The Potential for Methane Gas Development in Mongolia

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1.Introduction

Coal is the most important primary energy source in Mongolia, due to insufficient oil reserves, the absence of natural gas and the presence of large coal reserves. Coal supplies approximately 86.3 % of Mongolia's total energy requirements. Diesel power stations and renewable energy sources (hydro, wind, and solar stations, etc.) respectively supply 7% and 6.7%, as of 2014 (as D. Zorigt, Minister of Energy, presented at the Coal Mongolia 2015 investment forum).

Mongolia has huge coal resources, contained within 15 large-scale coal bearing basins. There are around 320 coal deposits (of which 80 deposits have been surveyed), according to the Geological Information Center of Mongolia. Total geological coal resources are estimated at approximately 150 billion tonnes, including about 20 billion tonnes explored (Figure, J. Byamba, 2014).

The Carboniferous and Permian coals are classed as bituminous to sub-bituminous or transitional (to lignite) coals. The Jurassic and Cretaceous coals are mostly lignite of high grade and partially transitional (to sub-bituminous) coals. About two thirds of all coal resources are lignite of a high grade. The main coal deposits in Mongolia by region are as follows:

Central Mongolia

Tavan Tolgoi, 6.4 billion tonnes (bituminous, sub-bituminous and coking coal)
Baruun Naran, 155 million tonnes (thermal and metallurgical coal)
Nariin Sukhait, 250 million tonnes (bituminous and metallurgical coal)
Ovoot Tolgoi, 150 million tonnes (bituminous and sub-bituminous coal)
Baganuur, 812 million tonnes (brown coal)
Shivee Ovoo, 2.8 billion tonnes (brown coal)
Tugrugnuurand Tsaidamnuur coal deposits, 2 billion tonnes (brown coal)
Ulaan Ovoo, 209 million tonnes (bituminous)

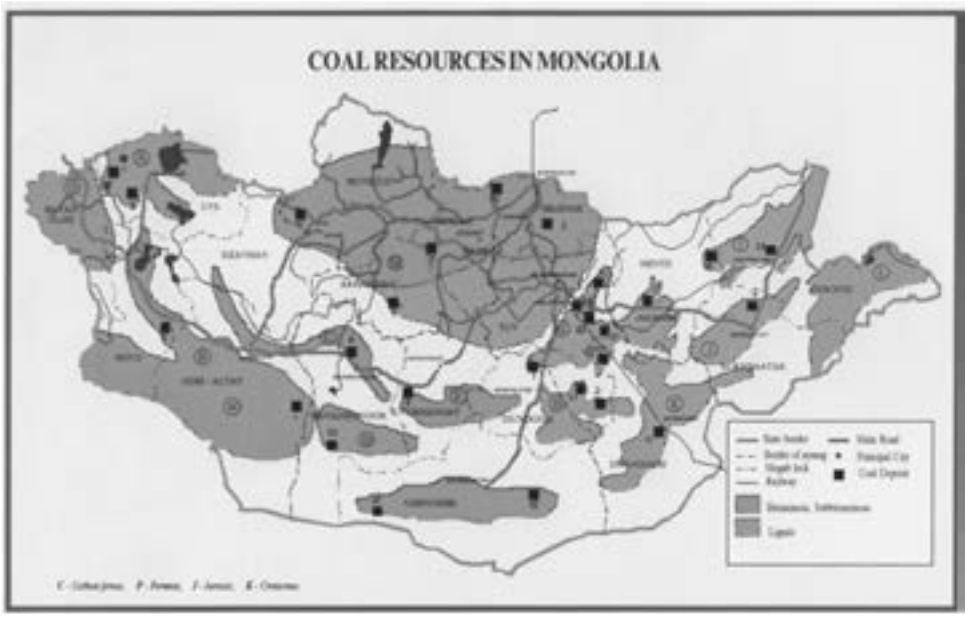
Eastern Mongolia

Aduunchuluun, 423.8 million tonnes (brown coal)
Tugalgatai, 3 billion tonnes (brown coal)

Western Mongolia

Hushuut coal deposit (300 million tonnes of bituminous and metallurgical coal)
(Source: Mongolian Mining Journal, October 2012)

Figure: Coal Resources in Mongolia



The current global initiative on using more carbon-free energy sources gives a message to Mongolia to rethink how to use its vast coal reserves, however.

2.Mongolia's Coal-Bed Methane Gas Resources

Coal-bed methane (CBM) gas is one possible source of energy and it can be used for clean and efficient energy development and other purposes in Mongolia. The methane gas resource is estimated to be 3.2 trillion cubic meters, which can be considered a world class resource.[1]

CBM occurs in association with coal during the coalification process. Technologically the survey process can be simple, as described as follows. Methane is locked in coal by the water, and water must be pumped out, and also the water quality in coal seams needs to be investigated. Generally, the gas content of coal increases with depth and the rank of the coal seam. Gas composition (60–90% CH_4+Nox, Cox) is important. Unlike natural gas from conventional reservoirs, CBM contains a very small amount of heavier hydrocarbons (propane, butane) and no natural gas condensate.

The advantages of using CBM in Mongolia can be described as:

- Relatively large reserves and high calorific value (1,000 cubic meters CBM equals 1 tonne of oil products);
- Significant environmental benefits due to reducing green-house gas emissions and the comprehensive utilization of natural resources;
- Economic benefits, encouraged by the relatively low cost of exploration and extraction compared with oil and natural gas;
- The possibility of using CBM as raw material for production of chemicals, including liquid fuel, syngas, fertilizers, methanol, ammonia, polymers, and solvents, etc.;
- Support for safe underground mine operations (avoiding gas explosions in coal mines, etc.).

Challenges have been encountered, such as the need for a significant amount of capital for infrastructure development, including gas transportation pipelines, compressor stations, distribution facilities, road networks, and railways, etc. We observe the limited possibility of direct filling of CBM into gas containers or cylinders under pressure due to the lack of a CBM cooling or liquefaction plant.

3. Studies Undertaken so far in Mongolia

The first comprehensive research was done by Storm Cat Energy (SCE), which started to conduct CBM projects in Mongolia and entered into a 49,101 square kilometers Production Sharing Contract (PSC) with the Mineral Resources and Petroleum Authority of Mongolia (MRPAM) in February 2004. The contract granted SCE exclusive rights to explore and develop coal-bed methane (CBM) resources in parts of the Nemegt-VI and Borzon-VII petroleum exploration blocks of Mongolia. The Nariin Sukhait coal mine is located in southwestern Mongolia, just 57 kilometers north of Ceke town (Mongolian–Chinese border), the mine's main distribution center for the coal it produces. The mine estimates that the coal production will be between seven to ten million tonnes per year for at least the next 15 years. The mine has resources of 220 million tonnes of high-volatile C bituminous coal, high in vitrinite reflectance, causing the coal deposit to be a significant source of methane with a high potential for storing gas. Gas desorption testing demonstrated that methane is present in the coal at depths as shallow as 150 meters and will be released into the atmosphere as surface mining takes place unless a methane drainage program is adopted by the mine operators.

The investigation area consisted of a 144 kilometers long and a 10 kilometers to 20 kilometers wide band of relatively steeply dipping, folded and faulted Upper Permian, Triassic and Jurassic strata to the surface. Six preliminary geological maps, covering a 900 square kilometers area, were compiled.

In addition to the geological mapping, Storm Cat drilled a series of 11 core holes to evaluate the location and quality of coals in the six mapped areas. In 2004 and 2005, the Company followed up by drilling five additional deep core holes to better determine the thickness and gas content of the coal. Four of the core holes, Noyon #1, #2, #3 and #4, were drilled and cored in the Central Nariin Sukhait area. The fifth core hole was drilled and cored in the Erdene Bulag (Khuree Del) area over 200 kilometers to the east. The results of the coring and desorption are as follows:

- Total coal thickness is 50 meters, locally up to 70 meters;
- Vitrinite reflectance Ro=0.62% to 0.87%;
- 15 coal seams are present in the Nariin Sukhait area coal measures;
- The main seam is 20 meters to 50 meters thick;
- The coal rank is high-volatile C bituminous to high volatile A bituminous;
- Ash content is low, 8–15%;
- Gas content ranges from 2.4 cubic meters /tonne to 11.9 cubic meters /tonne.

The potential CBM resources of the Nariin Sukhait area, calculated by SCE, range from 18.7 to 37.4 billion cubic meters. The best estimate is 21.1 billion cubic meters of gas. This estimate considers coal seams projected to a maximum depth of 1,500 meters. But no economic reserves have been identified. (Noyon Mongolia CBM project, December 2005, Storm Cat Energy Corporation).

SCE acquired a CBM exploration license for 22,407 square kilometers of land, namely Block Tsaidam-XXVI, in the form of a PSC with the Petroleum Authority of Mongolia in 2005. Under the terms of the contract SCE was to drill three exploration wells and included, but is not limited to, geological, geophysical and other technical studies. The three exploration wells are located in central Mongolia south of Ulaanbaatar with ten coal-bearing

[1] http://www.mm.gov.mn/news/view/257
Source in Mongolian. Reported in the Press Release by the Ministry of Mining.

basins. The results of this survey were not promising, namely the net coal thickness observed in the core hole equaled 125.4 meters, and the gas content for the above coals ranges from 0.03 to 0.06 cubic meters/tonne. (Tsaidam Mongolia CBM Project, 23 October 2005, Storm Cat Energy Corporation). SCE ended activity in Mongolia by late 2005, most probably because of the expected poor economic benefits.

The next research was done by Kogas. On 11 July 2010, the PAM and Korean Gas Corporation (Kogas) signed a "Joint Geological Survey of Coalbed Methane" contract for the Nalaikh coal mine, where the company drilled three wells, and prepared a total of 17 gas analysis samples. Each well depth was around 350 meters with unsatisfactory results. The estimated gas content of the coal seam in the Nalaikh coal mine was not economically viable for CBM development because it was below 5 cubic meters /tonne (Exploration Drilling & Gas Analysis of CBM in Mongolia Final Report, 5 April 2011, KIGAM).

Another noteworthy research study was implemented by the US Environmental Protection Agency, which has published a few reports on the coal mine methane (CMM) sector of Mongolia. The first report titled "Pre-feasibility Study for Coal Mine Methane Recovery and Utilization at Nariin Sukhait Mine, Mongolia" was released in March 2013. They evaluated the sparse data provided by the mine's technical staff, as well as conducted an extensive internet search for additional pertinent geologic data and information in order to better understand the factors that controlled the distribution and size of CMM resources contained within the mine lease boundary. After constructing a relatively simplistic 3-D geologic model it was apparent that the geology was much more complex than originally anticipated; however the Raven Ridge team estimated there are 253.1 million tonnes of coal beneath the lowermost extent of mining which has the potential to produce 204.1 million cubic meters of gas by the proposed 12-well pilot drainage system. It is estimated that the proposed pilot project could produce enough gas to fuel 8.55 MW power generation facilities to be used by the mine. The capital costs are estimated to be US$7.7 million with an internal rate of return (IRR) of 16.1 % and a payback period of 6.75 years. Carbon emissions would be reduced by 187,900 tonnes of CO_2e over the project's 15-year life.

The second report titled "Pre-feasibility Study for Coal Mine Methane Recovery and Utilization at Baganuur Mine, Mongolia" was released in December 2013. The Baganuur coal mine is located 130 kilometers east of Ulaanbaatar. The mine has resources of 600 million tonnes of sub-bituminous coal, and produces approximately 3 million tonnes annually, with plans to increase to six million tonnes annually by 2020. Gas desorption testing demonstrated that methane is present in the coal at depths as shallow as 100 meters and will be released into the atmosphere as surface mining takes place, unless a methane drainage program is adopted by the mine operators. After constructing a relatively simplistic three-dimensional geologic model, it was estimated that the proposed project could produce enough gas to fuel a 5.0 MW power generation facility: the energy produced by this facility would be used by the mine. The capital costs are estimated to be US$5.4 million with an IRR of 22.7 % and a payback period of 4.32 years. Carbon emissions would be reduced by 104,500 tonnes of CO_2 equivalent over the project's 10-year life by using the methane that would otherwise be released by mining.

Mongolian sources also became available. For example, in 2014 the Mineral Resource Authority (MRA), the implementing agency of the Mongolian Government, combined data on coal that were presented in the "The Mineral Resource Authority's (MRA) Initiative on Coal Seam Methane Gas, Surrounding Difficulties". According to the study, the Norwest Mine Services company's study/survey on some areas of the Tavan Tolgoi deposit indicated resources of around 20–30 billion cubic meters in 2007; an Australian company carried out a study/survey on Nalaikh coal mine which showed around 40 billion cubic meters of methane gas discharge in 2010, Kharkhiraa coal basin contains 60–90 billion cubic meters and the Onghi River coal basin contains 40–60 billion cubic meters. In addition, in 2011 Dr. Sc. B. Bayarsaikhan, who was employed at the MRA's Coal Research Department, calculated the grand total of all 22 coal mines' methane gas resources to be 68 billion cubic meters (Table 1).

The latest and ongoing research study is being developed by Erdenes Tavan Tolgoi (a subsidiary of "Erdenes Mongol LLC) in cooperation with Kogaz. On 24 February 2014, the Mongolian state-owned company Erdenes Tavan Tolgoi signed a Memorandum of Understanding with Kogas on cooperation for conducting a coal-bed methane and enhanced coal-bed methane survey in the Borteeg block of Tavan Tolgoi coal deposit. The Tavan Tolgoi coal deposit is currently considered as the largest deposit with total resources of 6 billion tonnes of coal, of which, 4.6 billion tonnes is thermal coal and 1.4 billion tonnes is coking coal. The operation of this deposit started recently and currently the coal from this deposit is exported to China after being extracted by the open-pit mining method. Research work on methane has been performed at Borteeg, a mineral exploration licensed site located in the southern part of the deposit, in order to increase its efficiency and to use environmentally friendly pure fuel. In 2014, two boreholes with depths of 783.5 (M-05) and 933 (M-01) meters were drilled for the purpose of investigating coal-bed methane content (Table 2).

This year (2015) test activities were launched in these boreholes to estimate the methane reserves. A preliminary technical and economic feasibility study for CBM development in Tavan Tolgoi, Mongolia, has been performed. The coal resources are limited to 1,000 meters in depth from the surface and a minimum apparent seam thickness of 2.0 meters. The coal resource in the Tavan Tolgoi Coalfield is estimated to be 6,400 million tonnes (to 1,000 meters) and around 6,120 million tonnes are from the major coal seams numbers 7, 10, 14, 15, 16, and 17, at about 300–1,000 meters depth (Table 3).

Total CBM capacity is estimated at approximately 40 million tonnes and the starting CBM production capacity at the well head is estimated at approximately 1 million tonnes/year, and is expected to be available for 20 years. The scope of the process included for this study were:

- Exploration and production;

Table 1: CBM Resources of the Main Coal Deposits of Mongolia

Coal basins	Resource, Million tonnes	CH_4 content, m^3/tonnes	CH_4 resource, million m^3
Nuurst Khotgor	143.3	4.53	715.7
Khar Tarvagatai	19.73	2.41	52.3
Khushuut	88	4.81	467
Zeegt	4.58	3.26	16.4
Mogoingol	4.1	2.55	11.5
Saikhan Ovoo	28.3	6.51	203.2
Uvurchuluut	3.8	1.42	5.9
Bayanteeg	29.7	2.83	92.7
Tevshiingovi	588	2.83	1835.4
Tavantolgoi	6,400	7.65	53,938.1
Shariingol	61.3	2.97	200.9
Nalaikh	58.85	2.97	192.9
Baganuur	511	2.92	1,642.9
Shivee Ovoo	563	2.97	1,845.2
Chandganatal	123	1.84	249.6
Talbulag	81.5	2.69	241.7
Aduunchuluun	241.26	1.42	376.5
Nariin Sukhait	21.84	3.4	81.8
Ulaan Ovoo	53.98	3.68	219
Khuut	87.5	1.84	177.5
Uvdughudag	159.2	1.84	323
Amangol	1,500	3.11	5,150.3
Total	**10,771.94**		**68,039.5**

Table 2: M-05 Well, Gas Analysis

Depth (m)	N_2 (%)	CH_4 (%)	CO_2 (%)
363.0~363.4	9	88.8	2.2
570.0~571.0	11.6	84.8	3.5
623.0~623.3	23.2	73.3	3.5
626.5~626.7	68.7	30.4	1
630.0~631.5	3.9	92.1	4.1
635.5~635.7	49.5	48	2.5
654.5~655.6	0.8	93.3	5.8

Table 3: Estimated total CBM Gas Resources in Major Seams of Tavan Tolgoi Coalfield

Seam	Depth, m	Thickness, m	Coal Resource, tonnes	Averaged gas, Nm^3/tonne	CBM Gas Resource (GIP)*	
					Nm^3	Million tonnes
#7	309.0-318.1	9.1	693,333,333	0.06	41,600,000	0.033
#10	462.1-497.8	35.7	2,720,000,000	11.69	31,796,800,000	24.929
#14	623.2-637.0	13.8	1,028,571,429	12.06	12,404,571,429	9.725
#15	654.1-656.8	2.7	205,714,286	3.06	629,485,714	0.494
#16	691.5-705.5	14	1,066,666,667	5.19	5,536,000,000	4.34
#17	708.1-714.0	5.9	411,428,571	1.63	670,628,571	0.526
Total		81.2	6,125,714,286		51,079,085,714	40.05

Note: * Gas In Place (GIP) is used to calculate CBM gas amount as GIP = Coal resource [tonnes] × Gas [Nm^3/tonne].

- Gas processing for each coal seam gas well;
- Central gas processing plant;
- Pipelines and re-compressor stations to transport gas from Tavan Tolgoi to Ulaanbaatar (545 kilometers).

Being at a very early stage, water management and treatment, and the generation of power from the CBM were not included in the scope of the study, which might seem critical. But potential is there, and if the estimated reserve is approved, there are several opportunities to use methane. One of them is to supply methane to thermal power stations in the capital city by pipelines from the deposit to Ulaanbaatar. This can be translated as 4 million tonnes of methane being supplied annually to meet the demand of power stations with a capacity of 1 GW. The total capacity of Mongolian power plants is 1.05 GW (as D. Zorigt, Minister of Energy, presented at the Coal Mongolia 2015 investment forum). If we use methane domestically, it may

result in significant reduction of air pollution along with introduction of eco-friendly technology. The majority of air pollution in the capital city originates from use of raw coal or oil products, which could be replaced by methane.

In addition, a preliminary economic valuation (developed by the RES Group of the United States at the request of KOGAS) shows that the construction of infrastructure to supply methane to power stations will cost US$634 million. In this case, it only requires installing an additional gas generator in the existing power stations, allowing them to operate a normal regime. Also, the estimated annual production of gas is 1 million tonnes, with exploration and mining-related drilling costs of US$52.5 million, costs of US$53.6 million to construct facilities that will collect gas extracted from boreholes, gas sorting and purification plant costs of US$20.9 million, gas pumping costs of US$50.9 million and gas transmission pipeline costs of US$280 million (Mongolia Tavan Tolgoi CBM Pre-Feasibility Study, Kogas, 2014).

4. Policy Development and Legal Reform

Mongolia is committed to creating an enabling environment for unconventional oil including CBM. Official state policy was approved by the Mongolian parliament in 2012 and 2014. In line with these state policies, the Mongolian parliament approved the new Law on Petroleum in 2014, which has created a convenient environment for conducting exploration, investigation and mining activities in the field of unconventional oil. Therefore, the new regulations on unconventional oil have been approved by the government, and have paved the way to support businesses operating in the shale oil, CBM and coal processing fields. The Petroleum Authority of Mongolia has received over 50 requests on prospecting agreements for unconventional oil over the last two years. There can be a clear sign of business interest in this new field. Also independent law firms have hailed the new law and recognized the step as "…it is another positive step in attracting more investors, foreign and domestic alike, into the petroleum sector."[2]

To attract more investments, Mongolian policymakers amended its taxation policy, including an exemption of import duty for the first five years.

5. Conclusion

Mongolian methane gas resources are estimated to be 3.2 trillion cubic meters. The new Petroleum Law in Mongolia provides the basis for reasonable regulation of the unconventional oil and gas sectors. In combination with the previous Tax Law, Foreign Investment Law and Company Law, the statutory framework will allow for protection of the economic, social, and environmental resources of Mongolia while encouraging foreign investment. For example, the PAM recently signed two Prospecting Agreements on Coalbed Methane and more contracts are being drawn up. Other alternatives include construction of gas distribution stations (currently there are 11 gas filling stations in Mongolia) providing gas-engine vehicles with fuel. As the reports indicate, the Mongolian CBM projects' presented CBM gas development potentialities in the country due to their reserves and quality. Introduction of world-class coal-bed methane practices in the country would provide customers with cleaner energy sources, while protecting the environment.

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