CDM/JI Project study 2006

"CDM feasibility study of cogeneration with Shaqu coalmine methane in Shanxi Province, China"

Summary Report

March 2007

JAPAN NUS Co.,Ltd.

１． Project Description

The proposed project activity will takes place in Shaqu coalmine located in Shaqu village in Ryulin hsien, Shanxi province. The proposed project activity will capture coalmine methane (CMM) currently emitted to the atmosphere to ensure safe working environment in coalmine, and use the CMM for power generation. The generated electricity will be supplied to local power grid. In addition, waste heat boilers will be installed to utilize the waster heat from the power generators. Coal fired boilers, which has been used to supply heat and hot water in coalmine, will be replaced by those waste heat boilers. An open flare system will also be installed to flare excess gas.

Shaqu area is a coal-rich field whose total area extends to 135km^2 and the estimated total coal reserve is 2252.28million tons. Shaqu coalmine in Shaqu coalfield is currently producing 3million tons of coal per year. According to the project development plan of Huajin Coking Coal Co., Ltd., an owner of Shaqu coalmine, the productivity of the coalmine will ultimately rise to 8million tons per year. As Shaqu is gas-rich coalmine, the gas extraction system has been installed in 2004 to ensure safe working environment in coalmine. This gas extraction system is designed to extract CMM prior to mining for safety reasons, and also extract VAM (Ventilation Air Methane) to maintain the standard of methane concentration in coalmine. All of the extracted CMM is discharged to the air. Shaqu coalmine currently emits about 50million m^3 of gas (as methane gas), however, as the coal production will increases in the future, gas emission will also increase. The amount of gas emission is expected to rise to 65million m^3 by 2010 and ultimately reach 75million m^3. At the moment, all of the CMMs are emitted to the air with no utilization. The proposed project activity aims to utilize those gases for power generation and heat supply.

The gases utilized for power generation in the proposed project activity include CMM, which is currently extracted from the coalmine for the purpose of keeping working environment safe and emitted to the air, and VAM, which is circulating in the coalmine. CBM (Coal Bed Methane) will not be used in this project. The total capacity of generator is 14,000kW, consisted of twenty generators of 700kW. The boilers that utilize waste heat from generators will not require any fossil fuel, so that no greenhouse gas will be produced from the boilers. Four waste heat boilers will be installed. Under

normal condition, three boilers will be operated and one boiler will be a backup. The maximum heat supply of this boiler system is 33.12GJ/hour. At the moment, coal-fired boilers supply heat and hot water to households living in the coalmine. The amount of heat needed for household in coalmine is approximately 22.93 GJ/h at the most, and therefore the waste heat boiler scan sufficiently supply the heat required in the coalmine residential area. An open flare system for destruction of excess gas will be installed to destroy gases that cannot be utilized in power generation. Under the National Coalmine Safety Regulation, the concentration of CMM must be 30% or above to be utilized for power generation and heat generation. For flaring, methane concentration has to be more than 25%. Therefore, coalmine gas that will be destroyed in open flare system includes CMM with concentration between 25% and 30%, but also CMM with concentration above 30%, which could not be treated in power generation because the amount of extracted CMM exceeds the capacity of power generators. CMM with concentration less than 25% will be emitted to the atmosphere under the National Coalmine Safety Regulation.

2. Location of the project activity

The proposed project will take place in Shaqu coalmine, which is located in Ryulin hsien, Shanxi province. From Taiyuan, a capital of Shanxi province, Ryulin hsien is located 190km to the west‐southwest. The precise location of the project site is at the coordinates of 37° 08’ 53” － 37° 37’28” north latitude and 111° 39’45” － 112° 05’33” longitude. Figure 1 shows the geographical location of Ryulin hsien in China.

Figure 1 The location of Ryulin hsien in China

3. Project boundary

The proposed project utilizes coalmine methane, and therefore uses the approved methodology ACM0008 “Consolidated methodology for coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat and/or destruction by flaring” Version 3. In addition, we use the approved methodology ACM0002 “Consolidated methodology for grid-connected electricity generation from renewable sources” Version 6 for the replacement of electricity of local power grid. For the assessment of additionality, we will use an methodology required by ACM0008; ”Tool for the demonstration and assessment of additionality” of the latest version (Version 2) and also use the additional methodology “Tool to determine project

emissions from flaring gases containing methane" for destruction of CMM in open flare system to estimate the amount of methane flared in an open flare syste.

The sectoral scopes related to the proposed project are Category 8 "Mining and mineral production" and " Category 10 "Fugitive emissions from fuels". A brief map of project boundary in accordance to ACM0008 is shown in figure 2.

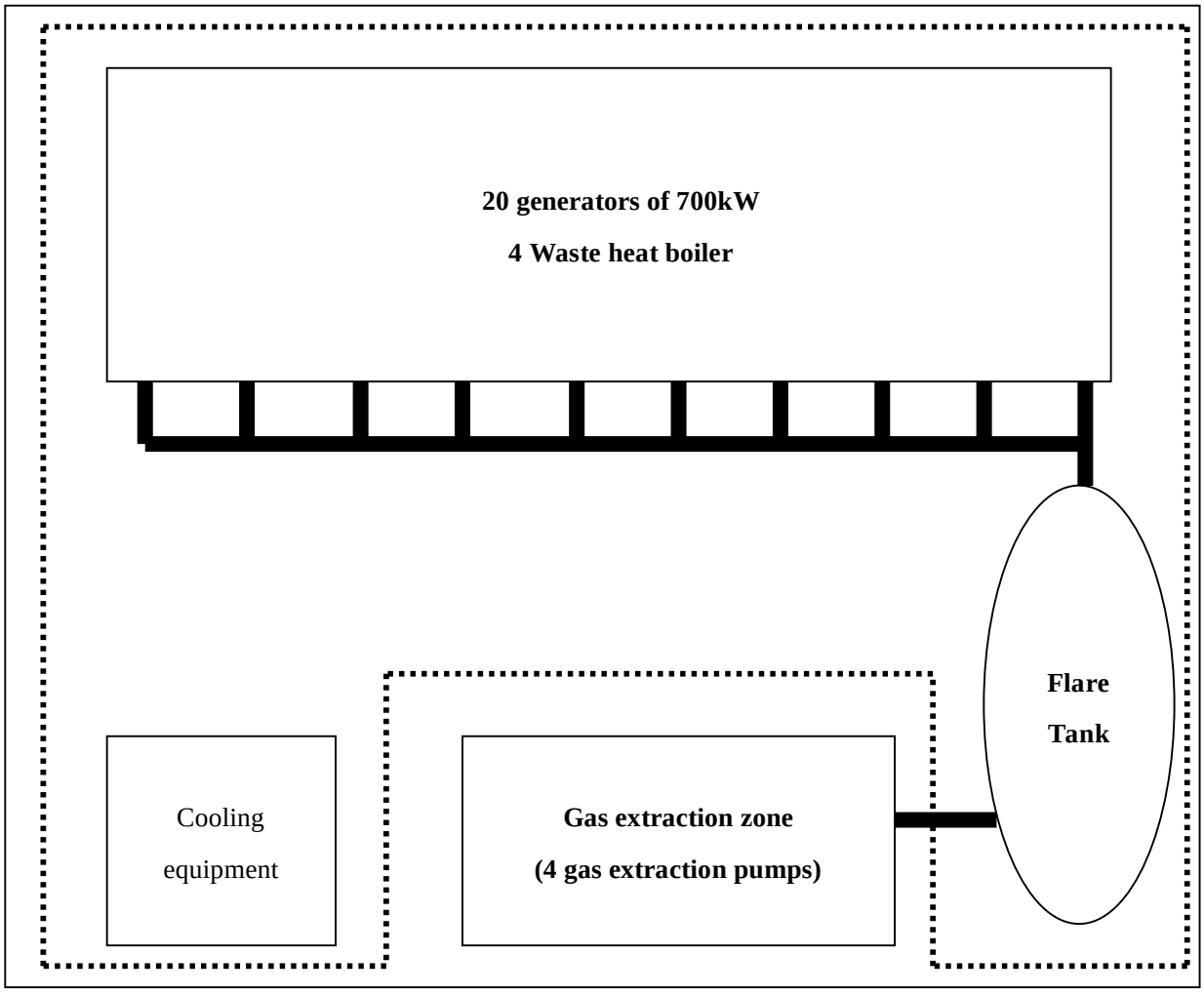

Figure2 Project boundary

The equipments newly installed for the proposed project inside project boundary shown in figure 2 are as follows:

・Power generators: Installation of 20 domestically manufactured gas engines of 700kW. Installation of a number of generators with small capacity can make the operation

more flexible to adapt to the variable gas flow rate. One unit consists of gas engine with 34% thermal efficiency and the generator with 92% efficiency.

- Waste heat boilers: Installation of 4 boilers that utilizes waste heat produced from the power generators. Under normal condition, three boilers will be operated (one boiler for a back-up). Under normal operation, the maximum of heat supply will rise up to 24.84GJ/h (9.857t/h of steam), which is enough to cover the needs of households living in the coalmine, which require 22.925GJ/h (9.145t/h of steam) of heat at the most.
- Fuel transportation system: the system that transports the CMM extracted to the power generators. This system consists of ①gas-clearing device which removes impurities and moisture from CMM, ②gas storage tank (10,000m3 in capacity) to homogenize gas quality and regulate the flow rate, and ③two pressure enhancing equipments (one is a back-up).
- Excess gas destruction system: installation of one open flare system. According to ACM0008, all CMM extracted for CDM project has to be combusted. In addition, National Coalmine Safety Regulation in China regulates that CMM with concentration less than 30% cannot be utilized for the power generation. It also requires the concentration of CMM used for flaring to be more than 25%. Thus, this flare system will destroy CMM with methane concentration between 25% and 30%, as well as CMM with methane concentration more than 30% when there is excess emission of CMM or power plant stopped its operation. The maximum combustion rate of the flare is 20,000m3/h (CMM of 25% in concentration).
- Coolant circulation system: a coolant system for power generators.
- Electrical facilities: Electricity generated in power plant is distributed through the electricity distribution system for internal use in coalmine and the grid connection system to supply electricity to local power grid outside coalmine.

Shaqu coalmine has 4 pumps to extract gases from coalmine. These pumps have been placed to comply with the National Coalmine Safety Regulation and they are not newly installed for the proposed project activity.

4. Assessment of Additionality

In accordance with methodology ACM0008, the continuation of current practices in

Shaqu coalmine is identified as baseline scenario. The baseline scenario includes extraction of VAM, emission of pre-mining CMM and post-mining CMM from coalmine to meet the safety standard and emission of all of the gases to the atmosphere. In baseline scenario, electricity used in coalmine is purchased from local grid, and coal-fired boiler is used to supply heat to households living in coalmine.

The proposed project activity includes the utilization of coalmine gases currently emitted to the air for power generation. The generated electricity will be supplied to local power grid. Coal-fired boiler will be replaced by waste heat boiler, which utilizes waste heat from power generators.

Financial assessment was carried out for determination of investment barrier against the project. The assessment was based on the cash flow of 20years, which is the lifetime of power generator, and the result indicated that the project IRR (Internal Rate of Return) will be estimated to 7.19%. Survey of other CDM projects in China that use coalmine methane showed that benchmark of IRR is 8～11% or a little more. However, the IRR of Shaqu coalmine methane project is sufficiently lower than those values. Such low profitability is a significant barrier to the investment. To overcome this barrier, we now take into account the profit from the sale of CER generated from the CDM project.

Annual GHG emission reduction by the proposed CDM project activity is estimated to be 664.488 tCO2e. If we recalculate the IRR for 20years based on the CER sales price of 8Euro/ton, and 1Euro=10RMB which is the current CDM standard approved by Chinese government, IRR significantly improves to 80.7% and thus the profitability of the project is sufficiently high. Therefore, it is possible to say that the proposed project has clear additionality.

5. GHG emission reduction by project activity

Under Chinese National Coalmine Safety Regulation, coalmine gas with methane concentration of more than 30% can be used for power generation and heat generation. Coalmine gas with methane concentration less than 25% cannot be even destroyed by flare and has to be emitted to the atmosphere.

The result of the analysis of the data of the first half of 2006 in Shaqu coalmine is as follows.

・Discharge of coalmine gas : 400m^3/min

・Percentage of gas with methane concentration more than 30%: 52%

・Percentage of gas with methane concentration between 25% and 30%: 32%

・Percentage of gas with methane concentration less than 25%: 16%

Table 1 shows main parameter in project scenario.

Table 1 Key parameters for calculation of main financial indexes

Key parameters	Value	Note
Installed Capacity	14,000 kW	700kW×20
Thermal efficiency of gas engine	34%	
Efficiency of power generator	92%	
Average amount of gas discharge	400m3/min	
Percentage of gas with methane concentration more than 30%	52%	30%. This is conservative.
Percentage of gas with methane concentration more than 30%	32%	25%. This is conservative.
Annual operation hours of power generator	7200hours	
Annual Electricity Generation	90,720,000 kWh	
Auxiliary power ration	4.1 %	
Electricity supply to power grid	87,000,480 kWh	
Annual heat supply	51630 GJ	From waste heat boiler
Total investment	74.340.000 RMB	
Operating & maintenance costs	11.460.000 RMB	Electricity 97%, Heat 3%
Electricity Sales Price	0.23RMB/kWh	
Heat Price	14RMB/GJ	
Value Added Tax (VAT) of electricity	17%	
Value Added Tax (VAT) of heat	13%	
Income Tax	17%	
Town maintenance construction tax	5%	
Education Tax	3%	
Project Period	20years	
Credit Period	7years×3	twice renewal

Considering the characteristics of gases and parameter in table1, the assessment of PEy, project emission and BEy, baseline emission resulted in as below.

PEy = 219,244 tCO2e

BEy = 883,732 tCO2e

Leakage (LEy) is estimated to be zero since the proposed project does not utilize CBM and does not influence heat demand outside the coalmine. Thus the emission reduction by project, ERy is as follows.

ERy = BEy – PEy – LEy = 883,732 – 219,244 – 0 = 664,488 tCO2e

6. Environmental Impact and Comments by stakeholders

Regarding to Environmental Impact Assessment, an Environmental Impact Assessment Table (EIAT) is submitted instead of Environmental Impact Assessment Report since the scale of power generation 14MW is very small.

EIAT is an A3-sized paper consisting of project description, environmental standards and estimated emission by project. From The EITA of the proposed project, we know that the project will not cause any environmental impacts to the surrounding environment.

As for the collection of stakeholders' comments, Tsinghua University CDM R&D Center and Huajin Coking Coal Co., Ltd. held a meeting with local people on 20th September 2006 to collect their comments. The participants included government officials (province level, city level and county level), local residents and people from neighbouring area who may be influenced by the project, and representatives from the electric power company which operate the local power grid. All participants were invited to the seminar mainly through face-to-face invitation or telephone.

In the meeting, Tsinghua University CDM R&D Center gave the explanation on Kyoto Protocol and CDM project, and Huajin Coking Coal Co., Ltd., explained about the description of the project, related Environmental laws to be complied with, and the impact to local area. There were few questions about the project because the environmental impact is expected to be small. This is because the scale of the project is small and there is no resident around project site. Provincial government said that they are welcoming the project as they are encouraging coalmine methane utilization CDM project.

Tsinghua University CDM R&D Center was responsible for preparing the section of

Environmental Impact and stakeholders' comments in PDD. After the completion of those sections, JAPAN NUS Co., Ltd. has reviewed and revised.

7. Financial Analysis of the project

Based on the assumption shown in table 1, the result of economic analysis of project of 20years, a life span of power generation, is presented in table2, and the result of economic analysis that takes CDM project (sales income of CER) into account is presented in table 3.

As mentioned above, without CDM, IRR will be 7.19%, which is too low for the investment, however with CDM, IRR will be 80.7%, which makes the project highly profitable.

Table 2 Estimation of the project IRR without CER (unit: RMB)

Year	Annual costs	Electricity sales	Heat sales	Total sales (Tax of Electricity and heat is deducted)	Income after deduction
0	Initial investment				-74,340,000
1	11,460,000	20,010,110	722,820	7,711,693	5,783,770
2	11,460,000	20,010,110	722,820	7,711,693	5,783,770
3	11,460,000	20,010,110	722,820	7,711,693	5,783,770
4	11,460,000	20,010,110	722,820	7,711,693	5,783,770
5	11,460,000	20,010,110	722,820	7,711,693	5,783,770
6	11,460,000	20,010,110	722,820	7,711,693	5,783,770
7	11,460,000	20,010,110	722,820	7,711,693	5,783,770
8	11,460,000	20,010,110	722,820	7,711,693	5,783,770
9	11,460,000	20,010,110	722,820	7,711,693	5,783,770
10	11,460,000	20,010,110	722,820	7,711,693	5,783,770
11	4,810,000	20,010,110	722,820	13,065,608	9,799,206
12	4,810,000	20,010,110	722,820	13,065,608	9,799,206
13	4,810,000	20,010,110	722,820	13,065,608	9,799,206
14	4,810,000	20,010,110	722,820	13,065,608	9,799,206
15	4,810,000	20,010,110	722,820	13,065,608	9,799,206
16	4,810,000	20,010,110	722,820	13,065,608	9,799,206
17	4,810,000	20,010,110	722,820	13,065,608	9,799,206
18	4,810,000	20,010,110	722,820	13,065,608	9,799,206
19	4,810,000	20,010,110	722,820	13,065,608	9,799,206
20	4,810,000	20,010,110	722,820	13,065,608	9,799,206
IRR					7.19%

Table 3 Estimation of the project IRR considering the sales of CER (Unit; RMB)

Year	Income after tax deduction by electricity and heat sales	Sales of CER	Income after tax deduction by CER sales	Total income
0	Initial investment			-74,340,000
1	5,783,770	53,318,532	52,252,161	59,963,854
2	5,783,770	53,318,532	52,252,161	59,963,854
3	5,783,770	53,318,532	52,252,161	59,963,854
4	5,783,770	53,318,532	52,252,161	59,963,854
5	5,783,770	53,318,532	52,252,161	59,963,854
6	5,783,770	53,318,532	52,252,161	59,963,854
7	5,783,770	53,318,532	52,252,161	59,963,854
8	5,783,770	53,318,532	52,252,161	59,963,854
9	5,783,770	53,318,532	52,252,161	59,963,854
10	5,783,770	53,318,532	52,252,161	59,963,854
11	9,799,206	53,318,532	52,252,161	65,317,769
12	9,799,206	53,318,532	52,252,161	65,317,769
13	9,799,206	53,318,532	52,252,161	65,317,769
14	9,799,206	53,318,532	52,252,161	65,317,769
15	9,799,206	53,318,532	52,252,161	65,317,769
16	9,799,206	53,318,532	52,252,161	65,317,769
17	9,799,206	53,318,532	52,252,161	65,317,769
18	9,799,206	53,318,532	52,252,161	65,317,769
19	9,799,206	53,318,532	52,252,161	65,317,769
20	9,799,206	53,318,532	52,252,161	65,317,769
IRR				80.7%

As for the initial investment of 7,434RMB shown in table1, 3,000 RMB is the self-investment by host company Huajin Coking Coal Co., Ltd., and the rest of cost, 4,434 RMB is met by a loan from a bank.

Electricity sales price of 0.23RMB/kWh (tax included) to local electricity company was determined under a temporary agreement, which was made between the host company and the electricity company at the time of planning the project. For heat, local administrative body is responsible for setting the price, and 14RMB/GJ is the heat price of the municipality where Shaqu coalmine is located.

8. Assignments for the project owner

In order to carry out the proposed project activity as CDM project, there are a few problems as shown below:

- There is a lack of data for coal-fired boiler currently supplying heat to households living in the coalmine.
- The construction work is almost completed.
- There is a need of checking measuring meter of parameters for monitoring.
- Monitoring plan has to be prepared.

Replacement of coal-fired boilers can reduce approximately 50.000tCO_2e which is insignificant amount comparing to the total reduction of 660.000tCO_2e. Therefore we may give up the claim the credit from the replacement even if the data could not be collected. Since the construction work is nearly completed, if any modifications to the meters for monitoring are required, equipments might need to be altered. However, because of high incentive of CER sales, project owner would deal with such problem. As for operation of the equipment, we are agreed to wait until DOE inspection is completed. We are preparing PDD at the moment and expecting the desk review by DOE in April 2007. Thus, there is no significant problem for carrying out this project as CDM and it is possible to get the project registered in CDM executive board by the end of 2007.