

## POSSIBILITIES AND RESOLUTIONS OF MONGOLIAN ENERGY SECTOR

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**ABSTRACT.** Mongolia is the part of the earth; therefore, earth's problem is Mongolian problem. In one hand, for the energy and gas sector, the main reason of utilization gas for the energy is of course environmental protection or reduction of air pollution. In other hand, energy manages the economy of every country. If the country has the energy resource, it can be decided any kind of method. Then, there are some air pollution problems, energy and economy dependence and also, the mineral resource. Thus with increase of coal mine capacity, emission of methane to atmosphere will increase. Greenhouse gas emission of Mongolia was estimated at 20 million tons in 2016. If the current development trend will be kept, greenhouse gas emission may reach 50 million tons by 2030. From the other hand, Mongolia has promised in Paris to reduce greenhouse gas emission by 14 percent by 2030. Mongolia is dependent country from energy, especially from petroleum products. This actual problem influences to Mongolian economics. There are many ways to become independent country. Here in: to build the oil refinery; to produce petroleum product from coal; to extract and refine the CBM and CMM at Tavan tolgoi coal mining (transform to LNG and CNG).

**Keywords:** coal, independence, pipeline, LNG, CNG

### ВЪЗМОЖНОСТИ И РЕЗОЛЮЦИИ НА МОНГОЛСКАТА ЕНЕРГЕТИКА

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**РЕЗЮМЕ.** Монголия е частта на земята; следователно, земният проблем е монголски проблем. От една страна, за енергийния и газовия сектор основната причина за използването на газ за енергията е, разбира се, опазването на околната среда или намаляването на замърсяването на въздуха. От друга страна, енергията управлява икономиката на всяка страна. Ако страната разполага с енергийния ресурс, може да се реши какъвто и да е метод. Тогава има някои проблеми със замърсяването на въздуха, енергийната и икономическата зависимост, а също и минералния ресурс. По този начин с увеличаване на капацитета на въглищните мини, емисиите на метан в атмосферата ще се увеличат. Емисиите на парникови газове от Монголия бяха оценени на 20 милиона тона през 2016 г. Ако сегашната тенденция на развитие ще се запази, емисиите на парникови газове могат да достигнат 50 милиона тона до 2030 г. От друга страна, Монголия обеща в Париж да намали емисиите на парникови газове с 14 процента до 2030 година. Монголия е зависима страна от енергията, особено от петролните продукти. Този действителен проблем влияе на монголската икономика. Има много начини да стане независима държава. Тук в: за изграждане на рафинерия за петрол; за производство на нефтен продукт от въглища; за извличане и рафиниране на CBM и CMM при добива на въглища Tavan tolgoi (трансформация в LNG и CNG)

**Ключови думи:** въглища, независимост, тръбопровод, ВПГ, СПГ

### Introduction

Mongolia is a Central Asian country neighbouring with the Russian Federation and the People's Republic of China. The country has a total territory of 1 565 600 km<sup>2</sup>. Mongolia has a sharply continental climate, with long, cold and dry winters and brief, mild, and relatively wet summers. Mongolia is divided into 21 aimags (provinces), and further into 331 soums (counties). Ulaanbaatar is the national capital; approximately 1,3 million people live in Ulaanbaatar. The Darkhan and Erdenet is the second and third largest cities with population of 70 000- 85 000 people. According to statistics of 2020, the population of Mongolia is 3 363 510. This is an increase by 1.6 percent or 640,3 thousand person since 2006. Since the collapse of the Soviet Union and COMECON in 1990 (withdraw of Soviet assistance was equivalent to the loss of 30 percent of GDP), Mongolia has faced with restructuring and transforming its previously centrally planned economy into one that is market-based and private sector driven. This result is published by Janarbaatar Jamsran (2018). Mongolia has implemented a series of economic reforms since 1990, aiming at stabilization of the economic performance and restructuring the economy

into a market based system. Before 1921, the main energy resource for heating homes was the animal waste in Mongolia. At first, Chinese people used the coal for heating homes and households in Mongolia around 1900. The first power and thermal plant was built in Ulaanbaatar city, in 1923. Following, the electricity transmitting lines were been constructed whole areas in Mongolia. Cities and towns were constructed all over the Mongolia and new power and thermal plants were been built. Now, there are 7 power and thermal plants in Mongolia. Of course, coal is still the main resource of heating for homes, apartments, public places and factories. At the same time, the first vehicles were imported to Mongolia and it was the establishment of Mongolian oil and gas sector. But, Soviet Union Government had been responsible the petroleum products export issues until 1941. In 1941, the government of Mongolian People's Republic made a decision and they established the petroleum products importing department and bought the all petroleum products storage depots and gas stations from Soviet Union. In other hand, the 78<sup>th</sup> anniversary of Mongolian oil and gas sector will be celebrated this year. In 1949, the "Mongol Neft Trans" was established and the crude oil and natural gas exploration were performed in Dornod and

Dornogobi provinces. The Zuunbayan and Tsagaan Els oil fields were discovered during above mentioned exploration and the first oil refinery were built in 1954. Unfortunately, the little explosion was occurred in the oil refinery in 1969 and also oil rate was reduced, new exploration plans were not implemented until 1990; at last the oil refinery was closed.

The collapse of the Soviet Union in 1989 had far-reaching impacts for Mongolia, politically, economically and socially. A parliamentary democracy was put in place, the development of upstream petroleum operation recommenced, and the Petroleum Law of Mongolia and related regulations were put into effect in 1991. The government initiated the "Petroleum Program" classifying prospective petroleum areas into contract blocks and releasing them for international bidding.

In 1993, the first Production Sharing Contract (PSC) was signed with SOCO from the USA and the first exploration well of 3,000 meters depth was drilled a year later. In 1997, well 19-3 on Block XIX was recorded as the country's first free flowing oil well. Soon after, oil was exported from Mongolia by trucks to China to be refined.

The second biggest oil refinery is been built in Mongolia nowadays. Also, some companies are trying to produce petroleum products from coal. Everyone knows that coal is the main energy resource which is located in the earth.

The petroleum product producing process from coal depends on the world market price of per barrel crude oil. Right now, the world market price of per barrel crude oil is not encouraging the coal processing and its product utilization activity. If I rank the above mentioned ways, I will put the CBM at the first and the CNG or LNG at the second. Because, utilization of natural gas is the basic method reducing air pollution. Natural gas can be produced from crude oil, coal and CBM or biomass, easily. In additional, the Mongolian coal reserve is calculated 175 billion tonnages and there are 15 coal basins, over 300 coal fields in Mongolia. Mongolia is ranked at the 15<sup>th</sup> country by coal reserve in the world. Some CBM occurrences have just defined in Mongolia. The pilot factory was built last year in Tavan Tolgoi coal mining site. Therefore, we have to study the CBM and its utilization possibility and other special, important problems. The data are published by Tseveenjav (2019), as well as by Zoljargal et al. (2019).

There is no natural gas deposit discovered in Mongolia. But large coal deposits contain methane gas in pores of coal, from where it is released to atmosphere during coal mining. It had been considered as economically unfeasible, however thanks to modern technology it is now being developed in many countries as profitable business.

Obviously there is large potential of coal mine methane in Mongolia as a country with vast coal resources. If we can use coal mine methane, it is the purist and cheapest fuel for electricity generation, for the transportation vehicle and for households. If not, just a greenhouse gas emission silently released to the atmosphere.

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## The overview of Mongolian energy and gas sector

In 2019, Mongolia's electricity production has reached a volume of 6,624.8 million kWh, an increase of 8.8% compared to the previous year's production. 93% of total electricity was produced by thermal power plants, 6% by solar and wind, 1% by hydro power sources, and 0.06% by diesel generators. Total heat energy production has been reached a volume of 9,425.1 thousand Gcal, an increase of 5% or 448.5 thousand Gcal, compared to the previous year.

During the year, 1,683.6 million kWh of electricity has been imported making an increase of 161.2 million kWh or 10.6% compared to the previous year.

The majority of heating and electricity energy is being generated by coal fired thermal power plant and the remained small amount is from hydro, wind, solar and diesel stations. Also, we got electricity from Russia, which takes 20 percents of our electricity supply.

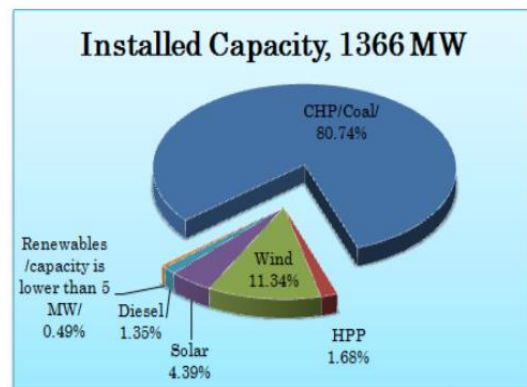


Fig. 1. Energy generation types

Likewise, the demand for refined oil products has been met 100% by imports. Consumption has been increasing nearly every year until it dropped slightly in 2014 and 2015 reflecting the country's economic downturn during these years. It is now back on upward trend, with the highest ever import of ca. 1.5 million tonnes petroleum products in 2019. Further increase is expected in the long-term.

More than 90% of the imported oil products come from Russia and the remainder from countries such as China, Republic of Korea and others.

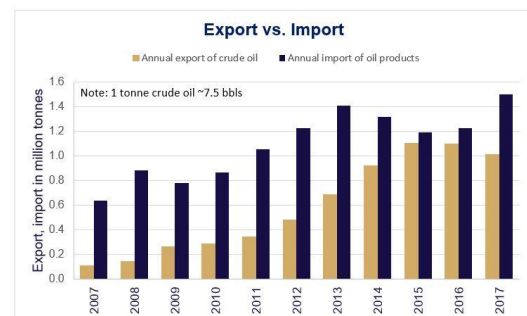


Fig. 2. Mongolian crude oil export and oil products import

To reduce its dependence on imports, the Government of Mongolia is seeking to build the country's own refinery, supported by a 1 Billion USD soft credit line from India. In June

2018, the Ministry of Mining and Heavy Industry reported that the final detailed feasibility study which was completed by “Engineers India Ltd” had been received. The refinery with an initial capacity of 1.5 million tonnes p.a. would be built in Altanshiree Soum near Sainshand City in Umnugobi province.

## Mongolian potential resources and reserves of energy and gas

### Coal resources

Mongolia has about 173.5 billion tonnes of coal, distributed among 15 basins and 3 fields. We have both thermal and coking coal deposits and their economic value and infrastructural surroundings are significantly varied. Estimated reserves of coal by A+B+C1 classification were 37.4 billion tonnes.

These reserves were estimated at an average depth of 300m, with most of it concentrated in the South Gobi and Choir-Nyalga basins in the central economic region. About 57.6% of the estimated reserves consist of hard coal and is mainly distributed in the West, Central and Khangai regions. Over 60% of explored reserves of hard coal is in the Tavan Tolgoi, Ukhaa Khudag, Baruun Naran and Naryn Sukhait deposits. The rest of the hard coal is in the basins of Kharkhiraa, Mongol Altai, South Khangai, Ongi River and South Gobi. Brown coal with high moisture and low calorific values makes for about 41% of the total estimated reserves and is mostly distributed in East and Central regions.

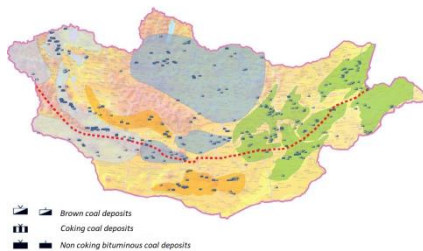


Fig. 3. Distribution of coal resources in Mongolia

### CBM

Coal mine study was started by Storm Cat Energy in 2004, when they drilled 11 boreholes in Noyon basin in South Gobi and concluded that 18.7 to 37.4 billion cubic meters of methane can be found at Naryn Sukhait coal deposit.

In 2012, a team of experts of Mongolian Nature and Environment Consortium and Raven Ridge Resources Incorporated from the US with support of the US EPA conducted studies on coal mine methane at three open pit mines of Baganuur, Tavan Tolgoi and Naryn Sukhait. They conducted gas analysis on core samples taken from Baganuur and Naryn Sukhait mines and prepared pre-feasibility study report for utilization of methane gas.

In 2014, Erdenes Tavan Tolgoi and Kogas of Korea signed MOU to start coal bed methane study at Tavan Tolgoi. Elgen LLC, a domestic drilling company cooperated with Kogas for drilling prospecting boreholes to depth of 700-900 meters and constructed pilot plant for extraction and purification of coal bed methane. Following those achievements, state owned Erdenes Methane LLC was created for further development of methane gas resources at Tavan Tolgoi. It is being considered

that Tavan Tolgoi coal deposit might contain around 40 million tons or 60 billion cubic meters of methane gas.

Over 300 coal deposits were discovered in Mongolia across major coal 15 basins. The country’s geological resources of coal are estimated at 175 billions tons. This clearly shows a huge potential for development of coal mine methane. The data are published by ADB (2018)

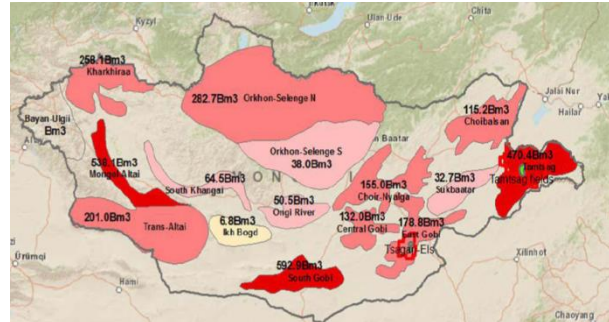


Fig. 4. Potential resources of methane gas in coal bearing basins of Mongolia



Fig. 5. Pilot plant of extraction and purification of methane gas at Tavan Tolgoi

### Petroleum

Petroleum exploration and production in Mongolia are performed solely under PSCs signed over each petroleum block between the investor and Government of Mongolia. There is no national oil company (NOC) in Mongolia.

As of 2019, there are a total of 32 petroleum blocks and Mongolia has concluded PSCs with 22 domestic and foreign companies on 27 blocks so far. Three of these blocks have advanced to production, one was cancelled and one relinquished, while the others are still being explored.

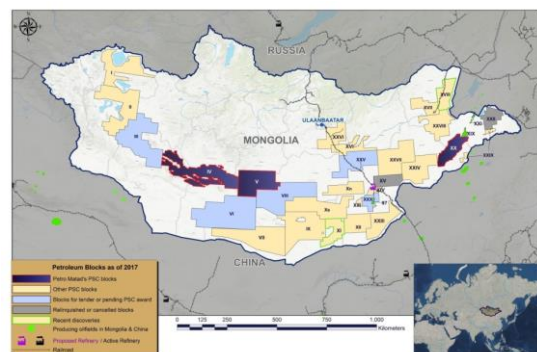
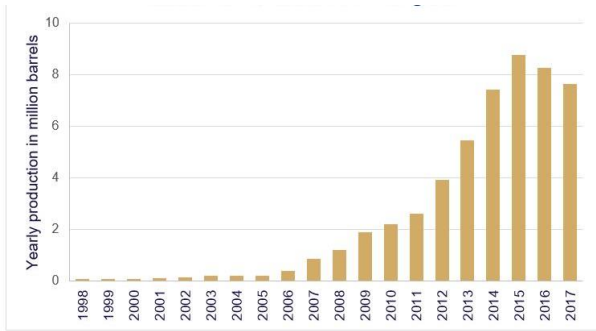


Fig. 6. Petroleum blocks in Mongolia

**Exploration, Production, Recent Discoveries**

After the resumption of upstream petroleum activities in the early 1990s, circa 51 million barrels of oil have cumulatively been produced in Mongolia between 1996 and 2017.



**Fig. 7. Crude oil production in Mongolia**

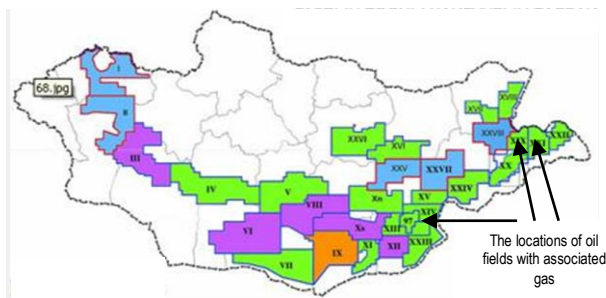
Mongolia's oil production steadily increased until 2015, reaching a daily production of ca. 24,000 barrels of oil. However, it has shown slight decreases in 2016 and 2017. More than 90% of the country's annual production has been solely from Blocks XIX and XXI in Tamsag basin in eastern Mongolia in recent years.

From 1993 to 2016, total 33,494 line km 2D seismic, 6,274 km<sup>2</sup> 3D seismic, gravity survey covering 272,890 km<sup>2</sup> area (incl. 11,000 km<sup>2</sup> FTG), 11,000 km<sup>2</sup> HRAM and 77,630 km<sup>2</sup> magnetic survey were conducted, and more than 1,500 wells have been drilled. Investments totaling 3.45 billion USD were made in petroleum exploration and exploitation in Mongolia by PSC contractors during the same period. Only about 70 of those 1,500 wells were drilled outside the three blocks that have advanced to production stage.

In addition to the three producing blocks, oil discoveries have been reported in two other blocks, namely Blocks XI and XVIII.

The (proved) ultimate recovery (proved reserves plus cumulative production) for the 3 producing PSC blocks was estimated at total 43 million tonnes (ca. 320 million barrels) of oil. The estimates were officially accepted by the state committee in 2011 and 2012, and no update has been reported since then.

**Associated gas reserve in Mongolia**

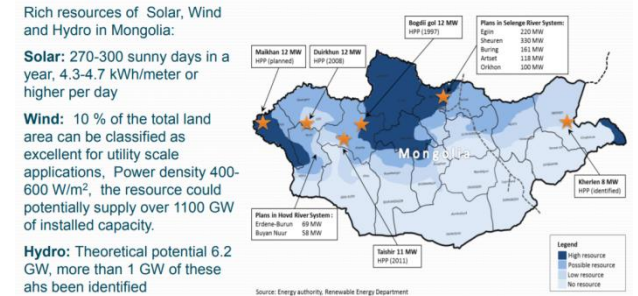


**Toson Uul –XIX**  
 Proven reserve – 6.98 trillion cubic meters  
 Probable reserve – 0.33 trillion cubic meters  
 Possible reserve – 2.98 trillion cubic meters  
 Proven reserve for developing – 0.77 trillion cubic meters

**Fig. 8. Associated gas reserve in Mongolia**

**Renewable energy**

Renewable energy accounted for more than 3% of the domestically produced energy used in Mongolia. The Mongolia's hydroelectric plants produce 28.3 MW, making the largest contribution to the country's renewable energy". Policy target: 20-25% of electricity provided by renewable energies by 2020

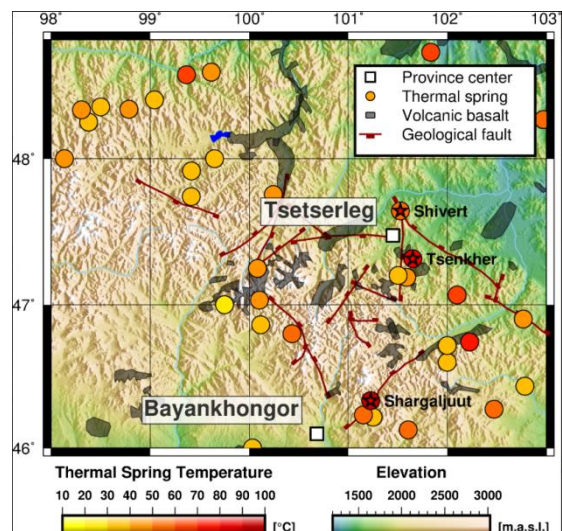


**Fig. 9. Renewable**

**Geothermal exploration and energy utilization in Mongolia**

The existence of numerous hot springs in Mongolia's Hangai province is indicative for large geothermal energy resources, which are remnants of the region's volcanic geological history. Previous studies have shown that a combined, geothermal heat and power plant could provide cheap and clean energy for the province center Tsetserleg. With this project we will introduce the missing geophysical component of the so far conducted geothermal exploration program in the Hangai. We will establish scientific methods to image the geothermal reservoir near Tsetserleg, which feeds the hot springs in Tsenkher and Shivert. The result will be of great importance for promoting the construction of geothermal power plant.

This project is a collaboration between ETH Zurich and the Mongolian Academy of Sciences. It is funded by the Swiss Programme for Research on Global Issues for Development (r4d programme) – a joint funding initiative by the Swiss Agency for Development and Cooperation (SDC) and the Swiss National Science Foundation (SNSF).



**Fig. 10. Geothermal energy study in Arkhangai province, Mongolia**

## **Biogas**

The main resource of biogas is the animal waste in Mongolia. There are 2 small plants in Mongolia near the cow farm. These plants were built by South Korean Government support. Unfortunately, these two plants are not producing biogas now. Because many Mongolians are nomadic people (nomadic herding still the same as before) and they do not have sufficient information about biogas and green house gas, also biogas trucks and cars. Although, animal waste will be the main resource of biogas in Mongolia.

The number of livestock animals in Mongolia reached 66.46 million, a record high since the nomadic country began a livestock animal census in 1918, a senior expert of the National Statistics Office said Thursday.

A census conducted between Dec. 7-17 showed the number of livestock animals in 2018 increased by 244,700, or 0.4 percent, from the previous year, Erdene-Ochir Myagmarkhand announced at a press conference.

According to the preliminary result of the nationwide census, sheep accounted for 46.0 percent of all livestock, goats accounted for 40.8 percent, cattle accounted for 6.6 percent, horses accounted for 5.9 percent and camels accounted for 0.7 percent.

Among the country's 21 provinces, the northernmost Khuvsgul has the largest number of livestock with 5.7 million, followed by Uvurkhangai and Arkhangai in the central provinces, with about 5.5 million respectively.

There are 230,800 herder households with livestock animals, up 0.8 percent from last year.

The promotion of animal husbandry is seen as the most reachable solution to diversify the landlocked country's mining-dependent economy. Currently, mineral products account for over 90 percent of its total exports. (Dugerjav, 2018, Narantsetseg et al., 2019, 2017a, 2016b, Gatumur and Oyuntugs, 2017, 2018, 2019)

## **Conclusion**

The first reasonable issue of this study is air pollution. Therefore, as before mentioned, air pollution is at the crisis level in Ulaanbaatar city, Mongolia, especially during the winter time. It can be seen that the PM<sub>2.5</sub> is 4 to 4.5 times higher than the permissible level of standard. In Mongolia, the main pollutant is the ger district (where people live in the Mongolian national habitat "ger" or private houses)-s in Ulaanbaatar city and other urban centers. Of course, because coal is used for heating homes and producing electricity (over 95 percent) in Mongolia. Using coal for heating and electricity producing has enough low KEП (in Mongolia, it is 44.12%). There are many experiences for reducing air pollution, the most optimal and successful version is natural gas and renewable energy.

The second reason is the energy or economy independent of Mongolia. Petroleum products are imported from Russia (up to 95%), China (to 3%) and other countries, although, electricity is imported from Russia during overloaded hours (evening hours), recently the LNG import has begun.

The third, energy sector's structure and activities are not clear, especially gas sector's laws, regulations, codes and standards are few and weak. Of course, there are some

policies in energy and gas sectors, although implementation and controlling issues are not as well as it can be.

The fourth, however, there are many kinds of energy resources in Mongolia, such as coal, crude oil (associated gas), animal feedstock, wind, solar, geothermal, CBM and etc. The proven reserve of coal was estimated over 37.1 billion tonnages in 2016, and anthracite occurred over 30 percent in the coal basins, resulting in, some CBM researches and studies have been processed in Mongolia, since 2000. For crude oil, the proven reserve of associated gas was calculated, although not enough high (proven reserve for developing – 0.77 trillion cubic meters). The (proved) ultimate recovery (proved reserves plus cumulative production) for the 3 producing PSC blocks were estimated at total 43 million tons (ca. 320 million barrels) of oil. The estimates were officially accepted by the state committee in 2011 and 2012, and no update has been reported since then. The next potential energy resource can be biogas, because the number of livestock animals in Mongolia reached 66.46 million, but mainly traditional nomadic herder life is dominated in Mongolia.

For the renewable, for example, solar, wind, hydro and geothermal; some projects are implementing.

As the above data, it can be seen that coal and CBM are the main future energy resources for Mongolia.

In 2012, a team of experts of Mongolian Nature and Environment Consortium and Raven Ridge Resources Incorporated from the US with support of the US EPA conducted studies on coal mine methane at three open pit mines of Baganuur, Tavan Tolgoi and Naryn Sukhait. They conducted gas analysis on core samples taken from Baganuur and Naryn Sukhait mines and prepared pre-feasibility study report for utilization of methane gas.

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Over 300 coal deposits were discovered in Mongolia across major coal 15 basins. The country's geological resources of coal are estimated at 175 billion tons. This clearly shows a huge potential for development of coal mine methane.

Mongolian Nature and Environment Consortium guesses that methane resources of Mongolia can be estimated at 3 trillion cubic meters in total. About 63.9 percent of all methane resources are concentrated in bituminous coal deposits, while brown coal and anthracite contain less methane.

These numbers are simply calculated through multiplying coal resources by typical content of methane gas in similar type of coal based on reference data from international and domestic studies. It should be noted that an extensive geological exploration shall be done in order to convert those suggestions to real reserves.

Overall, the future main resource can be the CBM (LNG, CNG or NG), therefore, researches and studies will connect with this future research.

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