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Cost Benefit Analysis for Coal Steam Power Plants in Energy Security Framework

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Abstract: Indonesia's energy security can be assessed using a four-pronged management approach: affordability, accessibility, availability, and acceptability. This aspect is influenced by various internal and external strategic environments, such as energy supply and demand trends, investment in supporting infrastructure development, and the impact of related and cross-sectoral policies and regulations. This study based on descriptive quantitative method with a cost-benefit analysis tool of sufficient coal supplies to coal steam power plants to meet supply quality and low-cost fuel-based electricity. Besides that, this study also uses PEST (Politics, Economy, Social, Technology) analysis to look at it from the external environment. The study used secondary data using cost-effectiveness analysis tools. In addition, Focus Group Discussion was conducted to identify variable indicators that can be used to analyze alternatives and interventions. FGD's are also conducted to assess the recognition of each variable index. The assessment uses the Likert scale. A limitation of this study is that it is a short-term effort, so the cost-benefit analysis is limited to identifying alternatives and interventions being analyzed. The results of this study are an analysis of the economic value of coal as a fuel for steam power plants as a booster of the economy in Indonesia because it can produce a lot of strong and stable electricity with inexpensive infrastructure investment. The limitation of this research is the efficiency of alternatives in analyzing the cost benefits of coal as a fuel for steam power plants.

Keywords: Coal, Electric Steam Power Plants, Inexpensive Infrastructure Investment, Low Cost Electricity, Management

A. Introduction

In the growth of an industry, electricity is part of the national infrastructure and it is very important to boost the economy(Amanda & Saputro, 2023). As the industry grows, new jobs are created that can increase the economic, social and cultural competitiveness of the community. To be an "economic engine," the electricity supply must be sufficient, reliable, not easily cut off, and cheap enough (economical) for consumer industries to compete. A minimum electricity supply of 1,000 watts per capita, or 260 GW, is ideal for Indonesia to become the backbone of a strong economy and industrial growth.

In facing various economic challenges and post-pandemic economic recovery, Indonesia's electricity needs are projected to continue to increase. This is also caused by Indonesia's optimism in facing economic opportunities and challenges in the future. Therefore, coal is an energy source that has an important role in supporting the electricity sector in Indonesia, especially for national economic recovery activities after the Covid-19 pandemic (Jaya & Juwono, 2023).

One of the strategic sectors driving the wheels of the national economy is energy and mineral resources. In addition to playing a role in ensuring the availability and distribution of energy in Indonesia, the energy and mineral resources sector also contributes around 17% annually to state revenue. Optimal energy availability to meet final energy needs is essential to support the implementation of national development. Economic activity affects consumer energy demand at the end (end use) and in the connection (intermediate) (septiana, et all, 2022). Population growth is also the main driver for the increase in energy demand (Zohuri & McDaniel, 2021). On the other hand, energy demand drives activity that affects the economy. End energy users include industrial, transport, commercial, domestic and other sectors (agriculture, construction, mining). Meanwhile, energy consumers on the connection side can occur, among others, through energy transformation (energy conversion and processing). The energy in question is electrical energy. As for energy security, it is assessed based on affordable prices, easy to obtain, available in the community and acceptable to the community.

Currently, even though the government has promoted the use of renewable energy, the energy supply is still dominated by fossil energy which is dominated by coal. Renewable energy is energy that comes from new energy sources that can be produced by new technologies, such as coal bed methane, liquefied coal and gasified coal. The amount of energy supply varies every year following the amount of energy demand obtained from national production and imports. Therefore, it is important for the government to enforce the Domestic Market Obligation (DMO) for coal and the Indonesian Coal Price Reference (ICPR) aimed at securing the security of domestic coal supplies in a sustainable manner and optimizing state revenues.

The coal industry is also an important element in supporting national energy security (Simanjuntak, et all, 2022). Based on data from the Coal Needs Planned Data by the Ministry of Energy and Mineral Resources of the Republic of Indonesia (ESDM), Indonesia's Coal Needs in 2023 amount to 195.9 million tons (ESDM, 2022). This value increased compared in the previous year of 188.9 million tons. Until 2025, the need for coal will also increase until it reaches a value of 209.9 million tones (ESDM, 2022). The electricity sector is still the largest coal user at the Indonesian domestic level.

Indonesia can rely on coal reserves to achieve low electricity bills. Coal-steam power plants remain one of the most productive due to Indonesia's large coal reserves and low prices. Coal is an important energy source that meets national energy needs and is also a source of government revenue through coal exports (Arifin, et all, 2022). As of 2021, total coal resources reached 151 billion tons, with proven reserves of 36 billion tons. If mined continuously with the same annual production of 614 million tons as in 2021, the coal can be used for the next 70 years (DEN, 2022).

The purpose of this study is to analyze the cost benefits of sufficient coal supplies to coal steam power plants in order to meet supply quality and low-cost fuel-based electricity. That purpose also a novelty of this research. The question of this research is whether coal is the most economical and efficient fuel source with an inexpensive investment value in infrastructure.

State of the art of this research are energy has been a critical economic driver since the dawn of the industrial and technological revolution (Batinge et al, 2022). Implementing the energy transition in the electricity sector by using coal as the primary source of power generation is one of the challenges in supporting energy security. This is caused by difficulties in implementing regulations, certainty regarding the target of transitioning coal-steam power plants to green power plants before 2030, as well as the availability of competitive domestic funding for renewable energy which are still the main factors.

Under the Power Supply Project Plan (RUPTL) 2021-2030, coal-steam power plants and solar power plants will play a major role in securing electricity supply over the next decade; it will be optimized by adding power plants generation, transmission substations and distribution (DEN, 2022). As the power plant with the lowest cost of production (BPP) in the country's electricity system, the role of coal-steam power plants in providing efficient power is very important.

The Ministry of Energy and Mineral Resources reported that the installed capacity of power plants in Indonesia reached 81.2 gigawatts (GW) in 2022. This number increased by 9.14% compared to 2021, which amounted to 74.4 GW. The steam power plant (PLTU) has the largest installed capacity, which is 42.1 GW, or equivalent to 51.85% of the total installed capacity of power plants in Indonesia in 2021.

In addition, the government also predicts that in 2023 the use of electricity at home per person will continue to increase, reaching 1,336 kWh or an increase of 13.9%. The post-pandemic caused this situation, prompting efforts to recover community economic activities. In addition, the installed capacity of power plants is expected to increase until 2024.

The Ministry of Energy and Mineral Resources (ESDM) also reports that the electrification ratio in Indonesia has reached 99.63% in 2022. This percentage has increased by 0.18% compared to the previous year, which came to 99.45% or is close to the electrification ratio that the government has set as 100%.

Powering the economy and making society more competitive today requires adequate, reliable, and economical electricity supply. This can be achieved by supplying power from the power plant. However, coal fuel used by electric steam power hereinafter referred to PLTU, is considered environmentally unfriendly because it produces by-products in the form of Fly Ash, Bottom Ash (FABA). Currently, FABA can be processed and used with prior approval from the Ministry of Environment and Forestry into products that have economic value and can be used, among others: 1) substitution of construction materials such as cement mixtures in the construction of roads, bridges and embankments, reclamation of former mines, materials for making bricks, paving blocks, cone blocks; 2) the agricultural sector as fertilizer and animal feed mixture, and; and 3) forestry and fishery sector.

A proper methodology that provides inference for efficient, effective, economical and targeted decision-making is required when conducting related analysis FABA. Cost-benefit analysis can be used for this problem.

Before conducting further analysis of the coal-fired electricity supply provided by the PLTU and the production of by-products in the form of FABA. The advantage of PLTU is that the power it produces is very large, so it is expensive to procure the cheapest electricity supply. PLTU uses steam coal or medium-low grade coal (calorific value < 5,100 kcal/kg ash dried basis (adb), used as fuel for low-grade coal boilers, which can be used directly as fuel for mine-mouth or lignite power plants. It can also be used unconventionally through techniques of upgrading brown coal, coal liquefaction, coal gasification, and so on. Described in Table 1 the advantages and disadvantages of coal-fired steam power plants.

Table 1. Advantages And Disadvantages of Coal-Steam Power Plants

Excess	Deficiency
Technology is well established	High initial investment costs
Low fuel costs	By-products in the form of FABA
The national fuel supply is sufficient	Location is inflexible, as much as possible near
Longer useful life	ports or large water sources for cooling

Source: Had processed, 2023.

Indonesia's coal production is expected to continue increasing, especially to meet domestic demand (power generation and industry) and external demand (exports). The development of coal production for the 2009-2018 period has increased considerably, with production achievements in 2021 of 614 million tons. Of the total production, the portion of coal exports reached 322 million tons (52,4%) and most of it was used to meet the demand of China and India. The high number of Indonesian coal exports makes Indonesia one of the largest coal exporters in the world besides Australia. Meanwhile, domestic coal consumption reached 237 million tons, bigger than the domestic coal consumption target of 133 million tons. The realization of domestic consumption exceeded the target due to an increase in electricity consumption as a result of economic growth supported by the realization of 21 smelters in 2021. This has encouraged an economic multiplier effect and people's welfare, so that the government continues to push for an increase in the added value of coal.

Indonesia has a Domestic Market Obligation (DMO) policy. The commitment of coal companies to sell some of their production for domestic consumption. The DMO amount is determined annually by the Regulation of the Minister of Energy and Mineral Resources. The amount of DMO is obtained from calculating the demand for domestic coal that has been proposed by domestic coal consumers, and calculating the Minimum Percentage of Domestic Coal Fulfillment (PMPBDN) for each company. Decree of the Minister of Energy and Mineral Resources No. 267. K/MB.01/MEM.B/2022 On Fulfillment of Domestic Coal Needs, 25% of the total production of coal companies in 2022 is designated as DMO. This provision states if the company does not meet the DMO, it will be subject to sanctions for reducing production volume in 2022, export quota. With the coal DMO, it can guarantee the availability of coal for domestic consumption needs. Table 2 summarizes coal production, DMO (domestic market obligation) targets, domestic consumption realization and the number of national coal exports from 2019 to 2023.

Table 2. Indonesia's Coal Production and Domestic Consumption 2020-2023

Information	2019	2020	2021	2022	2023
National coal production (million tons)	616	565.69	614.28	685.56	289.75
DMO target (million tons)	128,04	131.89	133.04	165.76	0
Realization of domestic consumption (million tons)	180,27	219.7	237.91	237.39	52.24
Percentage of domestic consumption	29,26	38.83	39.24	34.62	18.02
Coal exports (million tons)	454,5	331.94	322.07	326.42	75.35

Source: Had processed, 2023.

Decree of the Minister of Energy and Mineral Resources Number 188.K/HK.02/ MEM.L/ 2021 concerning the Approval of PT Perusahaan Listrik Negara (Persero) Electricity Supply Business Plan For 2021 To 2030, the mix energy production target for generation end year 2030 with coal is 48.4%. It shows that coal still has a big role as a PLTU fuel supplier until 2030. This is because coal, as the main fuel of coal-steam power plants, has the efficiency compared to other fuels with the following cost of production. But the strategy of using clean coal technology in coal-steam power plants, management of coal supply partners and transportation services to the PLUT location besides ensuring the reliability of coal supply and cost efficiency. Small-scale PLTU which is located far from coal sources, has a separate logistics pattern that aims to ensure the delivery of coal to the intended PLTU location. short-term and long-term strategies are needed to increase the reliability of coal supply and ensure that the coal supply chain runs smoothly both in quality, quantity and on time with efficient supply costs.

Table 3 explains the comparison of the average cost of electricity production per kWh between PLTU, Hydropower, Gas and steam power plants-Natural Gas (PLTGU), Fossil and Solar Power plants, that coal-fired PLTU has the lowest production costs (MEMR, 2022).

Table 3. Cost of Electricity Production Per Kwh

Fuel Generation	**Cost of Goods Produced (BPP) Average per kWh**	
	*Rp	USD
PLTU (Coal)	985	6.6 cent
Hydropower (Large)	1.058	7.1 cent
PLTGU (Natural gas)	1.499	10.1 cent
PLT Fossil (BBM)	1.573	10.6 cent
Solar Power Plant	1.308	8.8 cent

*Average exchange rate USD 2019 Rp14.800
Source: Had processed, 2023.

According to National Standardization Agency of Indonesia, based on SNI 4726:2019 concerning Guidelines for reporting coal resources and reserves, there is a specific definition of coal resources and coal reserves used in Indonesia. Coal resources are part of coal deposits in a certain form and quantity and have reasonable prospects that allow them to be mined economically. Coal resources are divided according to the level of geological confidence into hypothetical, inferred, indicated and measured categories.

Coal reserves are part of the indicated and measured coal resources that can be mined economically. A proper determination of reserves has been carried out which may include a feasibility study, which has considered all relevant factors such as mining method, economics, marketing, legal, environmental, social and government regulations. The determination must be able to show that at the time the report is made, economic mining can be determined as possible. Coal reserves are divided according to the level of confidence into probable coal reserves and proven coal reserves.

However, there is a big problem with the use of coal for power generation: it is not environmentally friendly. The existence of by-products in the form of FABA from the coal combustion process has a negative impact on the government in procuring electricity supply provided by PLTU at the construction site. Track record of PLTU infrastructure development projects (ESDM, 2019). PLTU Indonesia needs around 80 million tons of coal annually. The coal used for power generation has an average FABA content of 6-10%, which means 0.06-0.1 kg of FABA produced from 1 kg of coal. Given that the total capacity of coal-steam power plants in Indonesia has now reached 29,000 MW, FABA production of all coal-steam power plants in Indonesia is around 4.8 million to 8 million tons per year. In addition, FABA stocks held by PLN and

Independent Power Producers (IPP) reached around 10.8 million tons, of which PLN had 5.2 million tons of coal-steam power plants and 5.6 million tons of IPP power plants. Below is coal consumption data for 2018 and FABA probabilities and forecasts for 2019-2028.

In Indonesia, FABA is regulated in Law No. 32 of 2009 concerning Environmental Protection and Management, Government Regulation of the Republic of Indonesia No. 101 concerning Management of Hazardous and Toxic Waste, and Regulation of the Minister of Environment and Forestry No. 10. Regulated in 2020 for characterization and determination of B3 waste status. According to Government Regulation Number 1 of 2014 concerning B3 Waste Management. Based on these, FABA is still classified as Hazardous and Toxic Waste (B3) and is feared to pollute the environment. FABA is processed into economically valuable products and can be used as building materials. However, currently the utilization of Toxic and Hazardous Materials waste requires permits including storage permits, transport permits and utilization permits which process takes a long time and permits are applied for per location so that one permit can only be used at the location applied for. This is considered inefficient and uneconomical for entrepreneurs. Fly ash is left over from burning coal, usually produced in factories and power plants. Fly ash is in the shape of a fine powder. Bottom ash and fly ash are by-products of burning coal in steam power plant boilers (PLTU) (Mengxiao, 2015).

In countries such as the United States, Australia, Canada, Europe, Israel, Japan, Russia, and South Africa, FABA is classified as waste, but does not include B3 waste and must be treated and used properly. In other countries FABA is also regulated in landfill regulations and waste regulations, which define FABA as waste but are not classified as hazardous/toxic waste. FABA definition/classification uses the Basel Convention, REACH Regulation, and International Convention on Mercury. The experience of Japan and India can be a "lesson to learn." These countries demonstrated that a mix of policies helped them turn challenges into opportunities, using fly ash for manufacturing building materials and construction activities (Mekadinah et al., 2020).

Based on the above, it is considered important to analyze the efficiency and economic feasibility of procuring electricity from coal-steam power plants provided by PLTU. All laws and regulations related to FABA's coal-burning waste must be reviewed in order for it to be managed and used in a way that creates economic value. The social and environmental impacts on the communities surrounding the coal-fired power plant must be considered related to the added value of waste generated from burning coal at the coal-fired power plant, and the government must consider how to finance the supply of cheap coal. Socialized in society. Electricity can boost the Indonesian industry. China, the biggest developing country of the world, considers investment in electricity generation as a key policy to the economic development (Lin & Liu, 2016). It can also be a strategy for Indonesia due to its positive correlation with the economy.

B. Methods

This study uses a descriptive quantitative method with a cost-benefit analysis (CBA) tool focuses on the efficient use of factors of production without considering other aspects such as distribution and stabilization of the economy. Besides that, this study also uses PEST (Politics, Economy, Social, Technology) analysis to look at it from the external environment. The dynamics of the global strategic environment have also shown that the use of coal for power generation has become one of the energy sectors that has become an essential concern for many countries. Therefor it is necessary to look at it from the external environment by using PEST (Politics, Economy, Social, Technology).

The study used secondary data using cost-effectiveness analysis tools. In addition, Focus Group Discussion was conducted to identify variable indicators that can be used to analyze alternatives and interventions. This analysis determines a program solely in terms of its effectiveness, but the choice of program implementation is in the hands of the executive, who also considers other factors in making that choice. The great effectiveness of CBA lies in its ability to provide increased understanding of the consequences of proposed public programs (Ergas, 2009). Without revenue sharing, an efficient program may not be implemented. On the one hand, a cost-benefit analysis would choose a program that produces good revenue sharing, even if the program is not very efficient.

C. Results and Discussion

Based on coal-steam power plants are considered the most efficient and economical in securing electricity supply compared to power plants that use other fuels, especially other fossil fuels. Therefore, it is very important to conduct a comparative analysis of the costs and benefits of PLTU. Compared to other power plants, several variable indicators are considered superior to coal-fired Steam Power Plants (PLTU). These include: 1) Low prices because fuel sources and generator supply are still sufficient; 2) The initial investment of the coal-fired power plant is considered cheap; 3) the technology used is cheaper and more affordable 4) the cost of electricity production is cheaper; 5) the presence of by-product/waste emissions.

FGD has been carried out in finding the most relevant variable indicators of cost and benefit analysis of coal-steam power plants compared to other fossil fuel power plants and new renewable energy power plants. FGD is carried out jointly between study compilers, experts in the field of coal, experts in the field of electricity/power plants and experts in economics. The following is presented the table of cost-benefit analysis of coal-steam power plants (Table 4) compared to other fossil fuel power plants (Table 5) and new renewable energy power plants (Table 6). This matrix has an interpretation, the higher the score, the more efficient and economical the power plant is. The total score in each matrix is 20 points.

Table 4. Matrix of Cost-Benefit Analysis of Coal-Steam Power Plants (PLTU)

Value/Perception Variable	1	2	3	4	Total
1. Fuel				✓	4
2. Investment amount			✓		3
3. Applied Technology		✓			2
4. Principle production Cost				✓	4
5. Emission	✓				1
Total					14

Sources: Had processed, 2023

Table 5. Matrix of Cost-Benefit Analysis of Other Fossil Fuel Power Plants

Value/Perception Variable	1	2	3	4	Total
1. Fuel		✓			2
2. Investment amount			✓		3
3. Applied Technology		✓			2
4. Principle production Cost		✓			2
5. Emission	✓				1
Total					10

Sources: Had processed, 2023

Table 6. Matrix Cost-Benefit Analysis of New and Renewable Energy (EBT) Power Plants

Value/Perception Variable	1	2	3	4	Total
1. Fuel				✓	4
2. Investment amount	✓				1
3. Applied Technology		✓			2
4. Principle production Cost	✓				2
5. Emission			✓		3
Total					9

Sources: Had processed, 2023

Table 7. Description

Value	Description
1	Very Poor/Very Expensive
2	Poor/Expensive
3	Good/Efficient
4	Very Good/Very Efficient

Sources: Had processed, 2023

Based on the tables above, a cost-benefit analysis comparing coal-steam power plants, other fossil fuels, and new renewable energy. The variables studied are fuel efficiency, total investment efficiency, technology use, principle production cost and total emissions, with a total efficiency ratting score of 20 points. the higher the points, the more efficient. The table 4, shows that the coal-steam power plants with the highest score (score 14) are currently the most. While in table 5, other fossil fuels power plants have an efficiency score of 10 points and in table 6, new and renewable energy power plants have an efficiency score of 9. We can conclude that it is an excellent power plant. The most efficient and most economical. After that, more fossil power plants and renewable energy will be built.

It has been discussed earlier that the business world considers classifying FABA as B3 waste and asking for permission to dispose of FABA, which has no economic value but is inefficient and ineffective. So far, there is no evidence that FABA is B3 waste, but FABA is believed to be a construction material/substitute for cement. Laws and regulations still refer to FABA as B3 waste, and the licensing needs to be simplified, making it difficult for private electricity producers and PT PLN to sell or supply the product to third parties as raw materials. In addition, economic actors such as FABA providers (private electricity producers and PLN), transportation companies, and users are vulnerable to litigation. The FABA exemption proposal for B3 waste also aims to stop the demonstration of local and international community organizations against the existence of FABA.

This is very important to process FABA compared to hoarding with no economic added value. In addition to stockpiling, FABA processing also costs money. Storage and stockpiling are necessary to prevent FABA scattering. Therefore, the need for a storage area/landfill so that FABA does not fly, so that it has the potential to damage the environment and will have a negative impact on the health of the surrounding community, such as respiratory disorders, eye irritation and digestion. Regarding the follow-up discussion of Government Regulations and Presidential Regulations derived from the Draft Law on Job Creation and Industrial Waste Handling, the Coordinating Ministry for Economic Affairs in Industry asked business actors to discuss using FABA. Business actors propose FABA problems that have been an obstacle for the industry to resolve in several ways. One way to solve this problem is to simplify the rules from classification to FABA management.

It is undeniable that the proposal to revoke the FABA standard as various economic actors and even researchers have submitted B3 waste. The reason is the proposed elimination of FABA standards as B3 waste will impact the ease of management of FABA itself. For example, PLN admits it has been approved for FABA exemptions based on its experience. But in practice, it is even more difficult because the fulfillment of documents needs to be more transparent. The Ministry of Industry considers that FABA, included in the B3 waste category, must be removed from the list. Efforts made to date have included widely reported studies, and FABA's findings do not fall into the category of B3 waste. Regarding the international agreement, no one requires FABA to be classified as B3 waste.

Thirty countries of the Organization for Economic Co-operation and Development (OECD), including the United States and Japan, also do not include FABA in the category of B3 waste. Meanwhile, the Indonesian Coal Mining Association (APBI) has sent a letter to the president so that FABA can be used properly on other useful industrial materials, including building materials such as paving blocks for planting fertilizer, etc., taking steps to eliminate FABA as B3 waste. Like Indonesia, Canada also classifies FABA as B3 waste. This is because Canada is dominated by renewable energy (EBT) and has more efficient and economical power generation.

The results of the benefit-cost analysis carried out in the research based on the results of the FGD and literature review are listed in table 4, table 5 and table 6. In Table 4 Matrix of cost-benefit analysis of PLTU has a total efficiency ratting score of 14. Table 5 matrix of cost-benefit analysis of fossil fuel power plants has a total efficiency ratting score of 10. In Table 6 Matrix cost- benefit analysis of new and renewable energy (EBT) power plants has a value of 9. This matrix has an interpretation, the higher the score, the more efficient and economical the power plant is. The efficiency ratting score total in this matrix is 20 points.

Where the economic value of coal as a fuel for power plants compared to other fuels is higher because it can produce large and powerful energy with a cheaper infrastructure investment value compared to other power plant infrastructure investments. Reflected in Table 4 Matrix of cost-benefit analysis, PLTU has a score of 14; as for PLTU waste in the form of FABA, the laws and regulations need to be reviewed, adjusted and implemented so as to support the investment climate, in other hand that FABA waste can be processed and has economic value.

Based on the results of the PEST analysis that has been carried out, politically there is a conflict between Russia and Ukraine which causes an energy and food crisis. Russia is one of the largest coal producing countries in the world, with this conflict Russia has restricted exports of its coal and natural gas commodities. This has an impact on rising coal prices due to reduced supplies, besides that the price of natural gas provided by Russia as fuel for PLTU has also increased. Russia's restrictive export policies are forcing many Western countries to use coal as a short-term solution and disrupting the 2030 goal of using clean energy. Currently, technological advances are driving the efficient application of low-carbon technologies for coal-fired power plants and many countries are trying to develop clean coal technologies to reduce carbon emissions.

Based on the objectives and questions of this study to analyze the cost benefits of supplying sufficient coal to fuel a steam power plant in order to meet the quality of supply and electricity based on cheap fuel with investment value in inexpensive infrastructure, the objective of this research has been achieved. The results of this study are that coal-fired steam power plants are the cheapest with the most powerful and large electricity production results when compared to other fuel-fired power plants.

Based on the data above, the realization of domestic consumption exceeded the DMO target, this was due to an increase in electricity consumption as a result of economic growth supported by the realization of 21 smelters in 2021. This proves that the use of coal as fuel for steam power plants can produce cheap electricity which will encourage a multiplier effect for economic growth and people's welfare. Thus, the government needs to continue to encourage the increase in the added value of coal. However, the government still needs to carry out the settlement of coal combustion waste from a regulatory perspective with the consideration that this waste still has economic value.

Optimizing the utilization of coal combustion ash (FABA) for Steam Power Plants (PLTU) is an important step the government must put forward to reduce environmental pollution. This is the "best way" to be done considering the need for electricity consumption, and the manufacturing industry continues to increase. Although efforts to optimize renewable energy are still being pursued, they must be kept from the various challenges going forward. This does not mean that "green energy" is not being pursued. However, perhaps this is a long-term goal considering that its implementation is complex and requires many resources and significant funding/investment.

Therefore, the use of coal as a fuel for power generation can be optimized. However, what is essential is preventing or at least minimizing environmental pollution through using FABA for various economic things that promote a green environment. The best way to realize that is by increasing the use of FABA for processing construction raw materials such as cement or other infrastructure developments. The great demand for electricity is undoubtedly in line with the amount of FABA generated from the PLTU. However, with good management, using FABA can increase economic activity in Indonesia.

Good FABA management can have a positive impact on various economic sectors as well as an effort to preserve the environment. Related to this, it is vital to implement legal certainty and regulatory legality to encourage the use and management of FABA. The rule of law is also essential for optimizing the use of FABA in preventing environmental pollution from occurring regularly in its implementation.

Based on the analysis and discussions conducted, the following are suggestions for action: 1) Ministry of Energy and Mineral Resources, Ministry of Environment and Forestry (KLHK) and PT. PLN discussed determining how to use FABA, considering the many benefits of FABA that can support the economy in the masses and after Covid-19; 2) MoEF needs to revise the Government Regulation of the Republic of Indonesia Number 101 of 2014 concerning the Management of Hazardous and Toxic Waste to facilitate permits for the use of FABA in infrastructure development; 3) Ministry of Energy and Mineral Resources, KLHK and PT. PLN made a study by inviting various experts from the High Desert to determine the ability of FABA to be removed from waste B 3; 4) Encouraging BPPT to prepare FABA utilization technology so that it can be converted into high economic value commodities; 4) Encourage the Indonesian Employers Association (APINDO) to propose the removal/delisting of FABA from the B3 waste category to the MoEF; 5) Encourage the Ministry of Environment and Forestry to revise the Minister of Environment and Forestry Regulation No. 10 of 2020 concerning Procedures for Testing the Characteristics and Determination of the Status of Hazardous and Toxic Waste because it is difficult to implement in the field.

D. Conclusion

Based on the explanation in the previous chapter and answering the problems in this study, the following conclusions can be drawn: 1) As Indonesia's economy grows, an adequate, reliable, and cost-effective electricity supply is needed. Industrial growth requires an adequate supply of electricity, but as new industries grow, new jobs are created, unemployment decreases, and the country's GDP increases; 2) The electricity supply needed to build a new industry is about 1000 watts per person, or 260 GW, for the industry to grow significantly. Currently, Indonesia strives to meet the demand for sufficient, reliable, and affordable electricity to utilize existing resources to generate industrial growth. Indonesia has abundant fossil energy resources, especially coal, so the government seeks to optimize coal needs and production in the country, including using coal as a fuel for PLTU; 3) PLTU can produce large-scale, strong and stable electricity with the cheapest infrastructure development investment compared to other power plants, so it is sufficient, reliable and low-cost to boost the Indonesian economy. In addition, due to the low price of coal, PLTU has the lowest production cost compared to other types of power plants that use fossil fuels and new renewable energy. However, burning coal at coal-steam power plants produces by-products commonly called FABA or fly ash and bottom ash; 4) FABA, as a by-product/waste from the process of fulfilling cheap electricity supply from PLTU, has added value and can be processed and utilized. FABA can be processed into products of economic value and utilized, among others: a) Substitution of construction materials such as cement mixtures in the construction of roads, bridges and piles, reclamation of former mines, brick-making materials, paving blocks, cone block; b) the agricultural sector as fertilizer and mixed animal feed ingredients, and c) Forestry and fisheries sector; 5) Based on laws and regulations, namely Law No. 32 of 2009 concerning Environmental Protection and Management and Government Regulation No. 101 of 2014 concerning B3 Waste Treatment, FABA is classified as Category 2 B3 Waste, and its use requires complicated permits and requires a long time; 6) The inclusion of FABA into B3 waste makes FABA providers (private electricity producers and PLN), transportation companies and users vulnerable to lawsuits and protests from local and international community institutions/organizations from demonstrations against the existence of FABA; 7) Based on the above, business actors propose to eliminate FABA from B3 waste in order to be able to carry out FABA processing so that the electricity supply by PLTU is more efficient and cheaper.

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