

# **Methane to Markets Partnership**

## **Coal Mine Methane Subcommittee**

### **Country Profile: People's Republic of China**

#### **1. Summary of coal industry and CMM recovery/utilization**

##### **1.1 Coal Industry**

China is comparatively rich in coal resources. From within the earth's surface 2,000m down to the shell's surface layer, the total forecast prospective reserves of coal resources are up to 5,059.2 billion t. According to the classifying standard of international practice, the basic coal reserves available in China is 334.2 billion t. China has a rather complete coal varieties with low metamorphic bituminous coal taking 34%; metamorphic bituminous coal for coking taking 33.2% and lignite and anthracite taking 14% and 11.9% respectively.

Coal resources in China are distributed extensively. In terms of distributing region, North China has the most coal resources, accounting for 49.25% of the national available reserves. The second biggest distributing region is Northwest China, accounting for 30.39% of the national available reserves. The third biggest distributing region is Southwest China, accounting for 8.64% of the national available reserves. The ones after it are respectively East China accounting for 5.7%, Mid-China accounting for 3.06% and Northeast China accounting for 2.97% of the national available reserves.

China is the biggest coal producer in the world with annual output of 1.95 billion t in 2004. China is the biggest coal consumer in the world as well. The annual coal consumption in 2003 was equal to 1.126 billion t of standard coal, accounting for 67.1% of the total national energy consumption. Major coal consumers in China are respectively the power sector, the metallurgical sector, the building materials sector and the chemical sector. In 2003, coal consumption of the above mentioned sectors respectively accounted for 50%, 12%, 10% and 4% of the total national coal production. Since 2000, coal production and consumption have been in the tendency of rapid growth in the country.

In 2003, the volume of coal export reached 93.02 million t and the volume of coal import reached 10.76 million t in China, accounting for 6% and 0.6% respectively of the national output. Coal import and export in the country have been in the tendency of growth.

Coal mining in China has been focusing on underground production with only 4-5% of the output produced with open cast mining. Almost all key state-owned mines are employing the longwall mining method.

##### **1.2 Coal Mine Methane (CMM)**

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 m<sup>3</sup>. 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.

China Coalbed Methane Clearinghouse of China Coal Information Institute once compiled the “Technology Assessment and Development Strategies of Coalbed Methane Recovery and Utilization”. The current method available for calculating CMM emission sources and volume of emissions in China is mainly used to determine mine ventilation design and gas drainage plans. It is estimated that coal mines in China emit up to 13 billion m<sup>3</sup> 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 2003, 203 mines all over the country had established underground gas drainage system with the total draining capacity of 1.521 billion m<sup>3</sup>, a rather big growth over 2002. As for CBM gas exploitation, China had drilled more than 200 wells to drain gas from virgin seams by the end of 2002 and among them unit well production of over 30 wells exceeded 2,000m<sup>3</sup>/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 m<sup>3</sup>)**

Year	Emissions
1987	6,450
1992	8,320
1993	8,550

1994	8,950
1995	8,900
1996	9,280
2000	9,630
2002	9,871
2003	11,674
2004	13,535

**Table 2: CMM Emissions in China (Million Metric t CO<sub>2</sub> equivalent)**

Year	Emissions
1987	92.14
1992	118.86
1993	122.14
1994	127.86
1995	127.14
1996	132.57
2000	137.57
2002	141.01
2003	166.77
2004	193.36

**Table 3: CMM Drainage in China (Million m<sup>3</sup>)**

Year	Emissions
1997	760
1998	740
1999	790
2000	870
2001	980
2002	1,150
2003	1,521

**Table 4: CMM Utilization in China (Million m<sup>3</sup>)**

Year	Volume of utilization
1998	361.78
1999	362
2000	318.4
2001	458.28
2002	455.67
2003	629.21

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 gobbs of producing mines with expected available CMM reserves of up to several hundred billion m<sup>3</sup>.

## **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 m<sup>3</sup> 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 m<sup>3</sup> 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 9.76m<sup>3</sup>/t, the concentration of methane is 90.6%, the average richness of resources is 115 million m<sup>3</sup>/km<sup>2</sup> 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 15.07m<sup>3</sup>/min and the average relative mine gas emission was 17.10m<sup>3</sup>/min. In 2003 among 600-odd key state-owned mines in China, the average absolute mine gas emission was 19.8m<sup>3</sup>/min and the average relative mine gas emission was 13.9m<sup>3</sup>/min.

Between 1998 and 2003, the volume of CMM drainage in key state-owned mines in China was doubled, from 740 million m<sup>3</sup> in 1998 to 1,521 million m<sup>3</sup> 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<sup>3</sup> 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 gobbs(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. Challenges And/Or Priorities To Greater CMM Recovery And Utilization**

#### **3.1 Legal Framework**

Exploitation and utilization of CMM can only be exercised by coal enterprises with legal mining licenses from within the specified scopes of mining, including pre-draining before mining, draining during coal production, draining from gobs, draining from abandoned mines and the related utilization. Exploitation and utilization of CMM in coal mining areas belong to associated utilization during development and processing of mineral resources. CMM utilization can enjoy the relevant preferential policies of the Chinese government on comprehensive utilization of resources.

Approval procedures for CMM draining and exploiting projects are the same as the general ones, needing approval of the Development and Reform Commission at each level. Projects with investment more than RMB30 million yuan should be submitted to the National Development and Reform Commission(NDRC) for approval. Projects with investment less than RMB30 million yuan should be examined and approved by the provincial Development and Reform Commission.

##### **3.1.1 Royalty, Exploration and Mining Right Fee and Mineral Resource Compensation**

No Royalty, Exploration and Mining Right Fee and Mineral Resource Compensation would be imposed on coal enterprises with approved mining licenses from within the specified scopes of mining.

Compensation of mining mineral resources could be exempted when exploiting CMM from

abandoned mines after the joint approval of the department in charge of geology and mineral resources and the financial department of the provincial people's government.

### 3.1.2 Tax

For projects of exploiting and utilizing CMM, coal enterprises with approved mining licenses from within the specified scopes of mining could enjoy preferential policies of the state on comprehensive utilization of resources such as the resources tax, VAT, income tax of enterprises and tariff tax, etc.

### 3.1.3 Environment and Energy Conservation

Strict standards must be followed when developing CMM projects. All such projects must go through procedures of environmental evaluation and only those qualified ones can be put into operation. Environmental protection of the projects should be focusing on waste water drainage, atmospheric pollution and noise pollution etc. Energy conservation of the projects should be in accordance with the "Energy Conservation Law of the People's Republic of China" and the energy-saving regulations and measures concerned of the state and local governments.

### 3.1.4 Safety

The State Administration of Work Safety(SAWS) is the supreme monitoring organization in China on work safety currently. Laws and regulations such as "Coal Mine Safety Regulation" should be followed as well when developing CMM exploitation and utilization projects.

## 3.2 Preferential Policies

The Chinese government has issued some important laws and regulations to encourage CMM exploitation so far, which are respectively "*Resources Comprehensive Utilization Catalogue*", "*Current State-encouraged Key Developing Industries, Products and Technologies Catalogue*" and "*Foreign Investor's Industrial Guiding Catalogue*"

### 3.2.1 "*Resources Comprehensive Utilization Catalogue*"

In the "*Resources Comprehensive Utilization Catalogue*", jointly issued by the NDRC, the Ministry of Finance and the State Administration of Taxation in 2003, there listed the "Coal-series-associated Gas and its processed/utilized Products" and the "Power and Heat Produced with CMM". The production and construction projects listed in the "*Resources Comprehensive Utilization Catalogue*" could enjoy the relevant preferential policies on comprehensive utilization of resources. In addition, since CMM is considered to be the waste produced in the course of mining, drainage and utilization of CMM could enjoy preferential reductions of income tax.

### 3.2.2 "*Current State-encouraged Key Developing Industries, Products and Technologies Catalogue*"

In the "*Current State-encouraged Key Developing Industries, Products and Technologies Catalogue*"(revised in 2000), jointly issued by the former State Planning Commission and the State Economic and Trade Commission, there listed officially the "Exploitation and Utilization of

Low Heat Value Fuels and Coal-associated Resources”. For such CMM projects, domestic investors could be exempted from tariff and VAT of import links.

### **3.2.3 “Foreign Investor’s Industrial Guiding Catalogue”**

The former State Planning Commission, the former State Economic and Trade Commission and the former Ministry of Foreign Economics and Trade, jointly issued the “Foreign Investor’s Industrial guiding Catalogue” on March 4, 2002. In the Catalogue, “development and exploitation of coal-associated resources” was listed in the category foreign investors were encouraged to get involved. Foreign investors were encouraged to invest on such projects according to the laws and administrative regulations and enjoy the preferential treatment as well. The exploitation of CMM is of “exploration and exploitation of coal-associated resources” listed in the “Foreign Investor’s Industrial guiding Catalogue” and should be managed in accordance with the policies on resources utilization formulated by the state.

### **3.3 Climate Change Position**

China is a party to the UN Framework Convention on Climate Change and has ratified the Kyoto Protocol. As a developing country, China has no compulsory CH<sub>4</sub> emission reduction targets. Together with those countries listed in the Annex 1 of the Kyoto Protocol, China can develop CMM projects targeting at emission reduction by making use of the Clean Development Mechanism and help developed countries fulfill their obligations of emission reductions.

China has joined the “Methane to Markets Partnership” launched by the USA, which is to reduce the global emission of GHG via developing methane-related projects. The executive agency of the “Methane to Markets Partnership” in China is the China Coalbed Methane Clearinghouse of China Coal Information Institute at present.

### **3.4 Technical Difficulties**

- i) Scientific calculating method should be developed for CMM emissions in order to accurately calculate the volume of methane released during coal mining and the volume of methane emission during which the coal is transported and stored on the surface after mining until it is consumed, as well as the volume of methane available in the gob and abandoned mines after mining.
- ii) CMM recovery and utilization technologies of low cost and high efficiency should be developed in order to improve CMM drainage in seams with low permeability. Not only long borehole directional drilling technology and surface gob well draining technology should be developed in a large scale, but also the remote gas draining and releasing technology in group seams should be studied.
- iii) Demonstration projects of VAM recovery and utilization should be established.

### **3.5 R&D Resources**

At a regular meeting of the State Council, it was decided that the state would allocate a fund of RMB3 billion yuan in 2005 to support gas control projects in key state-owned mines and set up a CBM/CMM Engineering Research Center.

Engaged in the comprehensive research work of CBM/CMM information, the China Coalbed

Methane Clearinghouse of CCII can provide CBM/CMM information and consulting services for the government and companies at home and abroad, promoting CBM/CMM projects from the point of view of researches on information.

## **4. CMM Market And Projects**

### **4.1 Transportation of Methane**

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.

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.

### **4.2 CMM Drainage and Utilization Projects**

Major ways to utilize CMM are respectively civil consumption, power generation, industrial fuels, chemical industry and automobile fuels.

#### **4.2.1 Civil CMM Utilization Projects**

Civil CMM Utilization Project in Fushun Coal Mining Area

Fushun Mining Group had established the Phase I Civil CMM Utilization Project focusing on utilizing CMM in Laohutai Coal Mine. Annually, 58.80 million m<sup>3</sup> of CMM can be supplied to Shenyang, the capital of Liaoning province. The Phase II Civil CMM Utilization Project will be focusing on mixing the CBM of high concentration with CMM drained from underground and then supply the gas to Shenyang with capacity of 61.84 million m<sup>3</sup>/a.

#### **4.2.2 Power generation with CMM**

CMM Power Generation Project in Jincheng Coal Mining Area

In 1995, the former Jincheng Mining Bureau completed the 240kW CMM Power Generation Plant. In 1997, the 4\*400kW CMM Power Generation Station was completed nearby the pit of Sihe Coal Mine. Later on, another 2\*2000kW multi-production station was completed with an investment of RMB13.23 million yuan. At present, the 120kW CMM Power Generation Plant is under construction in Jincheng Coal Mining Area.

#### **4.2.3 Industrial Fuels Projects**

CMM Alumina Roasting Project in Yangquan Coal Mining Area

The project is under construction at the moment. It is to roast alumina by taking CMM as the fuel. The alumina production capacity would be up to 1.2 million t/a and CMM consumption be up to 130 million m<sup>3</sup>/a.

CMM Faku Ceramic City Project in Tiefu Coal Mining Area

The project is to take CMM drained from Tiefu Coal Mining Area as the industrial fuels for

ceramic furnaces. The volume of daily CMM supply would be up to 400,000m<sup>3</sup>. The project is expected to complete by the end of 2006.

#### **4.2.4 Chemical Industry**

Some mines in China have successfully produced methanal and carbon black with the CMM drained. Such operations in small scale can be found in Fushun, Huainan, Zhongliangshan and Songzao and Tianfu. Economic profits and results have been made to some extent out of these operations.

#### **4.2.5 Natural Gas Autos**

Gasoline for buses in Furong Coal Mining Area of Sichuan has been fully replaced with CMM. annual CMM utilization has been 5.49 million m<sup>3</sup>.

#### **4.2.6 Utilization of VAM**

The utilization of VAM has extensive prospects since the emission volume is so big. Some coal mining areas in China have expressed their interests in recovery and utilization of VAM. As long as it is feasible economically, they would take utilization of VAM into consideration.

### **4.3 Prices**

Prices of electricity are divided into selling price and grid price according to the current policies on electricity charges. For power generation enterprises, prices of electricity relate to their profits directly. In 2004, the average selling price of electricity was RMB0.416 yuan/kWh while the average national selling price of industrial electricity was RMB0.393 yuan/kWh and the average commercial selling price of electricity was RMB0.782 yuan/kWh. In 2004, the average national grid price of electricity was RMB0.29 yuan/kWh.

Coal prices in domestic market in China have been in the upward tendency. In 2004, the comprehensive selling price of commercial coal was RMB206 yuan/t, the price of power coal for key contracts was RMB161 yuan/t, an increase of RMB33 yuan/t and RMB23 yuan/t respectively compared with that in 2003.

In 2004, the average consuming price of natural gas in China was RMB1.6 yuan/m<sup>3</sup> and the average price of industrial natural gas was RMB1.9 yuan/m<sup>3</sup>. The price of CMM for civil and industrial consumption is far much lower than that of natural gas in China.

### **4.4 Carbon Credits**

Since China had signed the “Kyoto Protocol”, developed countries can make use of the CDM and cooperate with China in terms of financial and technical support, for instance projects regarding GHG emission reductions. Developed countries can fulfill their commitment of emission reductions in the “Kyoto Protocol” with verified and proven GHG emission reductions out of the said projects.

In China, CMM is one of the major fields to develop CDM projects. Development of CMM drainage and utilization projects can reduce GHG emissions. Through carbon credits trading, CDM can bring about additional profits for CMM projects in the country.

## **5. Key Stakeholders in the CMM Industry**

The following companies have invested in and/or operated CMM utilization projects in Chinese mines or provided services.

### **5.1 Main Mining/Energy Companies Related**

Yangquan Coal Group, Huainan Mining Group, Fushun Mining Group, Songzaa Coal & Power Group, Panjiang Coal & Power Group, Shuicheng Mining Group, Tiefu Mining Group and Huaibei Mining Group, etc.

### **5.2 Services**

China Coalbed Methane Clearinghouse of China Coal Information Institute

### **5.3 Governmental Organizations**

Bureau of Energy at the National Development and Reform Commission, the State Administration of Coal Mine Safety and China National Coal Association

### **5.4 Scientific research establishments**

China Coal Research Institute(CCRI), China University of Mining and Technology(CUMT)and China National Administration of Coal Geology(CNACG).

## **6. Finance**

Financial support is of critical significance to CMM projects. The following departments and institutions at home and abroad are major financial sponsors for R&D of CMM projects in China.

- National Development and Reform Commission
- State Administration of Coal Mine Safety
- Environmental Protection Agency, USA
- World Bank
- Asian Development Bank
- Global Environment Fund
- Clean Development Mechanism