Guizhou Small Coal Mine Preliminary Study Report

I. Introduction: Small Coal Mines in China and Guizhou

A. China

A small coal mine in China is usually defined as a coal mine with annual coal production below 300,000 tons. A recent Notice[1] from the National Development and Reform Commission (NDRC) defines a small coal mine as a *township coal mine* with production capacity less than 300,000 tons per year. According to Township Coal Mine Management Regulations (1994), township coal mines are those mines operating at the town or village level owned by cooperative companies, private coal companies, or other coal mining entities except state owned companies and foreign owned companies.

Large amounts of coal have come from these small coal mines for the past several years in China. Even as recently as 2007, small coal mines contributed close to 39% of China's total coal production (see Table 1).

Table 1: Coal Production Analysis in China (1990-2007)[2]

Year	Total Coal Production (100 M ton)	Major State-Owned Mines		Local State-owned Mines		Small Coal Mines	
		(100 M ton)	% of Total	(100 M ton)	% of Total	(100 M ton)	% of Total
1990	10.79	4.8	44.49	2.05	19	3.94	36.5
1991	10.87	4.81	44.2	2.04	18.72	4	36.8
1992	11.14	4.83	43.3	2.03	18.2	4.29	38.51
1993	11.51	4.58	39.78	2.04	17.72	4.89	42.5
1994	12.3	4.69	38.12	2.06	16.75	5.55	45.13
1995	12.92	4.82	37.32	2.13	16.51	5.97	46.17
1996	13.74	5.37	39.1	2.22	16.16	6.15	44.74
1997	13.25	5.29	39.93	2.26	17.03	5.7	43.04
1998	12.33	5.03	40.79	2.13	17.27	5.36	43.47
1999	10.44	5.13	49.13	2.14	20.5	3.17	30.37
2000	12.5	5.36	42.88	1.94	15.52	5.2	41.6
2001	13.1	6.3	48.09	2.2	16.79	4.6	35.11
2002	13.9	7.11	51.15	2.63	18.92	4.18	30.07
2003	16.67	8.08	48.5	2.83	17	5.76	34.5
2004	19.56	9.19	46.98	2.95	15.08	7.42	37.95
2005	21.51	10.24	47.61	2.92	13.58	8.36	38.87
2006	23.25	11.21	48.26	3.204	13.76	8.83	37.98
2007	25.23	12.4	49.15	3.24	12.84	9.59	38.01
Average (90-07)	**14.72**	**6.62**	**44.38**	**2.39**	**16.74**	**5.72**	**38.96**
2010 Target	26	14.56	56	4.42	17	7.02	27

According to the "Eleventh Five-Year Planning for Coal Industry", however, China plans to greatly reduce the number of small coal mines and also their coal production by 2010. The plan sets a target for a total coal production of 2.6 billion tons in 2010 and the production ratio for different producers (see above Table 1). According to the "Notice of Closing Small Coal Mines for the Last Three Years of the 11th Five-year Plan" issued 7 October 2008 by the State Administration of Coal Mine

[1] 《关于下达"十一五"后三年关闭小煤矿计划的通知》

[2] Source: Puqin Wang, "*Issues and policy analysis for small coal mine development*"; and other online reports: http://www.in-en.com/coal/html/coal-1627162770181188.html

Safety, by 2010, only 9,952 small coal mines will be retained out of the current 14,069 small coal mines. Twenty five hundred small coal mines will be closed down and 1,616 small coal mines will be consolidated. Guizhou will be able to continue operating 1,012 coal mines.

B. Guizhou Province

Towards the end of 2008, the Guizhou CMM Initiative investigated the status of CMM recovery and utilization among Guizhou small coal mines, which share the majority of coal mining operations in the Province. The Initiative visited and interviewed a few representative small coal mines and interviewed their owners to assess the status of CMM utilization, its potential, and barriers among the small, but important coal mines in the Province.

According to 2008 records, there are 1,279 small coal mines that each produces less than 300,000 tons of coal per year, comprising 97% of all coal mines in Guizhou Province[3]. The production capacity of these small coal mines total 60.7 million tons per year, accounting for 68.3% of the entire coal production capacity in Guizhou. Most of these small coal mines are active. It is obvious that small coal mines have a significant role in coal production in Guizhou.

Our investigation revealed that CMM recovery and utilization in Guizhou, even at small coal mines, is a pretty well known subject, thanks to the advocacy works of the provincial Coal Mine Safety Bureau. Some of them are actually taking action in CMM utilization. While others are considering if such activities make economic sense. Showcasing projects at the small coal mine level and conducting professional project feasibility studies will be very helpful to encourage more coal mines to utilize CMM.

II. The Coal Mine Interviews

A. Scope of Study

The coal mines this Initiative interviewed all have production capacity at the 300,000 tons level or less. Only one is a state-owned company; the rest are private companies.

B. Coal Mine A: No Utilization

Coal mine A is a private company owned by local residents. The designed production capacity is 90,000 tons per year. Coal seams are about 100 meters underground. There are three minable coal seams. Now coal mine A is working on K3 seam, which has the largest thickness, about 2.5 meters, and the mining method is long wall. Mine A has a proved reserve of 2.67 million tons of

Figure 1: Drainage pump of Coal Mine A

[3]蒲建江，《以典型引路 大力推进小煤矿瓦斯治理与综合利用促进煤矿安全生产形势稳定好转》，2008 年 8 月 13 日，来源：http://www.gzaj.gov.cn/ldjh/ldjh_ldjh/2008-8-29/20088291810133146.htm

anthracite. In 2007 the production was 120,000 tons and the production for 2008 is estimated at 100,000 tons. Within 3 kilometers of this coal mine, there are two 90,000 tons/year coal mines under construction and one 150,000 tons/year coal mine under system upgrade.

Coal mine A has a drainage station pumping methane from the gob areas. According to the data on the concentration of drained CMM and VAM based on six days (see Table 2), the average CMM concentration reached 78.52%. The chief engineer believed this number was inaccurate because the monitor was not calibrated (see Figure 2). He believed the real CMM concentration was about 20% (ranging from 14% to 27%) and pure methane recovery through drainage was about 66 m^3/minute. Drained CMM is not utilized and is released directly to the atmosphere. The chief engineer also pointed out that the average VAM concentration is 0.5% and the flow rate is 1,500 m^3/minute. It is obvious that the system record (Table 2) is quite different from the chief engineer's knowledge.

Figure 2: CMM monitor in Mine A

Table 2：Date of CMM and VAM at Coal Mine A in Six Consecutive Days

Coal Mine A	Drainage （%）		VAM（%）	
Dates	**Avg. Concentration**	**Max.**	**Avg. Concentration**	**Max**
1	85.74	96.7	0.03	0.12
2	76.46	93.2	0.11	0.39
3	74.74	80	0.14	0.29
4	80.32	100	0.1	0.48
5	81.7	88	0.05	0.16
6	72.15	91.5	0.08	0.34
Avg. Concentration	**78.52**		**0.09**	

The management of Coal Mine A is no stranger to CMM utilization, such as power generation. It will consider CMM utilization if the gas amount is sufficient enough. However, since the K3 coal seam resource is almost exhausted and the other two coal seams do not contain much methane, the chief engineer does not think that there would be much gas release in 2009. They have even considered discontinuing the drainage system at that time.

C. Coal Mine B: Considering Utilization

Coal mine B is a private company. The mine is under construction with a designed production capacity of 150,000 tons/year (see Figure 3). The coal seams are about 700 meters underground. The three minable coal seams are M1 and M10 (anthracite, average thickness of 1.3 meters) and M18 (bituminous coal, 2.2-2.5 meters thick) with a gas dynamic phenomenon. Coal mine B uses the long wall mining method. The proved reserve is 5.22 million tons. It is expected to operate in year 2010, with anticipated use of a drainage system. This coal mine is only 4 kilometers to the county capital town and there is no other coal mine near it within 10 kilometers.

Figure 3: Coal Mine B under construction

Coal mine B used to be owned by local residents. Recently investors outside Guizhou have participated in and gained majority share of this coal mine. The manager of this coal mine is experienced in CMM utilization from his previous experiences in other coal mines. He is confident that this coal mine will install gas engines for CMM power generation; conceivably at the capacity of 1 to 1.3 MW installed capacity. The outside investors are also interested in CMM utilization, though they are more cautious. They believe such a project must be proved sound and carefully designed with detailed calculation of inputs and outputs. In addition, they emphasize that it will be best if they can visit a CMM utilization demonstration project at a coal mine with similar coal production capacity.

Since the uninterrupted power station (double-circuit station) in this county has not been built, the coal mines in this county do not have access to uninterrupted power supply. This has caused difficulties for coal mine construction and acquiring operation permits. Due to this constraint, the chief engineer would like to know, if a CMM power generation project is feasible, would the CMM power and the power supplied from the county power grid be considered as double-circuit power supply? This question is beyond the Initiative's capacity to answer and may require more professional research. However, one thing is for sure, stable power for the coal mine would also require a stable CMM supply.

D. Coal Mine C: Private Company with Utilization

Coal mine C is also a private company with a designed production capacity of 90,000 tons per year. There are three minable coal seams 50-400 meters beneath the surface. Coal mine C is categorized as a gassy coal mine. However, it is managed only

as a coal and gas outburst coal mine. It was constructed in 2007 and produced 20,000 tons of coal. The 2008 production is estimated at 120,000 tons. Pure methane release is measured at 5.66 m^3/minute and 54.34 m^3/ton. Both high and low negative pressure drainage pumps are installed to drain gas from gob areas and coal seams. Daily drainage amount is about 14,000 to 20,000 m^3 methane.

One of the impressive things about Coal Mine C is the CMM utilization. When the interview was conducted, there were three 500 KW gas engines running and generating power (See Figure 4). The fourth unit was approaching a total capacity of

Figure 4: CMM Gas engines at Coal Mine C

2 MW. In addition to power generation, CMM was also used as town gas. The daily CMM utilization amount was about 6,500 m^3 (5,500 for power generation and 1,000 for local use), only one third of the drained gas amount. The rest was released into the air. The CMM power plant can generate enough power for mining activities with additional electricity sold to the local 10 KV power grid, which was connected with the power plant. In one instance, when the power grid was down, this CMM power plant became a very useful stand-by power and secured mining safety and operations.

Figure 5: CMM used in kitchen at Coal Mine C

Before its use for power generation, CMM had been used for civil uses. For

example, it was used for cooking in Coal Mine C's cafeteria (Figure 5), for the boiler to heat water for showers, and for heating in winter. All civil utilizations were equipped with anti-fire and anti-explosion measures developed by the coal mine.

Figure 6: CMM also used for boiler at Mine C

During the interview, the CMM concentration monitor was out of order and could not read properly (Figure 7). The concentration was measured manually every two hours. According to Coal Mine C, the CMM concentration was between 22% and 46%. An examination of the concentration data in the past 11 consecutive days revealed stable conditions: average concentration at 23.22% with a narrow range of 22.44% - 23.56%.

The management of Coal Mine C is aware of CDM and is working with a local CDM consulting company to explore CDM potential for their mine.

E. Coal Mine D: State-owned with Utilization Plans

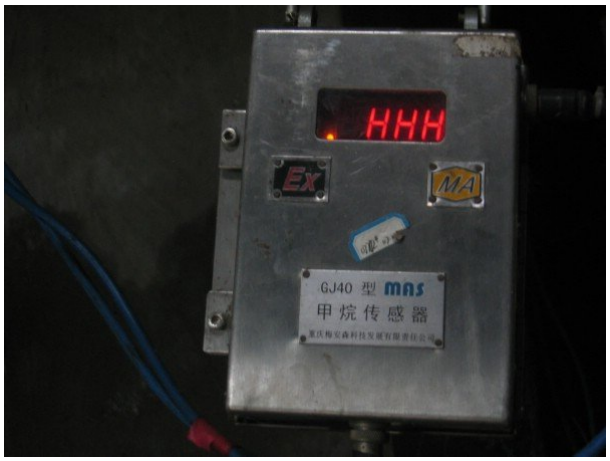

Figure 7: Malfunction CMM concentration monitor at Mine C

Coal mine D was the only state-owned coal mine interviewed. The production capacity is at 300,000 tons/year. The coal mine used to be a 30,000 tons/year mine owned privately by local residents. It was purchased by the current company in 2004 and was upgraded to a production capacity of 300,000 tons/year. Coal mine D is categorized as a gassy coal mine. Its absolute methane release is 8.78 m^3/minute and relative release is 74.38 m^3/ton. Drained methane concentration is between 9% and 27%.

The gas pump station drains methane at the rate of 90 m^3/minute to 120 m^3/minute and recovers pure methane at 486-864 m^3/hour. At present all methane is emitted to the air.

Coal mine D plans to install gas power generation with a total capacity of 2.5 MW. The gas engines will be Shengdong low concentration 500 KW engines. 1.5 MW will be installed in the beginning of 2009 and the remaining 1 MW will be installed at the end of the year. It is estimated that 9,504 MWh power will be generated in 2009, followed by 15,840 MWh power generated annually. All power will be used in local mining areas. Anticipated CO2e reduction will be 51,000 tons in 2009 and 85,000 annually thereafter.

Coal mine D has engaged with a local consulting company developing this CMM utilization project into a CDM project. Currently, they are preparing the feasibility study and PDD.

III. Summary

A. All Coal Mines:

Table 3 below provides a snap-shot view of the status of CMM recovery and utilization at those mines interviewed in Guizhou. From this view, it is clear that some coal mines simply do not have the capacity at this time to pursue CMM projects. Coal Mine A, for example, lacked basic data for CMM monitoring because they simply did not utilize the equipment properly, or at all. However, other small coal mines are already successfully utilizing CMM, up to 6,500 m3 daily for both power generation and local use by Coal Mine C for example. This shows real possibilities for CMM recovery and utilization exist.

Table 3. Summary of CMM Recovery and Utilization at Four Guizhou Small Coal Mines

	Coal Mine A	Coal Mine B	Coal Mine C	Coal Mine D
Utilization Status	None	Considering, in construction stage	Utilizing 6,500 m^3 daily (5,500 for power generation and 1,000 for local use)	Planning
Ownership	Private	Private	Private	State-owned
Production Capacity	90,000 tons/year	150,000 tons/year	90,000 tons/year	300,000 tons/year
Absolute Methane Release/Relative Methane Release	Unknown	Drainage system currently not constructed	5.66 m^3/ minute; 54.34 m^3/ton	8.78 m^3/minute; 74.38 m^3/ton

Methane Concentration	78.52% per monitor, most likely near 20% (14-27%)	Drainage system currently not constructed	Range between 22% and 46%	Range between 9% and 27%
Drained Methane Rates/Recovered Methane Rates	About 66 m^3/minute	Drainage system currently not constructed	14,000-20,000 m^3 daily	90 m^3/minute - 120 m^3/minute /pure methane recovery at 486-864 m^3/hour
VAM concentration/ Flow Rate	0.5%/1,500 m^3/minute	VAM system under construction	Unknown	Unknown
Utilization Plans	None at the moment, methane amounts low	Possibility of installing gas engines with 1 to 1.3 MW installed capacity	Using 3, 500KW, gas engines, 1 engine near total capacity of 2MW; Town gas	Gas power generation with total capacity of 2.5 MW; Low concentration 500 KW engines; Local mining use
CDM	Unknown	Aware of it	Working with local consultancy	Working with local consultancy

B. What are the possibilities for CMM development at Guizhou small coal mines?

Although Guizhou plans to close or consolidate some small coal mines within the next two years, there will still be around 1,000 coal mines in Guizhou. They will continue to be the major coal producers and CMM emitters. It is estimated that half of these 1,000 coal mines are gassy and gas drainage systems are required. The gas drainage amount will be increased within the next two years since more and more coal mines will complete the consolidation process and begin to operate. According to our interviews with these representative small coal mines, this Initiative believes that it is feasible to carry out CMM utilization projects among small coal mines, although there are barriers to overcome.

The possibility of utilizing CMM at small coal mines is based on the following observations:

1. Small coal production does not necessarily mean there will not be enough gas for a utilization project. According to the interview results, the smallest coal mine (90,000 tons/year) could yield a similar amount of gas as a 300,000 tons/year mine and gas could be utilized at a similar capacity level.

2. Small coal mine owners (mostly private companies) are rational and capable. If a CMM utilization project proves to be beneficial (from safety and economic perspectives), it will gain support from these owners. Coal mine C is an example: it is normally considered difficult to sell extra CMM-generated electricity to the power grid (even with supporting government policies), but Coal Mine C managed to achieve it.
3. Guizhou government is very supportive for such projects among small coal mines. The government hopes to see some successful demonstration projects and replicate their experiences all over the province.
4. Low concentration CMM power generation seems to have gained approval from the government and coal mine companies. From a technical view, such technology will meet small coal mines' needs: low concentration gas in small quantities.

C. Barriers

There are also barriers existing for CMM utilization among small coal mines:

1. Small coal mines lack the capacity for evaluating CMM resources and the technical skills for gas utilization. An accurate prediction of CMM resources is required for determining if a CMM utilization project is feasible. Since CMM has not traditionally been treated as a clean energy resource, small coal mines do not have good CMM data records and do not have the ability to evaluate this resource. Although there are professional gas utilization technology providers, Guizhou needs to have professional organizations that can perform an integrated feasibility study that includes assessing CMM resources and utilization options.
2. Small coal mines tend to have unreliable CMM monitoring equipment in addition to loose management (see Coal Mine A in Table 2, and Figure2, 7). Basic CMM data (such as concentration and flow) are incomplete or even incorrect. This will create difficulties for initial evaluation and future project management.
3. The government seems ambiguous in regards to CMM utilization standards and safety regulations. Low concentration CMM transport and power generation has been a focus of many debates. The conflict between the common application of this technology and current government regulations (which are against using CMM with concentrations lower than 30%) has left many such projects in a gray-shaded area. In case there is an accident during the utilization process, the coal mine company is unlikely to be protected by law or regulations. This will definitely discourage other coal mines to engage in such projects. At the same time, low concentration CMM is already being utilized as town gas, as shown from Coal Mine C. Is this safe? The government needs to have a say.