

Kartikasari, Lucy; Suntara, Trisna

Article

Coalbed Methane - an unconventional - clean energy, the forming, extraction, and potential of Indonesia's Coalbed Methane as future source energy for Indonesia

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COALBED METHANE – AN UNCONVENTIONAL – CLEAN ENERGY. THE FORMING, EXTRACTION, AND POTENTIAL OF INDONESIA’S COALBED METHANE AS FUTURE SOURCE ENERGY FOR INDONESIA.

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ABSTRACT

Coalbed Methane (CBM) is natural gas produced in coal seams through coalification process. CBM trapped in the pores of coal and mobilization capacity is affected by cracks which are owned by the coal reservoir. Methane is formed by mycobacterial activity (biogenic) or heat (thermogenic) during the coalification process. In use, the emissions that generated from CBM is around 25 tons per GWh. For comparison, the emissions generated by the use of coal exceeding one thousand tons per GWh. From these data, CBM is a cleaner energy source than coal. CBM potential in Indonesia is fourth ranked after the United States, China, and Australia. This potential spread in Central Sumatra, Sekayu, Barito, and Kutai. The total potential of CBM in Indonesia reaches 453 TCF. Thus, the CBM is one of energy source which is potentially provide greater energy intake in welcoming the issue of Indonesia’s energy independence in 2025.

Keywords: CBM, energy, Indonesia.

1 INTRODUCTION

Energy demanding in almost every country has increased with increasing the number of the population. As the world's fourth most populous country, Indonesia also requires considerable energy to cover the daily needs of its citizens. Energy has an important role to achieve social, economic, and environment purposes for sustainable development in Indonesia. So far the energy needs in Indonesia mostly covered by fossil fuels / conventional energy (oil, gas, and coal) which cannot be updated. Petroleum needs in 2011 reached 47.5%, while gas and coal is almost the same, reaching 20% of total primary energy supply (KESDM, 2012). Oil imported by Indonesia shows that Indonesia is no longer a country with sufficient energy resources to meet domestic needs. This condition makes Indonesia become net oil importer. Indonesia forced out as a member of OPEC (Organization of the Petroleum Exporting Countries). In other words, Indonesia is now experiencing a crisis of energy resources, especially for oil.

The issue of Indonesian independence in the field of energy in the form of the National Energy Policy as stipulated in regulation No. 5 of 2006 which become guideline to increasing capacity of national energy use. One of the important things in that policy is raising the utilizing of non-conventional energy (CBM, shale gas, shale oil) and renewable energy (geothermal energy, solar energy, wind energy, etc.). So far the geothermal energy is reputed as the future of energy source in Indonesia. But, geothermal energy reserves in Indonesia still has not been able to fulfill all the energy needs in Indonesia and its using is mainly just on the sector of electricity

energy. Thus, the other abundant energy resource is needed to fulfill energy needs of a growing Indonesia.

In addition to geothermal energy, Indonesia has an abundant coal reserves. But, most of coals in Indonesia relatively has poor quality (low to medium). Nevertheless, coal in Indonesia has another greater potential than its use as a fuel only. This potential is methane gas known as coalbed methane. Coalbed methane (CBM) is natural gas produced in coal seams. CBM become something interesting for several reasons, mainly because CBM is a clean energy and its presence is very abundant in Indonesia.

The purpose of this paper is to determine the total potential of CBM in Indonesian, CBM formation process, methods of extraction, as well as the drawbacks and advantages. Research on CBM Indonesia must be improved in order to optimize its use for the stability of the national future energy security.

2 RESEARCH METHODS

The data used in this paper came from a literature review conducted by searching for information on the potential of coal and coalbed methane owned by Indonesia. Information were taken through papers, books and e-books, and conference proceedings on CBM in Indonesia. This captured information, derived from the primary data from related companies so that the data had a good validity and was able to represent a potential CBM actually owned by Indonesia.

3 RESULTS

Coal is a rock that is rich in carbon element, derived from the remains of plants, which accumulated in swamps and buried as a result of an ongoing geological process. Coal has a small porosity but most of the stored gas adsorption capacity greater than conventional reservoirs. Gas is called the CBM. In other word, the CBM is natural gas that is formed simultaneously with the formation of coal. CBM is formed from mycobacterial activity (biogenic) or by heat (thermogenic) during coalification. Characteristic of CBM are odourless, colourless, and highly flammable.

3.1 The Formation of CBM

CBM formation process is divided into three stages, namely:

- Biogenic Methane

This process occurs when organic material turned into coal or often called coalification process. In this process formed some of gas and one is methane (CBM). The methane gas is formed from mycobacterial activity as a byproduct of mycobacterial respiration. Mycobacterial activity is strongly influenced by the presence of water in the rock layers. Good water circulation causing methane gas that is formed can be developed until the final stage. The formation of methane gas in coal seams is influenced by pressure, temperature and time. In general, methane gas is formed at shallow depths with temperatures ranging from 40-90 ° C.

- Thermogenic methane

This process occurs when the temperature of the coal below the surface increases due to the increasing the geothermal gradient (> 50 ° C). In this process formed carbon dioxide and nitrogen as a result of coalification. Thermogenic methane formation occurs when the temperature reaches > 120 ° C, the amount of methane produced exceeds the amount of carbon dioxide. Peak methane formation occurs at a temperature of 150 ° C. There is a possibility at higher temperatures and better grade coal, methane is formed but with a smaller volume (Rightmire, 1984; within Katz, 1987; within Daranin, 1995).

- Late Biogenic Methane

This process occurs when the coal has reached a stage of maturity. Methane gas formed is also a byproduct of mycobacterial respiration. This process occurs when coalification process no longer occurs. However, the results produced are generally not very significant.

3.2 The Extraction of CBM

Methane gas formed from coal seams is more produced relatively in deep depth than in shallow depth which has the lower pressure. The process of extracting methane from coal is held by pumping large volumes of water in the formation to reduce pressure on coal (dewatering process). Then, methane flow into cleats (specific term for porosity in coal) and fractures in coal through diffusion process, which will eventually flow into the production well.

In the production process, the cleats in the coal do not contact each other. This case complicates the process of CBM extraction. Therefore to take the CBM contained in coal seam, fractures are made by providing a relatively large force to the layer. This method is called the basement fracture.

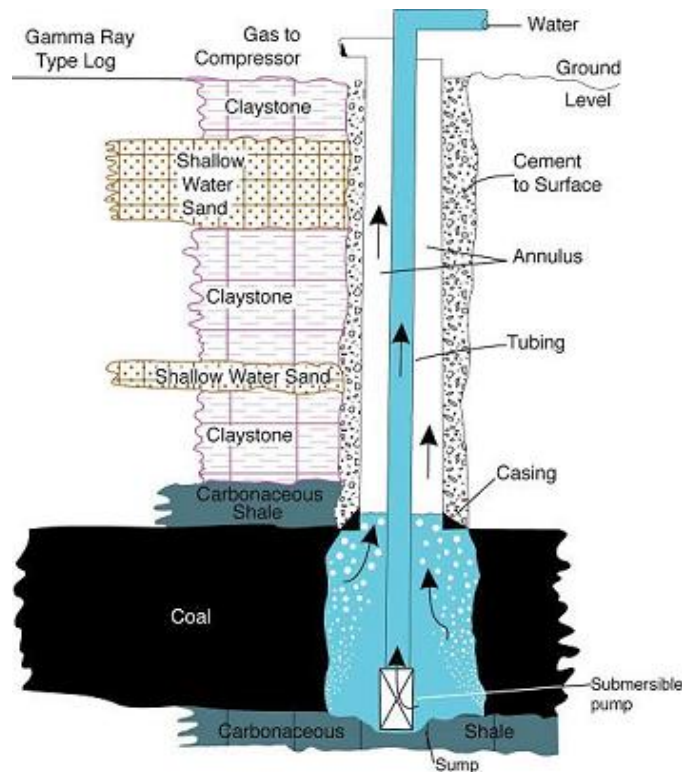


Figure 1: Coalbed Methane Well Illustration

(<http://www.wsgs.uwyo.edu/images/2ndlevel/GeologyBySubject/cbmwell.jpg>)

CBM is an unconventional gas as source rock and reservoir rock in the CBM present in the same lithology, which is the coal seam. The two parameters that must be owned CBM reservoir that can be produced are cleat permeability and gas saturation. CBM is stored in cleats of coal. Interconnectedness cleats in coal affect CBM production process. In early production, the amount of water produced is relatively high and methane gas tends to be low. However, when the formation water continuously pumped, it can cause pressure drop in the reservoir and it is shown with steep slope on the isothermal absorption curve. The result is the addition of methane gas release rates. Simultaneously, relative permeability of gas in the regime of two-phase (gas and liquid) increase in cleats result of the high gas saturation. In the end, CBM production reaches

peak phase from the fourth to the sixth year. And after that, there is a decreasing in production in the year onwards

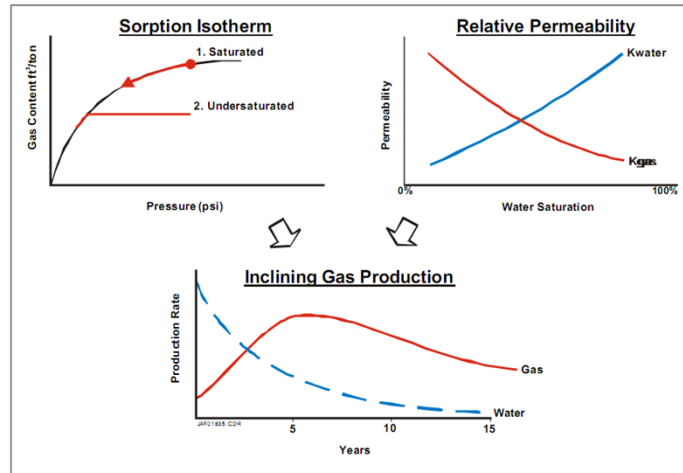


Figure 2: Graphs isothermal absorption, relative permeability, and gas production (Stevens and Sani, 2001)

Initial studies indicate the presence of CBM in Indonesia amounted to 213 TCF (Total Cubic Feet) of gas (Nugroho and Arsegianto, 1993a and b; Suyartono and Ginter, 1995 in Stevens and Sani, 2001). In this study, there are eleven coal basins with CBM potential which located in land. These basins are classified into two tectonic groups, namely kratonik and active tectonics. Kratonik group covers an area of Borneo and parts are not deformed in the east. Meanwhile, the active tectonics group covers an area of Sumatra and Java. For offshore basin, the analysis was not carried out due to the cost of its development is still high and difficult to reach areas.

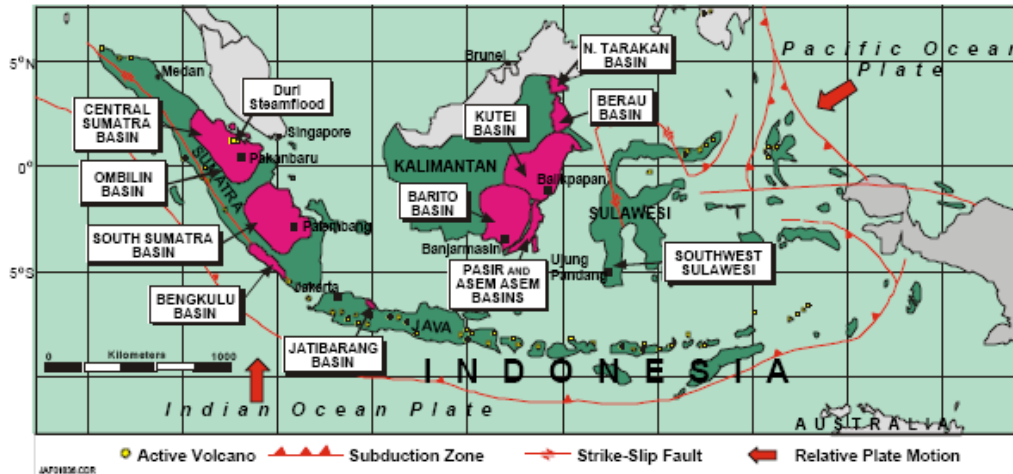


Figure 3: CBM Basins in Indonesia (Stevens and Sani, 2001)

- To estimate the prospects for CBM in Indonesia can use some of the following:
- To ensure sufficient gas content, the minimum depth of the reservoir layer is 1000 feet,
 - At the depth of 5000 feet above the cleats have a very low permeability,

- The thickness of the coal is measured from the data logs of petroleum and coal mines, confirmed by many other free logs (neutron / density, resistivity, gamma ray, caliper wellbore),
- Three hydraulic fracture treatment per well has been assumed. Each fracture is assumed to stimulate all the coal in an interval of growth,
- The content of the gas is determined from the rank of coal and isotherms absorption data,
- Ash content measurement data,
- Standard gas volumetric equation.

Province	Basin	Prospective Area (km ²)	CBM Resources (Tcf)
Kalimantan	Barito	15,000	75
	Berau	2,000	10
	Kutei	10,000	50
	North Tarakan	6,500	20
	Pasir/Asem Asem	1,000	3
Sumatra	Central Sumatra	15,000	50
	South Sumatra	20,000	120
	Bengkulu	3,000	5
	Ombilin	130	1
Java	Jatibarang	500	1
Sulawesi	Sengkang	1,000	2
Total		74,000	337

Figure 4: The estimated CBM resources in Indonesia (Stevens and Sani, 2001)

3.3 Several Potential CBM Basin in Indonesia

- Barito Basin: a thick layer condition, low level of coal with gas kicks on Warukin Formation age of Miocene and Tanjung Formation age of Eocene at a depth of prospective. The vast of basin is about 15,000 km² with a simple structure. CBM resource with full potential, based on only the eight exploration wells estimated potential of 101.6 TCF (1 TCF is equivalent to 178.1 billion barrels)
- Kutei Basin: The condition is relatively thick with a low level of coal occurs in Prangat Formation (Miocene), Kamboja Formation and Loa Kulu Formation. The structure is quite complex, with a high amplitude folds which may be caused by the gravitational shear (extension) of folds due to compression. Reserves are estimated at 80.4 TCF in the area of 10,000 km².
- Ombilin Basin: Contains coal with the highest levels in Indonesia, reaching the level of bituminous. Thick coal seams found in Sawahlunto Formation age of Eocene and Sawahumbang Formation age of Oligocene. The high levels of CO² may be a problem in the intra-montane rift basin. Reserves are estimated at 0.5 TCF.
- Central Sumatra Basin: The rate of coal is low to moderate in Korinci Formation (> 6,000 feet). This basin is a thermal enhanced oil recovery in the Duri Field to Singapore. Reserves reach 52.5 TCF in the area of 15,000 km².
- South Sumatra Basin: Thick low level coal in the Muara Enim Formation of Mio-Pliocene age and Talang Akar Formation of Oligo-Miocene age with a structure more complex than the East Kalimantan. Duri gas pipeline corridor currently transports 310 MCFD (Millions of cubic feet per day) over the conventional production, while PGN planning a new path southeast to Java. Complete CBM resources are estimated at 183 TCF in the area of 15,000 km².

- **Jatibarang Basin:** Although relatively small, deep, and complex structure, Jatibarang oil field is located close to the gas market in Jakarta. Strategically located coal basin as Jatibarang require further study for short-term development. Reserves reach amount of 0.8 TCF.

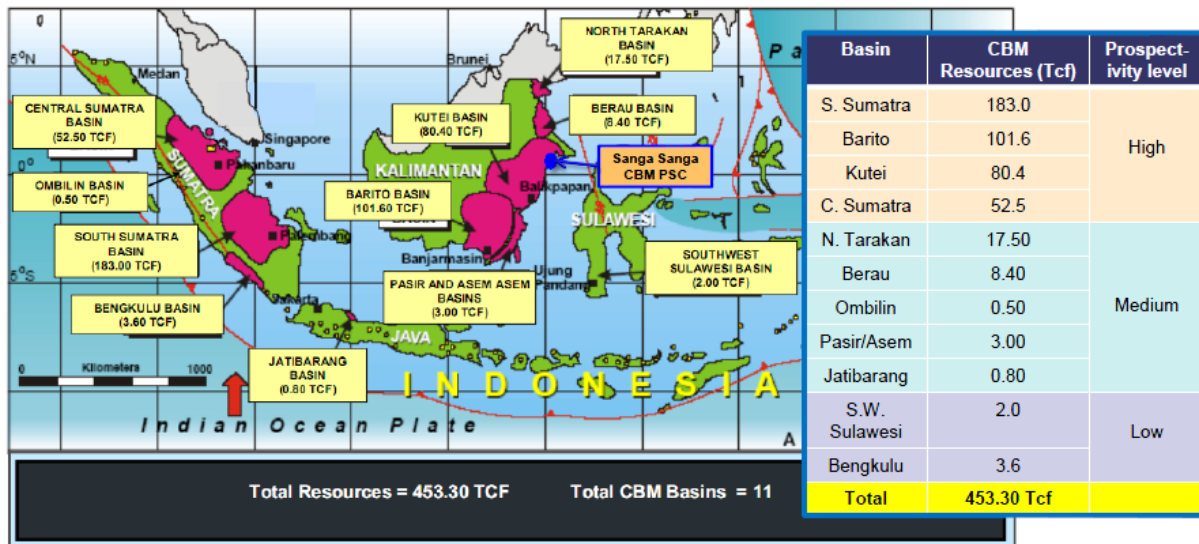


Figure 5: CBM potential in Indonesia (Indonesia Ministry of Energy and Mineral Resource 2010 in Ho Sook Wah)

4 DISCUSSION

Indonesia’s CBM Potential reached 453.3 TCF (KESDM, 2010). This makes Indonesia as a 4th ranked country of big CBM reserves in the world behind the United States, Australia and China. One TCF worth \$ 400-700 million depend on the quality of US-owned gas (CBM ASIA, Development Corp). Thus Indonesia’s CBM Potential is very large and able to provide significant contribution in facing future energy needs.

	USA	China	Australia	Indonesia
CBM Gas In Place	>500 Tcf	>500 Tcf	>500 Tcf	453 Tcf
Reservoir Quality	Excellent: Mostly High Gas Saturation & Permeability	Challenging: Low Gas Saturation &/or Permeability	Excellent: Mostly High Gas Saturation & Permeability	Excellent: Mostly High Gas Saturation & Permeability
Development Stage	Fully Mature Production: 5 Bcf/d	Struggling Production: only 300 MMcf/d after 20 years	Development: AUD30bn of mergers/acquisitions Production: >600 MMcf/d after 8 years - likely to outstrip USA by 2020	Exploration: Land grab and de-risking now underway Multi-billion dollar consolidation likely to occur as in Australia
Major Oil Company CBM Activity	ConocoPhillips, bp, Chevron, Anadarko, ExxonMobil	BHP, BP, ConocoPhillips, Chevron all tested CBM but then left due to poor geology.	ConocoPhillips, BG GROUP, Santos, TOTAL, Shell, KOGAS	Santos, Eni, bp, ExxonMobil, DART ENERGY, TOTAL, CBM ASIA DEVELOPMENT CORP.

Figure 6: Indonesia as 4th Ranked in CBM Reserves (CBM ASIA, Development Corp)

In addition to CBM, Indonesia has the resources of non-conventional energy in the form of shale gas. Shale gas is methane which the existence is found in the mudstone layer. Just as CBM, shale gas is an energy source that its benefits should be optimized. Currently, only the United States which are able to produce shale gas economically. Indonesian technology in processing of shale gas is still lagging behind and is difficult to get investors. According to the author himself, producing CBM is more feasible and worthy of being a top priority in Indonesia compared to other non-conventional energy and also Indonesian has a big potential of coal. It is because Indonesia CBM development likely to mirror Australia and USA, CBM has low geological risk (abundant conventional and coal control data), low capital at risk (USD7.5-10.0 mn per PSC to Plan of Development), and Value Potential: 1.0 Tcf NPV10 Model = USD400-700 mn (CBM ASIA, Development Corp).

There are two advantages of CBM uses as electrical energy compared to coal. First advantage is more environmentally friendly and produces a higher heat than coal. The use of CBM produces CO₂ emissions much less than burning coal. CO₂ emissions per unit of electricity from the combustion of sub-bituminous coal is 1180 tons / GWH and 600 tons / GWH of bituminous coal while the CBM combustion products produce CO₂ emissions only 25 tons / GWH (Geological Agency) . Combustion of CBM is also free sulfur oxides which known to result pollution and acid rain. In addition, a recent study found that CBM probably could be renewable energy. It is based on the type of bacteria that is commonly found methanogens in nature which can convert CO₂ into methane.

Emissions produced from CBM relatively smaller than emissions from coal use directly. CBM therefore referred to as a clean energy source. In addition, with a particular processing method, the relative content of CBM can be updated during the coal seam is still there and its condition qualifies. CBM development in Indonesia will go smoothly if supported by human resources such as researcher, employers and government.

Indonesian coal potential is huge and as the development time, its use will be more intensive. However, environmental issues are also become increasingly considered aspects. The use of coal will produce CO₂ emissions greater than CBM. The use of CBM as a power plant would generate electricity that supports clean-electricity of eco-friendly energy in the future.

Indonesia's CBM business regulation refers to the management of oil and gas is Law No. 22 of 2001 and PP No. 35 Year 2004 was a significant difference in the distribution of the results between the contractor and the government. In CBM concession contractors get greater benefit of 45% while for the oil and gas is only 15-20%. Planning in the management of CBM in Indonesia is the duty of the government, especially the Ministry of Energy and Mineral Resources to optimize potential of CBM in Indonesia.

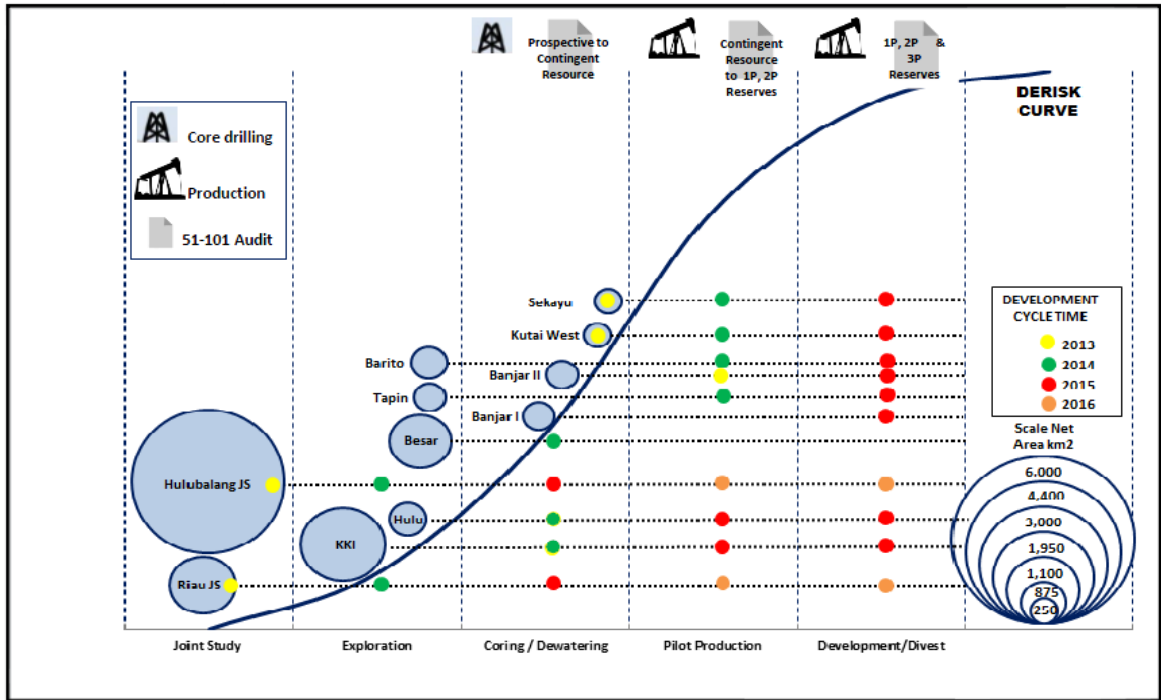


Figure 7: CBM Exploration and Development Timeline (www.cbmasia.com)

5 CONCLUSIONS

Indonesia's CBM potential is very large, reaching 453.3 TCF. This condition makes Indonesia as the 4th largest country which has CBM potential in the world. CBM potential depend of the coal resources in Indonesia which are abundant. CBM is formed during the coalification process and almost 95% in the form of methane gas. This methane can be formed in several ways, namely biogenic methane, thermogenic methane, and late biogenic methane. Extraction is done by pumping water contained within the formation to reduce the pressure so that the gas can escape from coal. CBM is referred to as clean energy because the emissions are much smaller than coal. In addition, CBM wells in Indonesia are relatively shallow so as to facilitate the extraction process as well as lower production costs compared to oil drilling. Great potential would require proper management of both the contractor and of the government. By utilizing the CBM resource is, of course, Indonesia can slightly remove dependence on petroleum resources dwindling reserves. Utilization of CBM can make Indonesia as the country's future energy security for the welfare of the Indonesian people.

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