 billion t of coal reserves were left in abandoned mines and gobs of producing mines with expected available CMM reserves of up to several hundred billion m³.

2. Overview Of CMM Potentials

2.1 Resources and Status of Gas Drainage

The total volume of CBM resources is up to 31,460 billion m³ from within the buried depth of the shell's surface layer of 300-2,000m in land-based bituminous and anthracite coal fields, equivalent to the total land-based natural gas resources of 30,000 billion m³ normally. CMM resources are mainly distributed in west China, accounting for 68.5% while that in East China accounting for only 1.2%. Forecast CMM resources with rather high degree of

control are mainly distributed in Mid-China, accounting for 66.9%.

According to the survey on 115 targeted CMM regions all over the country, the average gas content is $9.76\text{m}^3/\text{t}$, the concentration of methane is 90.6%, the average richness of resources is 115 million m^3/km^2 and the average gas content saturation is 41%. Except the Zhunge'er Basin, the Tuha Basin and Yili Basin in Xinjiang Autonomous Region in Northwest China, there are various coal mines scattering in ten-odd coal bearing regions in China, basically belonging to Coal Mining Areas or adjacent to Coal Mining Areas with 68% CMM resources of the national total.

With the increasing underground mining depth and steady growth of coal output, the volume of CMM emission has been changing continuously. In 1998 among 600-odd key state-owned mines in China, the average absolute mine gas emission was $15.07\text{m}^3/\text{min}$ and the average relative mine gas emission was $17.10\text{m}^3/\text{min}$. In 2003 among 600-odd key state-owned mines in China, the average absolute mine gas emission was $19.8\text{m}^3/\text{min}$ and the average relative mine gas emission was $13.9\text{m}^3/\text{min}$.

Between 1998 and 2003, the volume of CMM drainage in key state-owned mines in China was doubled, from 740 million m^3 in 1998 to 1,521 million m^3 in 2003. The number of mines with gas drainage system was increased from 140 in 1999 to 203 in 2003, going up continuously. CMM drainage rate and concentration have been increasing, too. In 2003, the average CMM drainage concentration in key state-owned mines in China was up to 26%. The total draining volume of ten Coal Mining Areas such as Yangquan, Huainan and Fushun was close to 1 billion m^3 in 2003.

2.2 Development of Technologies and Potentials of Utilization

Exploitation of CBM in virgin seams from surface-bored wells is considered the best way to conduct large scale commercial development. However, most of the coal in China has the permeability less than 0.01mD and between 0.01-1.00mD. With rather poor mineability, underground gas drainage has been the usual technology employed to exploit CMM.

Currently, CMM drainage can be divided into the following several technologies:

- i) In terms of drainage targets, it can be divided into draining from in-seam draining seams; draining from adjacent seams; draining from gobs(including draining from mining sections and abandoned mines) and draining from surrounding rock;
- ii) In terms of drainage methods, it can be divided into borehole draining method; gateway draining method; combined draining method and surface vertical well draining method;
- iii) In terms of time sequence of drainage and coal mining, it can be divided into

pre-draining before mining; draining during excavating; draining during mining and draining after mining.

Underground CMM draining technologies mainly include in-seam borehole draining, borehole released draining from adjacent seams, borehole draining from gobs, across-borehole draining and excavation of tail gate. In China, surface gob well in mining area and lateral horizontal well are two ways to exploit CBM with better prospects.

Most of the mines in China are located in remote mountainous areas. Limited by the scale of local population and economic conditions, it is difficult to construct long-distance pipelines delivering the drained CMM to large and medium-sized cities with dense population in terms of economy or investment. Only part of the coal mining areas close to the West-East Natural Gas Pipeline can deliver the drained CMM to the pipeline. Therefore, major ways to utilize CMM in China should be focusing on civil consumption of the Coal Mining Areas and local towns as well as some industrial fuels. In the meanwhile, CMM can be used to generate electricity for coal mining areas or joining the public grid directly.

3. Obstacles and Suggestions

The concept and idea of coalbed methane development and utilization have been widely accepted by leadership at all levels from the central government down to the enterprise level. However, some obstacles still remain in project development. Only on the basis of our clearer understanding of these obstacles and by working out relevant solutions can we finally push the development of the coalbed methane industry in China to a new high. The following are obstacles to project development identified by the Chinese.

- Coalbed methane geological theory calls for breakthroughs;
- China currently lacks the effective method and technical means to identify the methane rich zones with high permeability;
- Up-stream and down-stream industry development projects call for improvement;
- The network of natural gas pipeline in China has been incomplete systematically. Although the “West-to-East Natural Gas Pipeline” is under construction, some certain restrictions are still there in terms of CMM quality, CMM pipeline construction and CMM prices. CMM pipeline network had been constructed locally only in some cities in coal mining areas;
- Lack of financial support to promote CMM utilization, such as power generation, household use, etc;
- The state government should make available more favorable

coalbed methane encouraging policies

4. CMM Markets

CMM is primarily used for residential power and heating, industrial boilers, and chemical production, and it is an important supplement for natural gas. It is anticipated however, that demand for CMM/CBM as a fuel for electrical power plants will be increasing sharply.

Increased use of town gas, LPG (liquid petroleum gas), and natural gas has led to an improvement of people's living conditions in China. Still compared with the China's large population, the disparity between the supply and demand of fuel gas resources is serious, as shown in the following facts: The per capita gas consumption is low.

After 2010, the production of natural gas will supply only 60 percent of the market demand. Although importing natural gas and petroleum gas can help fill this gap, there will still be many problems related to cost and security. Increasing the production of CMM/CBM can help alleviate the shortage of natural gas.

Power generation with CMM has been proven technology so far. In recent years, the demand for electricity has been increasing with the economic development in China. Power generation with CMM is therefore a rather better way to utilize CMM in the country.

5. M2M Action Plans in China

- Preparing Inventory of CMM in Coal Mine Sector
- Developing cost-effective Technology for Methane Recovery
- Removing Barriers
- Technology and economic Support
- Project Planning, working together with USEPA

Basic Information of CMM Projects in China

1 Fuxin CMM Utilization

Information of Project Owner	
Company Name	CMM Company of Fuxin Coal Mining Group
Project Site	Fu Xin, Liaoning
Information of the Project	
Project Type	CMM Utilization
Project Description	CMM drained from underground and used as fuel of power generation with the capacity of 18MW, and provided to 70,000 households. The gas consumption is expected to be 78.99 million m ³ .
Time Starting Operation	2005
Specific Needs	Financing, Technologies

2 Yangquan CMM Utilization Project

Information of Project Owner	
Company Name	Yangquan Coal Mining Group
Project Site	Yangquan, Shanxi
Information of the Project	
Project Type	CMM utilization
Project Description	CMM used as the fuel of furnace system in alumina plant with the capacity of 800kt/a
Time Starting Operation	November, 2006
Specific Needs	Financing, Technologies

3 Yankuang Guizhou Nenghua CMM Utilization Project

Information of Project Owner	
Company Name	Yankuang Guizhou Nenghua Co.
Project Site	Guiyang, Guizhou
Information of the Project	
Project Type	CMM utilization
Project Description	CMM drained from underground and used as fuel of power generation with the capacity of 12MW
Time Starting Operation	TBD
Specific Needs	Financing, Technologies need to be selected, Pre-feasibility studies need to be performed

4 Henan Hebi CBM Utilization Project

Information of Project Owner	
Company Name	Hebi Coal Co.
Project Site	Hebi, Henan
Information of the Project	
Project Type	CBM utilization
Project Description	CBM drained from surface well and used as fuel of power generation with the capacity of 2.5MW
Time Starting Operation	TBD
Specific Needs	Financing, Technologies need to be selected, Pre-feasibility studies need to be performed

5 Jixi CMM Utilization Project

Information of Project Owner	
Company Name	Jixi Mining Group
Project Site	Jixi, Heilongjiang
Information of the Project	
Project Type	CMM Utilization
Project Description	CMM recovery and power generation with the capacity of 10MW
Time Starting Operation	October, 2006
Specific Needs	Financing, Technologies

6 Jiaozuo CMM Utilization Project

Information of Project Owner	
Company Name	Jiaozuo Coal Mining Group
Project Site	Jiaozuo, Henan
Information of the Project	
Project Type	CMM utilization
Project Description	CMM recovery and power generation with the capacity of 10MW
Time Starting Operation	October, 2006
Specific Needs	Technologies, Financing

7 Huainan Pansan Mine CMM Utilization Project

Information of Project Owner	
Company Name	Huainan Coal Mining Group
Project Site	Huainan, Anhui province
Information of the Project	
Project Type	CMM Utilization
Project Description	CMM drained from underground mines and used as fuel of power generation with the capacity of 4.8MW; provided to 4000 households, and flared with low concentration
Time Starting Operation	2005
Specific Needs	Financing

8 Huainan VAM Utilization Project

Information of Project Owner	
Company Name	Huainan Coal Mining Group
Project Site	Huainan, Anhui province
Information of the Project	
Project Type	VAM Utilization
Project Description	VAM recovered from shaft and used as fuel of power generation
Time Starting Operation	2005
Specific Needs	Financing, Feasibility studies need to be performed

9 Jincheng 120MW Coal Mine Methane Power Generation Project

Information of Project Owner	
Company Name	Jincheng Coal Mining Group
Project Site	Jinchen, Shanxi province
Information of the Project	
Project Type	CMM Utilization
Project Description	CMM drained from Sihe underground mines and used as fuel of power generation with the capacity of 120MW, with gas consumption of 1800million m ³ /a.
Time Starting Operation	2007
Specific Needs	Financing

10 Jincheng Energy Switch to Coal Mine Methane Power Generation Project

Information of Project Owner	
Company Name	Jincheng Coal Mining Group
Project Site	Jinchen, Shanxi province
Information of the Project	
Project Type	CMM Utilization
Project Description	Energy switch, coal to CMM (drained from Chengzhuang mine) as fuel of power generation with the capacity of 10.8MW, with gas consumption of 70 million m ³ /a.
Time Starting Operation	2006
Specific Needs	Financing, Technologies need to be selected, Pre-feasibility studies need to be performed

11 Hebi Coal Mining Group CMM Power Generation Project

Information of Project Owner	
Company Name	Hebi Coal Mining Group
Project Site	Hebi, Henan Province
Information of the Project	
Project Type	CMM Utilization
Project Description	CMM drained from underground No. 4 mine and used as fuel of power generation with the capacity of 1MW
Time Starting Operation	July, 2004
Specific Needs	Financing, Technologies

12 Songzao Coal & Elec Co. Ltd. CMM Comprehensive Utilization Power Generation Engineering

Information of Project Owner	
Company Name	Songzao Coal & Electricity Co. Ltd.
Project Site	Chongqing City
Information of the Project	
Project Type	CH ₄ capture and utilization
Project Description	In June of 2004 the 1st phase of 670 and Jinjiyan CMM power stations were established and put into test run respectively with installation capacity of 6×500kw and 8×500kw. After 6 months test runs the CMM gas engines and power generations are very well and will use 14 Mm ³ CH ₄ per year. The 2nd phase of 670 and Jinjiyan CMM power stations will add the capacity installation of 6×500kw respectively in the end of 2006. According to the design plan the other two CMM power stations, Songtong and Lianghekou, with capacity of 6×500kW and 8×500kW, will be completed in the end of 2007 and 2008 respectively. The total capacity of the engineering is 40×500kW.
Time Starting Operation	June, 2004
Specific Needs	Financing

13 Qidong Coal Mine CMM Power Generation Project

Information of Project Owner	
Company Name	Wanbei Coal and Electricity Group Qidong Coal Mine CMM Power Generation Plant
Project Site	Suzhou, Anhui province
Information of the Project	
Project Type	CMM Utilization
Project Description	CMM drained from gassy coal mine to keep the coal mine safety. Use the gas to generate power with the capacity of 3x1.2MW, the methane content of 25%, and pure methane consumption of 4 million m ³ annually.
Time Starting Operation	2004
Specific Needs	Financing, Technologies

14 Shenyang-Faku CMM Engineering

Information of Project Owner	
Company Name	Tiefa Coal Industry(Group) Co. Ltd.
Project Site	Diaobingshan, Liaoning
Information of the Project	
Project Type	CH ₄ capture and utilization
Project Description	The project is to drain the methane gas from the coal seam for safe coal mining operation and to utilize CMM as ceramic production line fuel instead of coal gas from coal-gas producers, and household gas instead of coal or LPG, rather than venting it directly to the atmosphere.
Time Starting Operation	Aug., 2005
Specific Needs	Financing

15 Nanshan Coal Mine CMM Utilization Project

Information of Project Owner	
Company Name	Hegang Coal Mining Group
Project Site	Hegang, Heilongjiang province
Information of the Project	
Project Type	CMM Utilization
Project Description	CMM drained from Nanshan coal mine to as fuel of power generation with the capacity of 2MW.
Time Starting Operation	TBD
Specific Needs	Financing, Technologies

16 Ningxia CMM Power Project

Information of Project Owner	
Company Name	Ningxia Coal Industry Group Co., Ltd.
Project Site	Yinchuan, Ningxia
Information of the Project	
Project Type	CMM Utilization
Project Description	<p>The project activity consists of two types of activity:</p> <ol style="list-style-type: none"> 1. generating electric power by using the CMM, 2. installing flare equipment to burn up the CMM. <p>The first project activity is to build a power plant where electricity is generated from CMM. Generator sets which have the capacity of 4.0 MW will be installed there. The methane that is utilized will have a concentration of 30% and above. The electric power thus generated will be used by Ningxia Coal Mine itself.</p> <p>The second project activity is to flare the CMM that has a concentration of methane from 25% to 30% or which exceeds the demand of the power plant and the storage capacity of the tank. The main purpose of electricity-generating and CMM-flaring is to destroy methane which contributes to the rapid rising of global temperature and to turn it into carbon dioxide which has less GWP.</p>
Time Starting Operation	2007
Specific Needs	Financing, Technologies

17 Shuicheng Mining Group CMM Utilization Project

Information of Project Owner	
Company Name	Shuicheng Mining Group
Project Site	Liupanshui, Guizhou Province
Information of the Project	
Project Type	CMM Utilization
Project Description	<p>The methods of gas drainage are working coal seam drainage, gob drainage and special roadway drainage. The gas output was 110million m³ in 2004.</p> <p>The main gas utilization is as follows:</p> <p>1. Gas-fired power generation In this process, the power is generated through gas fired and generator sets with the capacity of 40x500kW, and power output of 96million kWh/a and the gas consumption of 30million m³.</p> <p>2. Residential gas The 4 gas storage tanks (10000m³) are located Dahebian coal mine, Dawan coal mine, Wang coal mine and Lao mine respectively. The consumption of gas is 12million m³/a.</p>
Time Starting Operation	2004
Specific Needs	Financing

18 Huaibei Mining Group Luling Coal Mine CMM Utilization Project

Information of Project Owner	
Company Name	Huaibei Mining Group
Project Site	Huaibei, Anhui province
Information of the Project	
Project Type	CMM utilization
Project Description	<p>The project is to drain the methane gas from the Luling coal mine for power generation with the capacity of 2.9MW (0.5x1+1.2x2), and the gas consumption of 22.2 million m³.</p>
Time Starting Operation	TBD
Specific Needs	Financing, Technologies