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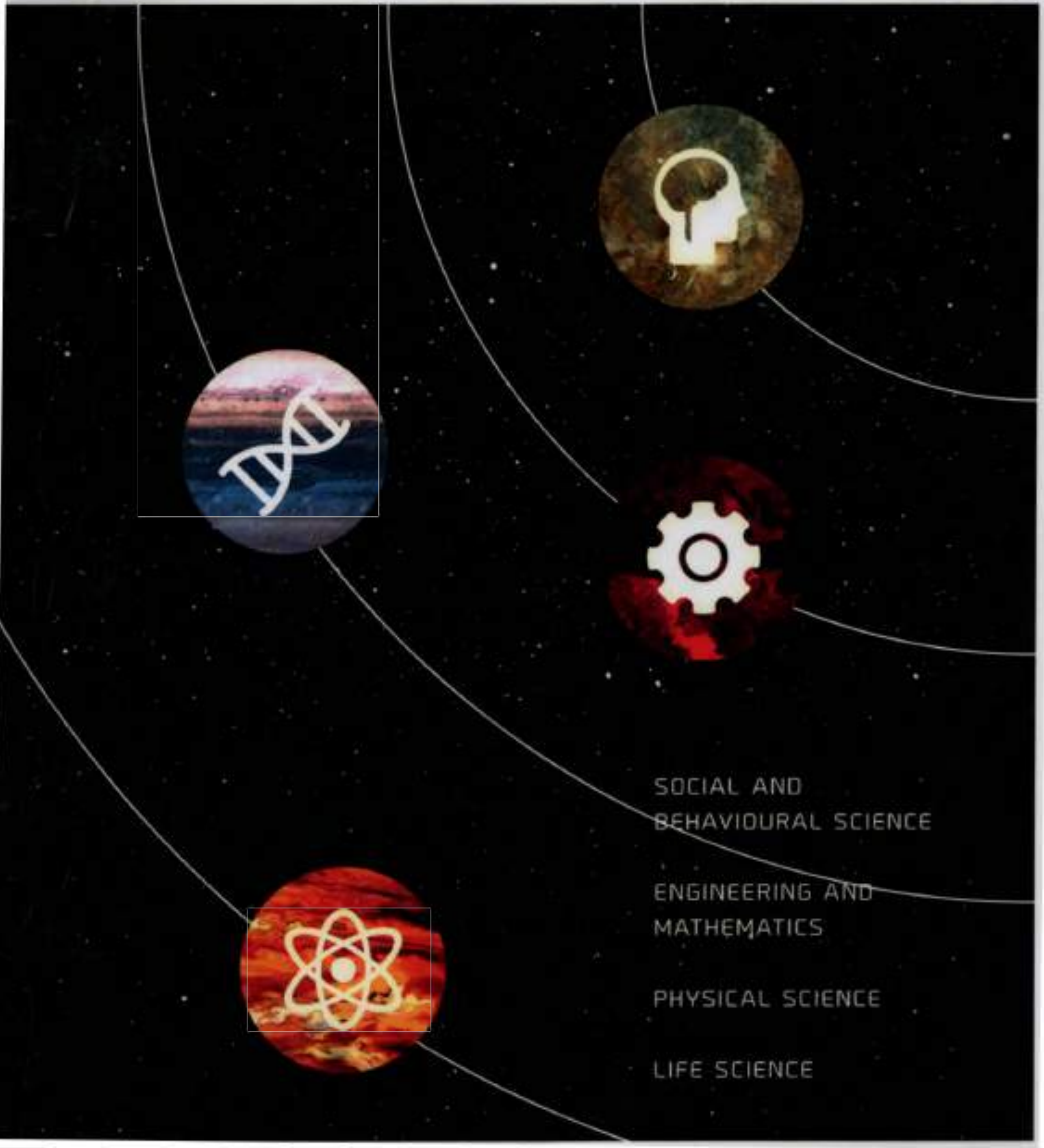

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Contents

Editorial

Following the inception of Indonesian Scholar Journal (IS Journal) in early 2013 and our first edition published last year, I am happy to introduce the second edition of IS Journal publications. IS Journal is an open access journal initiated by Indonesian scholars around the world. Its mission is two-fold: (i) to advance research and knowledge of Indonesian scholars, and (ii) to create awareness of the significance of effective scientific writing and at the same time improve the scientific writing skills of Indonesian scholars.

As most of us realize, research process can be divided into several stages. The first few stages comprise the identification of research problem, design of experiment, the experiment itself, and data analysis. However, this is really not the end of the process. The dissemination of research through publication, which is the next stage, is also as important—if not more important. Research dissemination has been used as the basis of determining research focus direction of a country, research funding decision, and it is the key component to creating a snowball effect on a certain research topic. Based on SJR SCImago Journal & Country Rank in 2012, Indonesia is number 61 for total number of publications and number 57 for the impact of these publications (H-index). While this is definitely not the worst, this low ranking should alarm us to start taking concrete actions. In South East Asia, Indonesia is far below Singapore, Malaysia and even Thailand. As a comparison, there are ~150,000 scientific publications output from Singapore, while there are only ~20,000 from Indonesia. The numbers are even more worrying if we look at the output per capita. IS Journal is therefore present as an answer to this condition, and we hope that the concrete improvement can be realized in the near future.

In this second edition of IS Journal, the papers are still categorized into four areas: life science and medicine, social and behavioral science, mathematics and engineering, and physical science. Life science and medicine combined with mathematics and engineering make the majority of the papers. We would like to take this opportunity to appreciate all authors for their contribution to IS Journal. We thank your trust in publishing your work with us and we look forward to your future contributions. At the same time, we also invite all Indonesian scholars to be involved with IS Journal, be it by contributing your research work and publishing at IS Journal, or by joining us as one of our committee or editorial board members.

We feature the following paper in this edition: "Shale Gas as an Alternative Energy in the Fulfillment of Gas Energy Requirement for Indonesian State Electricity Company (PLN)" authored by Dr. Ing. Ir. H. KRT. Nur Suhascaryo, B. Eng, M. Eng

Editorial

and Hongki Budi Prasetyo. The paper poses a clear problem faced by Indonesia in terms of meeting the gas demand. Based on their projection, PLN is set to face ~1.4 billion standard cubic feet deficit of gas each day. In order to solve this, they propose the exploitation of shale gas (non-conventional type of gas; natural gas trapped within shale formations) as the solution to meet this deficit. As the potential of shale gas in Indonesia is about 574 trillion standard cubic feet, they conclude that it is clear that the development of shale gas in Indonesia should be explored. While the topic of shale gas exploitation is still an ongoing debate, this paper clearly serves to increase our awareness of such problem and therefore deserves a spotlight in our current edition.

Through this opportunity, I am also pleased to report that we have conducted a Scientific Writing Workshop from March-June 2014. Done in collaboration with Radio PPI Dunia, we invited Indonesian students to undergo series of online lecture/tutorial that is aimed to improve their scientific writing skills. This is very much in line with our missions stated above. This workshop is planned to occur regularly as a part of our concrete contribution to the Indonesian scholars community.

Finally, I would like to thank all individuals and parties that have contributed to the continual existence of IS Journal. First, it is without a doubt that most appreciation should go to my fellow committee and editorial board members for all the necessary hard work in running such a publication. While we are greatly dispersed to separate locations across the world and most of us have not physically met each other, the fact that we are able to run the organization and the publication itself deserves an acknowledgment. We also thank all our partner conferences for the wonderful collaboration that we have had. Finally, a big thank goes to the Masyarakat Ilmuwan dan Teknolog Indonesia (MITI), the Ikatan Ilmuwan Indonesia Internasional (I4), and the Overseas Indonesian Students Association Alliance (OISAA) for their generous support.

We sincerely hope that our current edition would be interesting and beneficial for you. Your comments, suggestions, and recommendations are always welcome at editorinchief@isjournal.org.

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Shale Gas As An Alternative Energy in The Fulfilment of Gas Energy Requirement for Indonesian State Electricity Company (PLN)

Dr. Ing. Ir. H. KRT. Nur Suhascaryo, B.Eng., M.Eng & Hongki Budi Prasetyo*

Study Programme of Department of Petroleum Engineering Universitas Pembangunan Nasional "Veteran" Yogyakarta
*hongkibudi@yahoo.co.id

Abstract. The consumption of gas energy which is increasing especially in the fulfillment of power plant requirement, and not offset by the supply of gas energy, causes the deficit of energy—especially gas energy—in Indonesia. Therefore, the findings of new sources which produce gas energy through geological and geophysical exploration are needed to settle the problem. The type of this research is qualitative descriptive study using data collection method in the form of literature study and objective analysis of the data. Data analysis method used is a combination of trend analysis and descriptive analysis. Based on the analysis result, the requirement of gas for PLN's power plant reached 1.8 BSCFD (Billion Standard Cubic-Feet per Day) but only about 1 BSCFD is met. In 2015, the requirement of PLN's power plant is expected to increase to 2.1 BSCFD and be totalized with the private power plant requirement. However, the supply of gas is only expected to reach 0.8 BSCFD. This means there are still 1.4 BSCFD needed. Indonesia shale gas potential is about 574 trillion standard cubic feet (TSCF). It is greater than Coal Bed Methane (CBM) and gas, which are only about 453.3 TSCF and 334.5 TSCF, respectively. Finally, based on a combination of trend and descriptive analysis, it is proper to develop the potential of shale gas to meet the requirement of national energy, especially sources of gas energy for power plant in Indonesia.

Keywords: *Alternative Energy, PLN, Shale Gas.*

NOMENCLATURE

PLN : Indonesian State Electricity Company

A. INTRODUCTION

The depletion of oil reserves and the threat of a surge of energy subsidies have supported Indonesia's switch to natural gas, given the availability of much larger reserves than oil. More optimal utilization of gas, as well as the commitment and seriousness of the government in its management are needed. Until now the use of natural gas is not optimal, so that many activities across various sectors (e.g., electricity, industrial, household), still relies on the use of petroleum energy such as coal. Natural gas has been used to replace and meet the energy needs of the natural gas in Indonesia but has not been able to meet the needs of domestic gas because demand growth is not accompanied by an increase in the production infrastructure capacity, transmission and distribution of gas. Up to this time, domestic gas consumption for electricity generation is dominated PT. PLN and gas industries but these have not met the energy needs for the power plant. It is necessary to search new fields through exploration and exploitation to increase gas production.

Onshore Indonesia represents a hyper-mature gas development play. Most conventional reservoirs have already been exploited. With the current high price for gas, more effort is being applied to the development of non-conventional gas plays: tight gas, coalbed methane, and shale gas.

(Source: Indonesia Ministry of Energy and Mineral Resources; Directorate General of Oil and Gas)

Figure 1. Indonesia shale gas potential

Some of the earliest gas wells were produced from shales; however, their low flow rates limited development interest. Recently, gas shales have become a more attractive target because they represent a huge resource (500 to 780 TCF[1]) and the economic challenges for their development have lessened with rising gas prices and new evaluation and completion technologies.

There are currently 7 basins in Indonesia that contain shale gas and 1 klasafet shaped formation[2]. 3 basins are located in Sumatra: Baong Shale, Telisa Shale and Gumai Shale. In the island of Java and Kalimantan, there are 2 basins each. In Papua, only klasafet shaped formation exists. Figure 1[3] shows the potential of shale gas in Indonesia. Each of these formations, if explored and exploited, will result in new gas field and eventually large enough gas energy production. Gas production from shale gas is large enough and expected to meet the energy needs for the fulfillment of particular gas power plant in Indonesia.

B. APPROACH

Shale Gas Characteristics

However, shale is the most common sedimentary rock. Shale with the potential to be an economic gas reservoiris relatively rare. Due to their low permeability, gas shales are self-sourced. They must have the requisite volume and type of organic matter and proper thermal history to generate hydrocarbons, especially gas. The first step in any evaluation is the identification of a potential gas shale reservoir[4]. Shale is a fine-grained, clastic sedimentary rock composed of mud that is a mix of clay minerals and tiny fragments (silt-sized particles) of other minerals, especially quartz, dolomite, and calcite[5]. Shale is characterized by breaks along thin laminations, parallel to the bedding. Mudstones are similar in composition but do not usually show layering within the zone.

From a petrophysical analysis point of view, clay-rich shales have traditionally been called "shales" and non-clay shales have been called "silts" . Petrophysical analysis deals with minerals, not particle size, so it is confusing to us when a zone is called shale when the logs show little presence of clay. Figure 2[5] shows the composition and their petrophysical characteristics of shale.

Shale-gas formations are both the source rocks and the reservoir rocks. There is no need for migration and since the permeability is near zero, it forms its own seal The gas may be trapped as free gas in natural fractures and intergranular porosity, as gas is sorbed onto kerogen and clay-particle surfaces, or as gas is dissolved in kerogen and bitumen[6]. The shale gas reservoirs are characterized by low production rates (20-500 MCFPD) but are usually spread over large areas and are up to 450 m thick.

Figure 2. Core photo of gas shale - about 50% clay, 50% quartz plus calcite, 10 - 15% total porosity, 3 - 6% effective porosity, < 0.001 mD permeability)

They are organically rich with total organic carbon content (TOC) varying from 1 to 20 wt%, such that the reservoirs contain large gas reserves (2 to 20 BCF/km^2). Shale gas reservoirs rely on natural fractures for porosity and permeability as the matrix porosity or permeability is low. In the absence of natural fractures, these reservoirs need stimulation by way of hydraulic fracturing. Compared to conventional reservoirs, shale gas reservoirs have low recovery factors (~20%). For the wells drilled into these reservoirs, the initial decline rates are rapid (~70%) but bottom out gradually (~6%) in later years[7].

Shale Gas Potential in Indonesia

The study of shale gas potential of the region has been carried out, and some of them have been found to be potentially attractive for considerable energy. Shale gas potential in Indonesia is predicted at 338 TCF in North Sumatra, 558 TCF in Central Sumatra, 964 TCF in South Sumatra, 1,723 TCF in East Kalimantan and 6,480 TCF[8] in West Papua.

In Sumatra there are 3 potential basins as area of shale gas, which are Baong shale, Telisa shale and Gumai shale. Figure 3[9] shows the location of shale gas in Sumatra basin. Figure 4[10] shows the stratigraphy of North Sumatra basin. Formation of blue zone indicates areas that have the potential formation as shale gas areas Based on the research that has been done, there are several formations as a potential shale gas areas in North Sumatra basin, namely Belumai formation, Baong formations and Bampo formation. Belumai formation has an average level of Total Organic Carbon (TOC) of 0.94 and an average T.max at 429 ^{0}C. Baong formation has an average level of Total Organic Carbon (TOC) of 0.90 and an average T.max at 433 ^{0}C. Bampo formation has an average level of Total Organic Carbon (TOC) of 0.59 and an average T.max at 439 ^{0}C. Figure 5[9] shows the NW-SE seismic section of North Sumatra area. From the figure, the direction and sequence of formations in North Sumatra basin can be observed. The sequence of formation of old to young is Parapat – Bampo – Belumai – Baong – Keutapang formation. Bampo Formation indicates fair shale gas quality, whereas Belumai and Baong Formations show fair-good shale gas quality. Shale gas resource calculation of these formations is 114.35 TCF[9].

Shale gas potential is also found in South Kalimantan precisely located in the Barito basin. Figure 6[11] shows the location of shale gas potential in the Barito basin. Potential of shale gas in this basin is in Tanjung formation. Sandstones of the Tanjung Formation are quartz arenites and sub-litharenites[13] and plot within the 'craton interior' and 'quartzose recycled' fields[14]. Figure 7[14] shows detrital modes of sandstones from the Tanjung, Montalat and Warukin formations. Figure 8[12] shows stratigraphy of Barito basin South Kalimantan. Tanjung formation has an average level of Total Organic Carbon (TOC) of 0.53 and an average T.max at 450 ^{0}C. Figure 9[9] shows the NW-SE seismic section of South Kalimantan area.

Figure 3. The location of shale gas in Sumatra basin

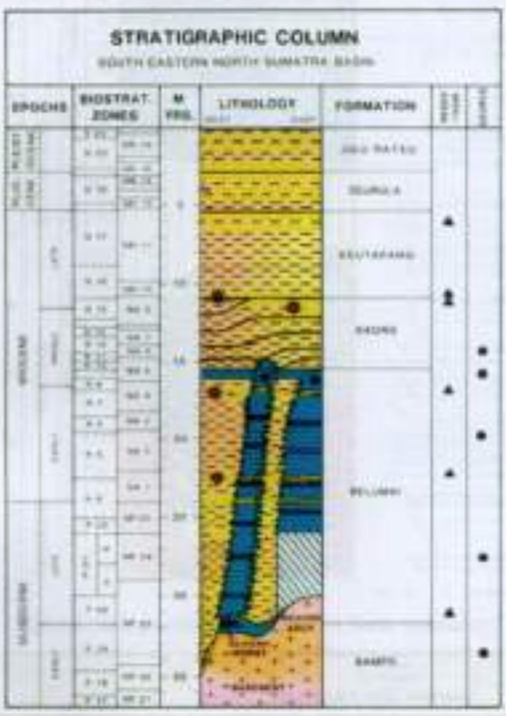


Figure 4. Stratigraphy of North Sumatra basin

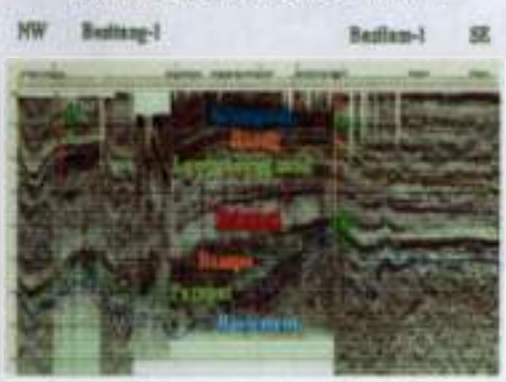


Figure 5. NW-SE seismic section of North Sumatra area

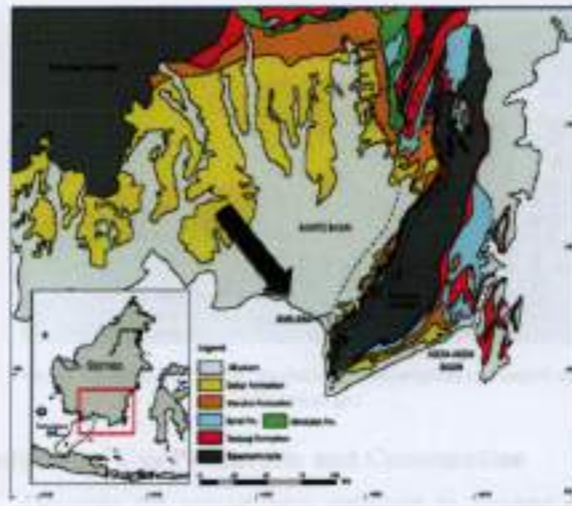


Figure 6. Location of shale gas potential in the Barito basin

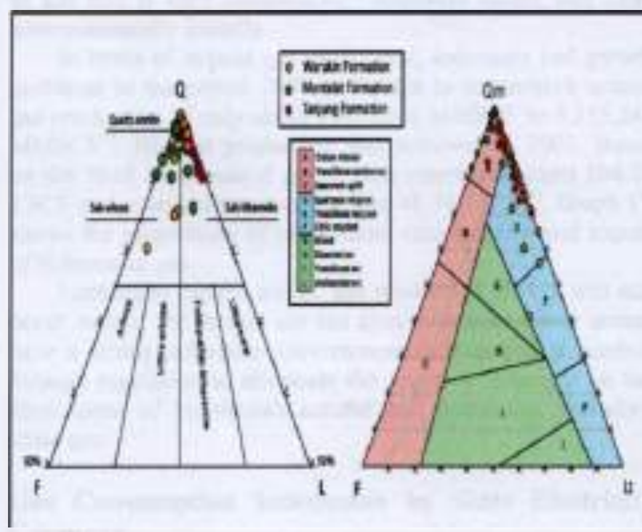


Figure 7. Ternary diagrams showing detrital modes of sandstones from the Tanjung, Montalat and Warukin Formations. (Left) sandstone classification according to Folk (1968). (Right) tectonic setting according to QmFLt ternary plot of Dickinson & Suczek (1979). Q: quartz, Qm: monocrystalline quartz, F: feldspar, L: lithics, Lt: total lithics (including polycrystalline quartz).

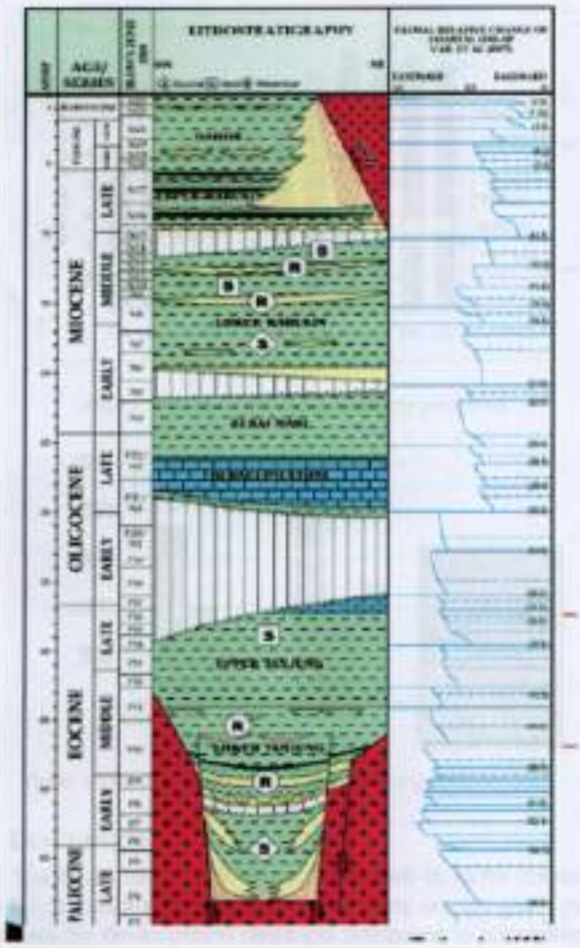


Figure 8. Stratigraphy of Barito basin in South Kalimantan

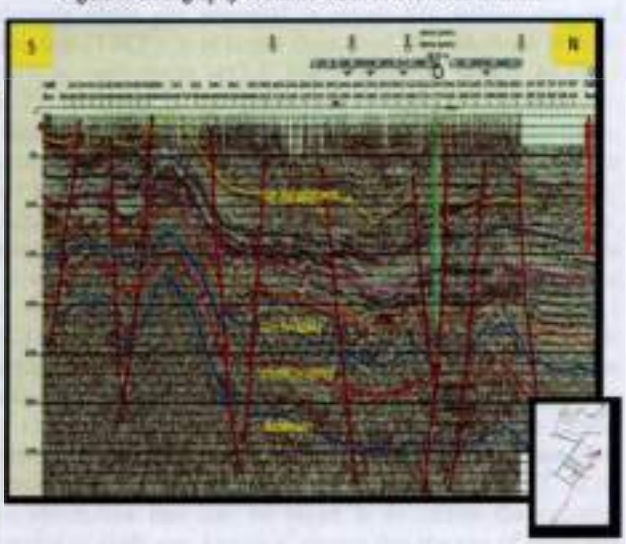
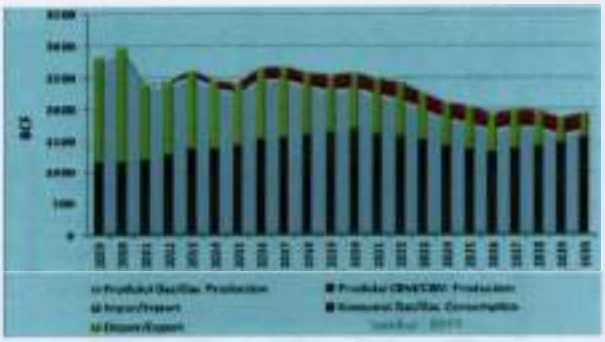


Figure 9. NW-SE seismic section of South Kalimantan area



Graph 1. The projections of production, consumption and export of Indonesian gas

Indonesian Gas Production and Consumption

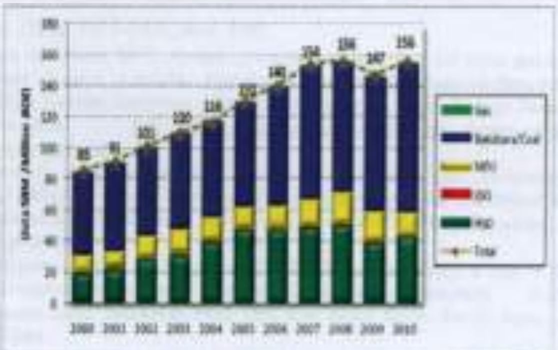
Domestic gas consumption continues to increase every year, especially in the industry sector. This is because the price of gas fuel is very competitive, relatively stable, and more environmentally friendly.

In terms of natural gas production, Indonesia had growth problems in the period 2000-2009, due to Indonesia's natural gas production of only about 2,805,540 MMSCF to 3,155,243 MMSCF[15]. Highest production was achieved in 2003. Based on the 2010 data, natural gas proven reserves reached 104.71 TSCF and potential reserves reached 48.74 TSCF[16]. Graph 1[15] shows the projections of production, consumption and export of Indonesian gas.

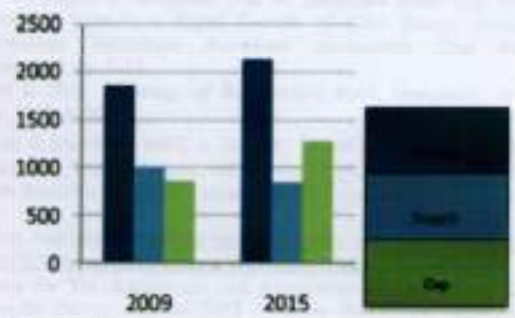
Looking at current trends, gas production growth will still occur even if the factors are not directly related (error terms) have a strong influence. Government intervention is needed, through regulation to eliminate the negative influence on the error terms of Indonesia's natural gas production, including shale gas.

Gas Consumption Indonesian by State Electricity Company

In the last 5 years, the total gas consumption continues to rise. Graph 2[16] shows fuel consumption for electricity generation. In 2005, gas consumption reached 3,541 MMSCFD, a year later increased to 3,716.1 MMSCFD and 2009 was 4,233.7 MMSCFD. Increase in gas consumption, mainly in the sectors of fertilizer, power and other industries[17]. Based on data and projections from the PLN, the requirement of gas for PLN's power plant reached 1.8 BSCFD (Billion Standard Cubic-Feet per Day) but only about 1 BSCFD is met[15]. In 2015, the requirement of PLN's power plant is expected to increase to 2.1 BSCFD, and be totalized with the private power plant requirement. However, the supply of gas is expected to only reach 0.8 BSCFD. It means there are still 1.4 BSCFD needed. Graph 3[15] shows domestic gas consumption for power generation sector. Based on the graph, there will be a substantial gas demand that is not matched by the production of gas. This leads to a very large difference in gas that must be met in order to be able to meet the needs of the power plant.



Graph 2. Fuel consumption for electricity generation

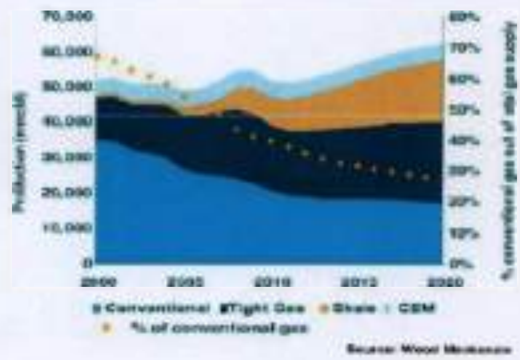


Graph 3. Domestic gas consumption for power generation sector

C. Discussion

Shale gas has begun to be developed in some countries and the results are contributing in fulfilling energy gas. Graph 4[3] shows the development shale gas compared to conventional gas. Indonesia has a very large the potential of shale gas. Indonesia shale gas potential is about 574 trillion standard cubic feet (TSCF). It is larger than Coal Bed Methane (CBM) which is only about 453.3 TSCF and gas which is 334.5 TSCF[2]. Currently, Indonesia gas production is still not sufficient to meet the energy needs, especially in electricity sector. The shale gas potential is supposed to be developed to meet national energy needs, especially in the electrical energy needs, as PT. PLN still requires a considerable supply of gas. Increasingly large gas that is not offset by the gas supply leads to a very large supply-demand gap. For 2015, the estimated gas demand for electricity generation is increased to 2.1 BSCF, and private power plants by 0.1 BSCF. With the shale gas potential of 574 TSCF, it is very prospective to meet the needs of the power plant.

Graph 2[16] shows that the gas consumption for power generation every year will always increase. This increase must be balanced with the production and supply of gas to PT. PLN. One alternative that can be taken is to utilize the existing potential of shale gas. Graph 4[3] shows that the use of shale gas can provide a substantial contribution to gas production. Based on the trend, gas production from shale gas will always go up every year. This increased gas production should be be sufficient for the gas to PT. PLN.



Graph 4. Development shale gas compare to conventional gas

D. Conclusion

From this study, the following conclusions have been made:

- Shale gas potential in Indonesia is realized in North Sumatra at 338 TCF, Central Sumatra at 558 TCF, South Sumatra at 964 TCF, East Kalimantan at 1,723 TCF and West Papua at 6,480 TCF.
- The requirement of gas for PLN's power plant reached 1.8 BSCFD (Billion Standard Cubic-Feet per Day) but only about 1 BSCFD is met.
- Gas production from shale gas will always go up every year. Increased gas production should be sufficient for the gas to PT. PLN.

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