SENJOp
http://senjop.ppj.unp.ac.id/index.php/senjop

Science and Environmental Journals for Postgraduate
Vol. 5 No. 2 (pp. 119-126) June 2023
p_ISSN 2655-5085
e_ISSN 2655-5239

Distribution of Potential Resources, Reserves and Use of Coal in Indonesia

*Fitrya Monica, Marisa Meliana Fitri, Iswandi Umar, Ali Amran, Mulya Gusman

Master Program of Environmental Science, Postgraduate School-Universitas Negeri Padang
*E–mail: fitrya.monica@gmail.com

Received: 06 Mar. 2023, Revised: 23 Apr. 2022, Accepted: 01 Jun. 2022

ABSTRACT

Indonesia has abundant coal resources and is a well-known mining sector as a producer and exporter of coal. Even though Indonesia has adequate coal reserves, the ever-increasing energy needs pose challenges in meeting domestic and export needs. Therefore, this study aims to analyze the potential of coal resources and reserves in Indonesia, their utilization in the electricity sector, and find solutions for sustainable use of non-renewable energy. This research uses the method of literature study or literature search. The data sources used are accredited academic journals and related publications, as well as secondary data from the Geological Agency of the Ministry of Energy and Mineral Resources [ESDM] and Recapitulation of Coal Reserve Balance in Indonesia. The results of this study classify coal resources and reserves based on SNI 5015 - 2019 classification. There are several categories, such as inferred coal resources, indicated coal resources, measured coal resources, probable coal reserves, and proven coal reserves. Geologically, economically valuable coal deposits are found in Sumatra and Kalimantan. Coal quality can be classified based on calorific value, such as low, medium, high, and very high calories. With a better understanding of available coal resources, it is hoped that sustainable solutions for future energy needs will be developed.

KeyWords: Coal, Reserves, Electricity Sector, Natural Resources.

INTRODUCTION

Indonesia is a very rich country with an abundance of natural resources. Starting from forest resources, minerals, coal, oil, and geothermal which can be used for people's welfare. Indonesia is known to be one of the well-known mining sectors as a producer and exporter of coal, in the early 1970s coal has become a central part of Indonesia's energy policy (Arif, 2014). Based on data from the Statistics Review of World Energy 2020, Indonesia ranks 6th as one of the most well-known countries and has the largest coal reserves in the world. This proves that Indonesia has an important role in the global coal industry. However, coal reserves are relatively significant compared to other fossil reserves (Batubara *et al*., 2021). According to Law No. 4/2009 concerning "Mineral and Coal Mining". Coal is a deposit of carbonaceous organic compounds that are formed naturally from the remains of plants (Brooks & Smith, 1967).

With the population growth and the higher standard of living, it will result in an increasing need for a supply of energy consumption, this has been felt from year to year. Given these problems, it is necessary to analyze the potential of coal resources and reserves. Coal is an important source of energy for industry and power generation in Indonesia. There are a lot of resources and reserves of around 28.5 billion tons, but it is reported that currently, the capacity of coal reserves is quite alarming for domestic and export needs (Hudaya & Madiutomo, 2019). On the other hand, electricity consumption in

Indonesia has increased by around 26% in four (4) years. finally 812 kWh per person in 2014 and 1,021 kWh per person in 2017 (Rosadi & Amar, 2019). Electricity, in Indonesia is heavily dependent on fossil fuel power plants (Kumara, 2010).

More than 88% of electricity in Indonesia is generated from fossil fuels, 66% from coal, 22% from natural gas, and 6% from oil, and only 12% is produced domestically from renewable energy (Afin *et al*., 2021). Based on the electricity supply business plan, PLN last published a report in February 2019 on the need for coal for power plants, which is expected to increase from the current 90 million tons to 150-160 million in 2028-2030 (Miladyah, 2020). In the last 4 years, there have been very significant changes starting from the last number 25% lower than the 2015-2024 electricity supply plan (Haryadi *et al*., 2018). From the existing problem issues, the purpose of this research is to determine the potential of coal resources and reserves in Indonesia, utilization in terms of the electricity sector, and solutions to the problem of using non-renewable energy so that it remains sustainable from generation to generation.

METHOD

Data sources and data collection methods. The type of search used in this study is by conducting a literature search or literature search. This type of research is used by researchers to obtain information by examining literature sources such as academic journals and publications on the subject under study. The data source comes from Google Scholar and the data collection method is qualitative in the form of a literature search (document analysis).

In this study, the data sources obtained by researchers are data sources from national/international journals that are well accredited and selected within the last 10 years of publication as well as secondary data from the Geological Agency ESDM, as well as from the Recapitalization of the balance sheet of Coal Reserves in Indonesia in 2021. The data collection technique used in this study was the use of a literature search/literature search. This research will be used and selected both as library material and as material for analysis. Considering that the data used by researchers in their work is in the form of national newspapers and publications, the research information obtained is then obtained from search results, which are then checked and notes are made containing the results needed for the research. previous literature research methods and various written results from this literature research were carried out and published in online magazines. This research conducts data analysis using brief data reduction, choosing important points, focusing on important things, choosing themes, then presenting the existing information, and presenting the data. The presentation of data selected by the author is the presentation of data using content analysis which includes activities to collect and analyze textual content.

RESULTS

3.1 Data analysis Results

Classification of Coal Resources and Reserves

Based on SNI 5015 - 2019, the classification of coal reserves and reserves is divided into exploration targets, resources, inferred resources, proven resources, measured resources, probable resources, and proven resources. Carbon dioxide mapping is one of the government's duties and authorities in mapping the national carbon potential. Reports issued by the government are not only based on assumptions but are the results of field observations. This report captures the country's untapped coal potential. Their use may be limited by several factors, such as coal locations on the outskirts of cities or in areas that overlap with protected areas. Potential coal fields that overlap with nature reserves can be divided into National Protected Areas (WPN) which can then be used as national strategic assets. The following is an understanding of the classification of resources and reserves (Setiawan, 2018), namely: 1) Inferred coal resource is that part of the total estimated coal resource whose quality and quantity can only be estimated with a low level of confidence. Points of information that may be supported by supporting data are not sufficient to prove the continuity of the coal seam and/or its quality. The estimates from this confidence category may change significantly with further exploration; 2) Indicated coal resources are part of the total coal resources whose quality and quantity can be estimated with a reasonable level of confidence, based on information obtained from observation points that may be supported by supporting data. The Information Points are sufficient to interpret the continuity of the coal seams, but not sufficient to prove the continuity of the coal seams and/or their quality; 3) Measured coal resource is part of the total coal resource whose quality and quantity can be estimated with a high degree of confidence, based on information obtained from observation points which are supported by supporting data. The observation points are close enough to prove the continuity of the coal seams and/or their quality; 4) Probable coal reserves are part of indicated coal resources that can be mined economically after the relevant adjustment factors are applied, it can also be part of measured coal resources that can be mined economically, but there is uncertainty in one or all relevant adjustment factors are applied; and 4) Proved coal reserve is the part that can be mined economically from a measured coal resource after the relevant adjustment factors are applied.

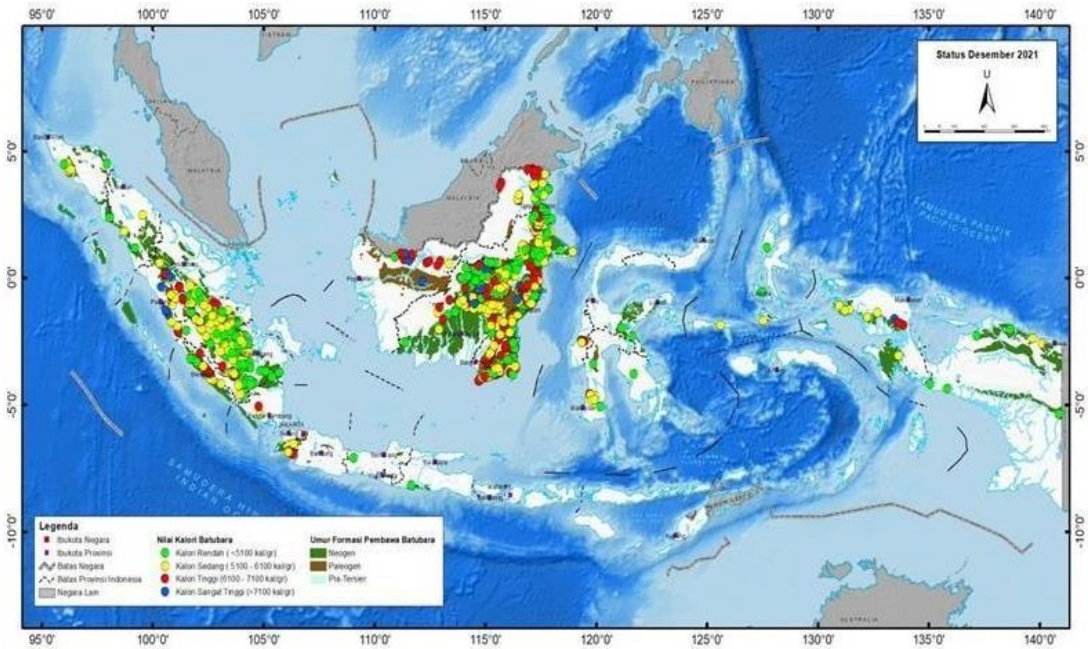

Figure 1. Map of Potential Distribution of Coal Resources and Reserves for 2022 (In Indonesian). *Source: Executive Summary Update on Mineral Resources Data and Balance Sheet Status (2022)*

In Indonesia, economically valuable coal deposits are located in the Tertiary Basin in the western part of the Sunda Shelf (including Sumatra and Kalimantan). In general, these economic coal deposits can be classified as Eocene Carboniferous or Lower Tertiary about 45 million years ago and Miocene or Upper Tertiary about 20 million years ago geologically according to time scales. Some of these are classified as peatlands, which form above the average water table in a humid climate all year round. In other words, these peat domes formed under conditions that allowed inorganic minerals from the water to enter the system and form locally thickened, low-ash, and low-sulfur coal seams. This is especially common in Miocene coal. In contrast, Eocene coal deposits tend to be thinner, richer in ash and sulfur. Both ages of these coal deposits formed in lakes, coastal plains, or estuaries, similar to the peat formation areas that currently exist in East Sumatra and most of Kalimantan. Where coal quality based on calorific value class on an air-dried basis (Presidential Decree No. 13/2000 updated with PP No. 45/2003) (Wibowo & Windarta, 2020), namely: 1) Low Calories < 5100 cal/gr; 2) Moderate Calories 5100 - 6100 cal/gr; 3) High Calories 6100 - 7100 cal/gr; and 4) Very High Calories > 7100 cal/gr.

Surface Coal

The following is the data that was successfully collected and it is noted that the data collected for coal comes from the 2021 Energy Resources Data Recapitulation and Balance Sheet, which is indicated by the quality of energy resources coal reserves and reserves are shown in Table 1 below.

Table 1. Quality of Indonesia's Coal Resources and Reserves in 2021

quality	exploration (million tons)	total inventory (million tonnes)	resources (million tonnes)					reserves (million tonnes)			
			guessed	indicated	measurable	total	Total (verified)	estimated	proven	total	total (verified)
Low	417,17	11.252,41	14.961,91	11.979,49	10.402,32	37.343,72	29.703,20	7.523,85	5.401,22	12.925,07	10.869,81
Moderate	2,06	547,38	14.625,47	18.356,99	26.869,92	59.852,38	51.868,94	9.464,74	11.220,50	20.685,24	18.811,62
High	5.040,47	10.717,99	3.368,46	3.135,27	3.228,12	9.731,85	7.246,56	1.139,99	885,96	2.025,95	1.456,17
veryhigh	681,42	1.848,07	1.394,31	878,63	869,02	3.141,96	2.787,34	246,34	396,25	642,59	558,02
Total	6.141,12	24.365,84	34.350,15	34.350,38	41.369,38	110.069,91	91.606,04	18.374,92	17.903,92	36.278,85	31.695,63

Source: Executive Summary Update on Mineral Resources Data and Balance Sheet Status (2022)

The results of the assessment show that of the total coal reserves and reserves that will be inventoried in 2021, 83.22% (91.606 Mt) of resource data and 87.36% (31.695 Mt) of reserves data are confirmed information from KP. More detailed information on certified resources and reserve data can be seen in Table 2. Compared to the 2020 balance sheet certified data, the amount of certified data for 2021 has also increased. Verified information should reach 100% by 2022.

Table 2. Indonesia's Coal Resources and Reserves each Province in 2021

No	PROVINCE	resources (million tonnes)				reserves (million tonnes)		
		guessed	indicated	guessed	indicated	guessed	indicated	guessed
1	Aceh	275,42	399,13	129,24	803,79	322,57	106,07	428,65
2	Bengkulu	108,00	94,98	160,60	363,58	45,90	57,40	103,30
3	Jambi	1.057,05	1.018,64	1.753,76	3.829,45	625,47	1.033,12	1.658,59
4	Riau	109,42	481,73	265,38	856,52	184,66	174,47	359,12
5	West Sumatra	14,56	13,21	12,09	39,87	6,20	17,42	23,63
6	South Sumatra	7.890,95	8.299,98	7.830,09	24.021,01	5.090,99	4.200,17	9.291,17
7	West Kalimantan	0,98	0,48	-	1,46	0,43	-	0,43
8	South Kalimantan	3.138,80	3.047,87	5.860,32	12.046,99	1.344,82	2.334,79	3.679,61
9	Central Kalimantan	3.525,03	2.593,39	2.300,38	8.418,80	883,50	1.111,61	1.995,11
10	East Kalimantan	8.763,33	13.395,26	17.865,51	40.024,10	7.184,08	6.430,02	13.614,09
11	North Kalimantan	412,75	420,80	350,06	1.183,61	284,69	246,89	531,57
12	West Sulawesi	5,42	2,71	3,15	11,28	1,80	6,79	8,59
13	South Sulawesi	3,02	1,84	0,72	5,57	1,16	0,61	1,77
Indonesian Total		25.304,73	29.770,01	36.531,30	91.606,04	15.976,28	15.719,35	31.695,63

Source: Executive Summary Update on Mineral Resources Data and Balance Sheet Status (2022)

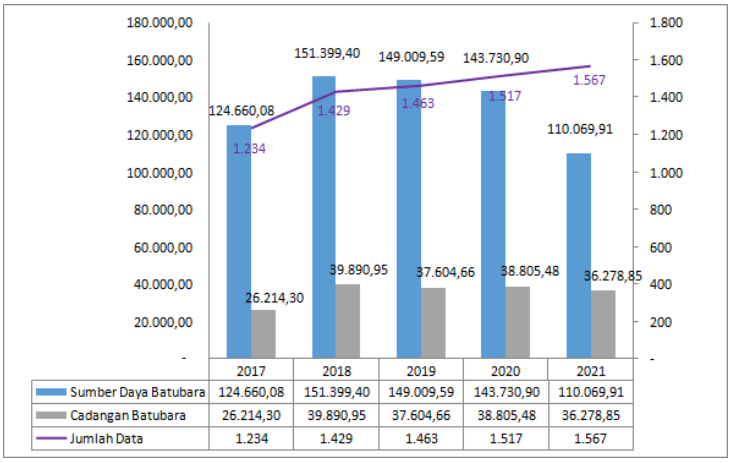

Figure 2. Statistics of Coal Resources and Reserves for 2017-2021 (In Indonesian).

Underground Coal

Underground coal reserves are coal reserves that are underground at a depth of 100 to 500 meters. Information on underground carbon stocks was obtained from internal data, while underground carbon stocks were obtained from IUP PMA and IUP PMDN. Underground coal reserves in December 2021 amounted to 488.94 million tons (Table 3), with total reserves of 173.25 million tons. Apart from being mined using the underground coal mining method, underground coal can also be used for the development of Underground Coal Gasification (UCG) and GMB.

Table 3. Mining Coal Resources in Indonesia Status in 2021

No	Island	province	inventory totals	resources (million tonnes)				reserves (million tonnes)		
				guessed	indicated	measurable	total	estimated	proven	total
1	Sumatra	West Sumatra	7,99	120,370	61,406	95,859	277,635	37,970	63,26	101,233
		Jambi	970,60							
		South Sumatra	21.195,92							
2	Kalimantan	South Kalimantan	1.019,16	19,548	33,208	94,149	146,905	12,477	31,29	43,764
		East Kalimantan	17.527,29	0,004	36,117	28,280	64,401	11,387	16,87	28,252
		Central Kalimantan	88,45							
		North Kalimantan	2.210,33							
Indonesian total			43.019.74	139,92	130,73	218,29	488,94	61,83	111,42	173,25

Source: . Executive Summary Update on Mineral Resources Data and Balance Sheet Status. Geological Agency ESDM. (2022)

Coal utilization

The power generation sector is the largest coal consumer in Indonesia. The growth of coal consumption in electricity production is very important, from 56 million tons in 2006 to 126 million tons in 2025. To offset this energy demand, the Indonesian government has set a target to produce electricity up to 135.5 GW in 2025. stipulated in Regulation President (PerPres) No. 22/2017. Indonesia's primary energy supply is largely based on fossil fuels such as oil, gas, and coal. The national energy policy determines the portion of energy sources in 2025, namely oil (20%), gas (30%), coal (33%), and renewable energy (17%). More details can be seen in Fig 3 below.

Figure 3. Assumed Coal Demand for 2021-2030 (In Indonesian).

3.2 Discussions

With the existence of existing resources and reserves with the increasing use of coal, it cannot be denied that it can hurt the environment. We can see this in the following elaboration regarding the impact of coal on the environment. Environmental impact of using coal in electricity generation.

- CO^2 emissions, an increase in carbon dioxide in the air due to the burning of fossil fuels increases the greenhouse effect, which can cause global warming and ultimately affect climate change and damage. Carbon dioxide is not a poison that will be harmful if inhaled and can be absorbed by plants as a raw material for photosynthesis. The formation of CO^2 gas as a result of combustion is unavoidable, and a high concentration of CO^2 gas indicates complete combustion. However, CO^2 gas plays an important role in the formation of the greenhouse effect, when the sun's heat absorbed by the earth is trapped under the CO^2 layer in the atmosphere. Increasing the amount of CO^2 gas in the air can prevent heat loss from the earth and increase the greenhouse effect which can cause an increase in the earth's temperature known as global warming, the Poles, which can cause flooding, especially in coastal areas, melting of glaciers and extinction of certain species of life, as well as damage the earth's ecosystem (Finahari *et al*., 2007).
- Coal produces several emissions that have an impact on the environment, including CO, CO^2, NOx, and SOx. CO emissions cause ozone (O3) depletion, which can cause skin cancer, and carbon dioxide emissions exhaled by humans reduce oxygen levels in the bloodstream, which can cause death (Setiawan *et al*., 2018).
- Radioactive pollution from coal-fired power plants Coal naturally contains radioactive elements. In the direct combustion process, thermal cracking occurs, as a result of which natural radioactive elements are released along with other combustion-product gases or enter into the combustion ashes. The most dominant radioactive impurities in coal are natural radioactive elements such as U-238, Th-232, and -40. It can be explained that the active radio pollutants Pb, Po, Pa, Ra, Th, and U are classified as heavy metals, and if they enter the human body they will hurt health. Exposure to p-radiation produced by Pb-210 is an external and internal radiation hazard for the human body, while radiation from Po-210 to U-238 is an internal radiation hazard. External radiation hazard means that a radioactive element, even if it is outside the body, can still be a source of radiation hazard due to its high permeability. Regarding the dangers of internal radiation, it

means that radioactive elements are not dangerous if they are only outside the body because of their relatively short penetrating power, but become dangerous if they enter the human body because of their high ionization power (Finahari *et al*., 2007).

– Pollutants from motorized vehicles and industrial facilities such as burning and waste disposal are very dangerous for public health. The biggest impact on health problems is the respiratory system, nerves, liver, blood vessels, and kidneys (Yusad, 2003). Based on research led by scientists at the Max Planck Institute for Chemistry, air pollution is known to be the main cause of nine million premature births each year. The number is double the estimate. Air pollution is also largely responsible for 8.8 million deaths worldwide. The main targets of air pollution are respiratory organs, heart activity, and also blood circulation which performance decreases. Air pollution is also largely responsible for 8.8 million deaths worldwide. The effects of small pollutant particles or PM 2.5 particles that penetrate the respiratory organs and also into the lungs are mostly caused by burning wood, vehicle exhaust gases, industrial production, and of course fossil fuels (Widyaningrum, 2019).

Efforts to overcome the problem of air pollution due to the burning of coal power plants**:** 1) Carbon dioxide emissions from coal-fired power plants can be reduced by equipping production units with flue gas cleaning equipment. CO^2 gas processing is done by absorbing CO^2 gas with calcium hydroxide and forming calcium carbonate. Calcium carbonate can be used as a raw material for the food, pharmaceutical, and construction industries; 2) The current development of the digital era has prompted the emergence of air monitoring technology, an important concept for checking whether the air around us is fit to breathe. The technology is based on smart sensor micro transducers and web-based applications that download pollutant concentrations to transfer data to a computer for further processing. Air quality is monitored via the Internet using high-resolution surveillance network cameras (Sirsikar & Karemore, 2015); 3) Strengthening the rules related to the use of coal or all of it, it is considered to be able to reduce the burden on the community to bear the decrease in air quality due to the use of coal; 4) Replacing coal fuel with nuclear fuel or new and renewable fuels; and 4) Ash containing radioactive impurities from burning coal can be used as an additive to concrete building materials, and the radioactivity contained therein is not much different from that of conventional concrete additives or other building materials such as granite and red brick.

CONCLUSION

The sustainability of the dam or the sustainability of fish farming greatly influences one another. Prolonged management in dams will affect the sustainability of fish farming. Prolonged management in fish farming will support the sustainability of the dam as a whole, on the contrary, bad management of dams or fish farming will become an obstacle to the realization of sustainable management. The results of the analysis of indicators for the sustainability of dams and fish farming are presented in Chart 1, in addition to the analogy for the sustainability of dams and fish farming presented in Fi 1. We can conclude that from a sustainability perspective, we must pay close attention to the perspectives that have a very significant impact, namely environmental science view, economic views, and traditional social views. From the totality of the review posts, we can conclude, every time a policy is developed, whether it has a development character or not, we must analyze these 3 important views, namely the view of the area or its ecosystem (environmental science), the economic view and by no means surrender is social. local customs.

REFERENCES

Afin, A. P., & Kiono, B. F. T. (2021). Potensi Energi Batubara serta Pemanfaatan dan Teknologinya di Indonesia Tahun 2020–2050: Gasifikasi Batubara. *Jurnal Energi Baru Dan Terbarukan*, *2*(2), 144-122.

Arif, I (2014). Indonesian Coal. Main Library Gramedia.

Batubara, A., & Amiludin, A. (2021). Coal Mining Investment Opportunities in Indonesia on Goverenment Regulation Number 3 of the Year 2020 Concerning Mineral and Coal Mining. *Indonesian Journal of Law and Policy Studies*, *2*(2), 111-121.

Brooks, J. D., & Smith, J. W. (1967). The diagenesis of plant lipids during the formation of coal, petroleum and natural gas—I. Changes in the n-paraffin hydrocarbons. *Geochimica et Cosmochimica Acta*, *31*(12), 2389-2397.

Finahari, I. N., Salimy, D. H., & Susiati, H. (2007). Gas C02 dan Polutan Radioaktif dari Pltu Batubara. *Jurnal Pengembangan Energi Nuklir*, *9*(1).

Geological Agency of the Ministry of Energy and Mineral Resources [ESDM]. (2022). Executive Summary of Updating of Data and Balance of Mineral Resources Status 2022. Mr Global. (2020). Bp Statistical Review Of World Energy.

Haryadi, H., & Suciyanti, M. (2018). Analysis of Estimated Coal Needs for the Domestic Industry for 2020- 2035 in Supporting Domestic Market Policy Obligation and National Energy Policy. *Journal of Mineraland Coal Technology*, 14(1), 59–73.

Hudaya, G. K., & Madiutomo, N. (2019). The availability of Indonesian coal to meet the 2050 demand. *Indonesian Mining Journal*, *22*(2), 107-128.

Kumara, N (2010). Urban Household Scale Solar Power Generation and Its Availability in Indonesia. *Electrical Technology*,9(1), 68–75.

Miladyah, Fm (2020). The Effect of Return On Equity, Return On Assets, and Net Profit Margin on Stock Returns with Price To Book Value as an Intervening Variable (Study of Mining Sector Companies Listed on the Indonesia Stock Exchange in 2016-2018)[Phd Thesis]. Yogyakarta Veterans National Development University.

Rosadi, M., & Amar, S. (2019). Factors Affecting Electricity Consumption in Indonesia. Journal of Economic and Development Studies, 1(2), 273–286.

SNI (5015). 2011. 2011. Guidelines, Reporting, Resources and Coal Reserves. Jakarta: Bsn. Law No. 4 of 2009 concerning Mineral and Coal Mining.

Setiawan A. (2018). Potential Mineral and Coal Reserves In Indonesia And The World. *Journal of Mining Research*. 1(1).

Sirsikar, S. & Karemore, P. (2015). Design and Implementation of Real Time Web Based Geographic Pollution Monitoring System. International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC).

Wibowo, S. A., & Windarta, J. (2020). Pemanfaatan batubara kalori rendah pada PLTU untuk menurunkan biaya bahan bakar produksi. *Jurnal Energi Baru dan Terbarukan*, *1*(3), 100-110.