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MORALITY BEFORE KNOWLEDGE

# Optimizing the utilization of coal in Indonesia through downstreaming: Economic benefits, challenges and solutions

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## ABSTRACT

**Background:** This study delves into the strategic optimization of coal resources in Indonesia through downstreaming, aiming to contribute to sustainable and value-driven utilization of the country's mineral wealth. **Findings:** By adopting a holistic approach, the study seeks to maximize the economic potential of Indonesia's coal resources while ensuring environmental sustainability and global competitiveness. **Methdos:** The research highlights the benefits of downstreaming, including increased economic value and state revenues, while acknowledging the challenges such as environmental impacts and the need for advanced technologies. **Conclusion:** The study emphasizes the importance of collaboration between mining companies, downstream companies, and the government, as well as the implementation of supportive regulations and incentives to encourage coal downstreaming. Overall, the study provides strategic recommendations for Indonesia to enhance the efficiency and responsible utilization of its coal resources through downstreaming. **Novelty/Originality of this article:** This study underscores the strategic importance of coal downstreaming in Indonesia, highlighting its economic potential, environmental challenges, and the need for collaboration and supportive policies to ensure sustainable resource utilization.

**KEYWORDS**: coal; downstreaming; envronmental sustainability; global; optimization.

## 1. Introduction

Due to its large mineral reserves and high levels of coal, copper, gold, tin, bauxite, and nickel production, Indonesia is a major player in the worldwide mining industry (Yasin et al., 2021). The country, which is made up of 17,000 islands in the Pacific Ring of Fire, has historically had strong economic growth driven by the mining sector. This industry makes a substantial contribution to Indonesia's GDP, exports, tax income, and jobs.

Furthermore, most of the nation's mines are situated in rural and isolated areas, where the mining sector is vital to the growth of local economies. Mineral extraction acts as a major stimulant for development in these regions, promoting the construction of infrastructure and generating jobs. Earnings from oil and gas, minerals, and coal surpassed IDR 90 trillion, constituting 95 percent of total natural resource revenues. Furthermore, the oil and gas as well as mining sectors collectively contribute 7.2 percent to the Gross Domestic Product (GDP), positioning them as the primary contributors following the trade, agriculture, and construction services sector (Ibrahim & Fadillah, 2021).

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Indonesia's strategy for coal is a crucial component of the country's larger goal for development powered by commodities. This strategy, which is sometimes referred to as "resource nationalism," is influenced by the 2009 Mineral and Coal Mining Law (BPK RI, 2009). This policy is backed by fiscal, non-fiscal, and regional incentives (Ragimun & Rosjadi, 2020) and is strongly linked to Article 33 of the 1945 Indonesian Constitution, which affirms the state's sovereignty over land, water, and natural resources for the benefit of the populace to the greatest extent possible. Instead of only exporting the raw ore, Indonesia wants to attract investments in smelting and processing facilities to increase the value of its coal reserves. After building a fully integrated steel supply chain in recent years, the nation is now trying to establish itself as a center for battery manufacturing (Yasin et al., 2021).

Indonesia, as one of the world's largest coal producers, possesses a valuable natural resource in the form of abundant coal reserves (Aimon et al., 2023; Bößner et al., 2023; Wollff, 2020). These resources have long been the backbone of the national energy and economic sectors. However, the use of coal also comes with significant environmental impacts and challenges in its management (Pambudi et al., 2023; Yudiartono et al., 2023). One strategy to address these challenges is through coal beneficiation, which involves converting raw coal into higher-value-added products. China and India are significant coal producers, with China experiencing a surge in domestic production (Ordonentz et al., 2022; Wang & Cheng, 2023) and India aiming to reduce imports by increasing its own production. Indonesia, as the world's third-largest coal producer, is also expected to expand its production, with a focus on increasing exports. China's increased demand new annual record, with expected growth of 8% for the full year, reducing the need for imports and replenishing stocks this means thermal coal from Australia and Russia has led to a shift in imports by India, with China reducing its volumes bought from Indonesia (Aimon et al., 2023).

By delving into the strategic optimization of Indonesia's coal running resources through downstreaming, this study endeavors to contribute to the discourse surrounding sustainable and value-driven utilization of Indonesia's mineral wealth. Through a holistic and forward-looking approach, the study seeks to chart a path towards maximizing the economic potential of Indonesia's coal resources while ensuring environmental sustainability and global competitiveness (Vilakazi et al., 2022).

Coal mining and other land-based activities usually share the same amount of space. This overlap has an impact on social change (Xue, 2022), the sustainability of land use outside of mining activities, and the economic structure of the local communities most notably, the loss of sources of livelihood all of which have an indirect positive impact on the human development index (Afkarina et al., 2019). Agricultural land has suffered harm from licensed coal mining sites, which have also resulted in environmental degradation and damages (Afkarina et al., 2019; Nasir et al., 2023; Rasimeng, 2019; Setiawan et al., 2016).

For downstream coal projects, the government offers incentives including extended permit periods and fiscal and non-fiscal policies. These initiatives are part of Indonesia's larger plan to increase the value it derives from the manufacture and export of refined coal products, which will help the country's mining industry and economy as a whole flourish. Utilizing digital technologies throughout the coal supply chain to reduce production and maintenance costs, enhance workers' safety, and improve productivity.

Coal downstreaming in Indonesia is still facing challenges. Several projects aimed at increasing the added value of coal are encountering significant obstacles, one of which is financing and project economics, causing the feasibility study process to remain incomplete. However, businesses or companies are required to adhere to the coal downstreaming project plans submitted to the Directorate General of Minerals and Coal at the Ministry of Energy and Mineral Resources. If there is an extension of the coal downstreaming project beyond the original plan, the company must reapply to the Ministry of Energy and Mineral Resources. For companies that have extended their Coal

Mining Business Work Agreement (PKP2B) to become Special Mining Business License (IUPK), downstreaming becomes an obligation that cannot be ignored.

PT XYZ, a part of MI** **, a state-owned mining holding company, is known to continue exploring coal derivative products. The CEO of PT XYZ, AI, has statet that coal derivative products are not limited to Dimethyl Ether (DME) but also include Monoethylene Glycol (MEG), anodes, and graphite. PT XYZ is assessing various downstreaming potentials for immediate realization. Previously, the coal gasification project to produce DME failed to materialize because the American partner, Air Products, withdrew from the project. Arsal Ismail said that the company is in negotiations with an investor from China to manage the coal gasification project to produce DME, replacing the position previously held by Air Products.

This study intends to lessen the losses incurred by a coal mining company in Indonesia, analyzing several scenarios for the national energy policy and coal gasification with Dimethyl Ether (DME) production by providing a comprehensive analysis and strategic recommendations for Indonesia's coal resources down streaming, emphasizing the enhancement of economic value, sustainability, and worldwide competitiveness in the coal sector. The goals include a thorough assessment of Indonesia's coal industry as it stands today, the identification of down streaming opportunities and obstacles, and the formulation of plans to optimize value addition via operations like processing, upgrading, and the production of high-value goods. In addition, the paper highlights the importance of diversifying the coal product portfolio to include cleaner energy sources and cutting-edge materials, encouraging sustainable practices, assessing the effects of economic growth on the economy as a whole, minimizing the effects of the environment, navigating regulatory frameworks, evaluating the dynamics of the global market, encouraging cooperation and investment, and offering concrete policy recommendations to help legislators support the responsible and optimized utilization of Indonesia's coal resources through downstream.

## 2. Methods

This study used qualitative research methods with the approach of the strategy to enhance the efficiency of coal utilization through downstream analysis, a comprehensive approach was adopted, involving the collection of insights from seven diverse informants. This inclusive strategy aimed to gather a holistic understanding of the complexities associated with optimizing coal utilization in the face of diverse challenges (Anugrah, 2023). Because it was used for data gathering and analysis was a qualitative multiple comparative analysis technique, which allowed for a comprehensive understanding of the various perspectives and insights provided by (Ndjebayi, 2017) was adapted.

Using document analysis, a full set of Environmental Impact Assessment (EIA) and Environmental and Social Impact Assessment (ESIA) reports, along with supporting documents, relevant regulations, International Finance Corporation Performance Standards (IFC PS), and other relevant guidelines, were examined extensively. With the use of descriptive analysis the aims was to provide a detailed account and interpretation of a situation or phenomenon. It involves summarizing, organizing, and interpreting data to reveal patterns and insights the approach was adopted to comprehensively document and analyze the strategies used in optimizing coal utilization through down streaming. According to the Indonesian Coal Mining Association (ICMA), the nation will produce more coal in 2023 than the 695 million metric tonnes that is the stated goal. According to (Hawari, 2023) the most recent figures, 690 million tonnes have already been produced. Significantly, September and October saw an average monthly coal output rate of 61 million tonnes. This allowed for a detailed examination of the various factors influencing the process. The key issue to understand is the slow progress and stagnation of coal downstreaming in Indonesia despite the incentives provided by the government. Table 1 presents a list of informant, each holding different positions in companies or the mining sector, who shared their experiences and perspectives on their respective fields.

Additionally, their views on coal beneficiation, including its benefits, challenges, and potential solutions, are essential for further analysis.

Table 1. List of the informants

| No | Code | Position of the Informants | Job Description |
|---|---|---|---|
| 1. | Informant-1 | Executive director of Indonesian Coal Mining Association | Bridging the interests of coal companies with stakeholders |
| 2. | Informant-2 | Special staff of the Minister of Energy and Mineral Resources for accelerating downstreaming | Assisting the Minister of Energy and Mineral Resources in controlling the implementation of mining sector downstream programs by stakeholders |
| 3. | Informant-3 | Director of a mining services company | Together with the BoD the company creates, implements and controls mining activity programs and seeks opportunities for cooperation and collaboration with other stakeholders in the coal industry |
| 4. | Informant-4 | Executive director of Center for Energy Security Studies | Making studies on the implementation of energy policies, including in the coal generation and mining sectors |
| 5. | Informant-5 | Former commissioner of a state-owned enterprises in the coal energy sector and intelligence agents of state intelligence agencies | Providing input to the state intelligence agency regarding macro and micro conditions regarding energy, especially in relation to coal mining |
| 6. | Informant-6 | Chairman of the Indonesia Mining Association | Accommodating input from IMA members, some of whom are large coal mining companies such as PT AE, PT XYZ, PT IE regarding the maximum use of coal for national interests |
| 7. | Informant-7 | Legal counsel manager for the largest coal mining company in Indonesia | Providing legal counseling support related to the company's coal mining operations in addition to interacting with fellow coal companies within IMA |

## 3. Results and Discussion

Coal has long been the backbone of the global energy industry. Despite global movements towards cleaner energy sources, coal still plays a crucial role, especially in developing countries and energy-intensive industries, including Indonesia. As one of the most abundant fossil energy sources, coal provides approximately 38% of the world's electricity.

Many countries, particularly in Asia, heavily rely on coal for their energy needs. In China, India, and Indonesia, for example, coal is the primary source of electricity production. This dependence is due to the abundant availability of coal and its relatively low production costs. However, this reliance also poses challenges in reducing carbon emissions and meeting global climate change targets. The coal sector also serves as a major source of employment for millions of people, so transitioning away from coal must consider social and economic impacts.

On the other hand, coal is one of Indonesia's major export commodities and significantly contributes to the country's Gross Domestic Product (GDP). The mining

sector, including coal, is a crucial pillar of Indonesia's economy, providing both direct and indirect contributions to the national economy. Indonesia is also one of the world's largest coal exporters. Coal sales to international markets generate a significant amount of foreign exchange. This revenue is vital for the country's trade balance and macroeconomic stability (Wang et al., 2023).

Coal still remains the largest contributor to non-tax state revenue (PNBP) in Indonesia. In 2020, approximately 85% of the total coal and mineral mining (Minerba) PNBP came from coal, and this revenue depends on the amount of coal produced by producers. In 2022, the government of Indonesia collected state revenue from the mineral and coal mining sector amounted to IDR 127.90 trillion, exceeding the revenue target plan. During the period of January-April 2023 alone, the Indonesian government received deposits of IDR 55.9 trillion from the mineral and coal mining sector, a 146% increase compared to the same period in 2022. In 2022, the realization of non-tax state revenue (PNBP) for the entire year reached IDR 588.3 trillion, with a significant increase driven by commodity price increases, especially coal (Saria, 2023).

Furthermore, the coal industry provides employment for hundreds of thousands of people in Indonesia, both directly and indirectly. This includes jobs in coal mines, transportation, and related sectors such as construction and services. The coal industry also contributes to infrastructure development and economic growth in mining regions. This includes the construction of roads, healthcare facilities, education, and other public amenities.

The coal sector provides significant revenue to the Indonesian government through taxes and royalties. This revenue is used to finance various government programs and national development. Coal mining activities impact several other sectors in the economy, such as the construction sector, heavy equipment manufacturing, and the services sector. This creates a chain reaction that supports overall economic growth.

According to Saria (2023), coal will remain the primary source of energy in Indonesia for the next 20 years due to its significant potential, with reserves of 35.02 billion tons and resources of 99.19 billion tons as of the end of 2022. Of this total, 54% is medium-calorie coal, 34% is low-calorie coal, 9% is high-calorie coal, and 3% is very high-calorie coal. The latest data on Indonesia's coal reserves for the first semester of 2023 reached 36 billion tons, with resources of 110 billion tons. The composition includes 54.38% medium-calorie coal, 33.93% low-calorie coal, 8.84% high-calorie coal, and 2.85% very high-calorie coal. The majority of these reserves are located in Kalimantan, accounting for 66.97%, and Sumatra, accounting for 33% (Handoko, 2023). On the other hand, the use of environmentally friendly renewable energy is still very low, making coal dominant in energy utilization. However, the role of coal in the future must be adjusted in line with the government's strategy to reduce carbon emissions to achieve the net-zero emissions target by 2060 or earlier.

The new chapter of the transition towards net-zero emissions in Indonesia actually began in 2020. One of the targets and strategies to support this energy transition is the shift from fossil fuel-based energy sources to carbon-free energy sources. Several strategies have been prepared, including energy efficiency from both consumers and suppliers, maximizing the transition from fossil energy to electricity, deploying low-intensity energy and low-emission technologies, as well as optimizing and utilizing domestic energy resources to reduce imports, and providing energy in a cost-effective and low-carbon emissions manner (Handoko, 2023; Rahman et al., 2023).

The concept of coal beneficiation in Indonesia is primarily based on the Mineral and Coal Law No. 3 of 2020 (BPK RI, 2020), which amends Law No. 4 of 2009 (BPK RI, 2009). Article 102 of the Mineral and Coal Law states the obligation to increase the value-added of minerals and coal (Handoko, 2023). The value-added enhancement for coal mining commodities can be achieved through the development and utilization of coal. This obligation is carried out by Special Mining Business Permit holders as a continuation of the Coal Mining Work Agreement to develop and/or utilize coal domestically. This aligns

with Article 169 (paragraph 4). Article 169 (paragraph 5) of the Mineral and Coal Law states that Special Mining Business Permit holders, as a continuation of the operations of Coal Mining Work Agreement holders who have fulfilled the obligations for integrated coal development and utilization according to the approved development plan for the entire agreement area, shall be granted a 10-year extension each time they apply for an extension.

The Mineral and Coal Law's explanation also mentions that coal development includes six aspects: improving coal quality, making coal briquettes, producing coke, liquefying coal, coal gasification, and coal slurry/coal water mixture (Lim et al., 2021). Meanwhile, coal utilization involves self-development of steam power plants at the mouth of the mine.

The government strengthened these beneficiation rules through Government Regulation No. 96 of 2021 concerning the Implementation of Mineral and Coal Mining Business Activities. The obligation for the development and/or utilization of coal domestically by Special Mining Business Permit holders is stipulated in Article 125 and Article 126, consistent with the explanations provided in the Mineral and Coal Law.

A roadmap for coal development and utilization is also included, as shown in Figure 1. The projections are prepared in stages until 2025, followed by a strategic phase from 2026 to 2030, during which coal undergoes gradual optimization through the application of clean coal technology and coal beneficiation, including for steam power plant generation. Looking at the coal beneficiation roadmap, until 2025, the stages involve preparation and the use of Clean Coal Technology (CCT) in coal beneficiation, including for steam power plants (Informant-2). According to data from the Ministry of Energy and Mineral Resources and PT PLN in 2022, there are already 13 coal-fired power plants in operation using CCT, including supercritical and ultrasupercritical boiler technologies. Furthermore, there are currently 12 coal beneficiation projects underway, with most of them in the feasibility study stage.

> *"It can be said that the development and optimization of the coal mining industry is proceeding as planned and not experiencing stagnation. However, it needs to be monitored in the future for ongoing and upcoming projects to ensure they align with the initial plans." (Informant-2).*

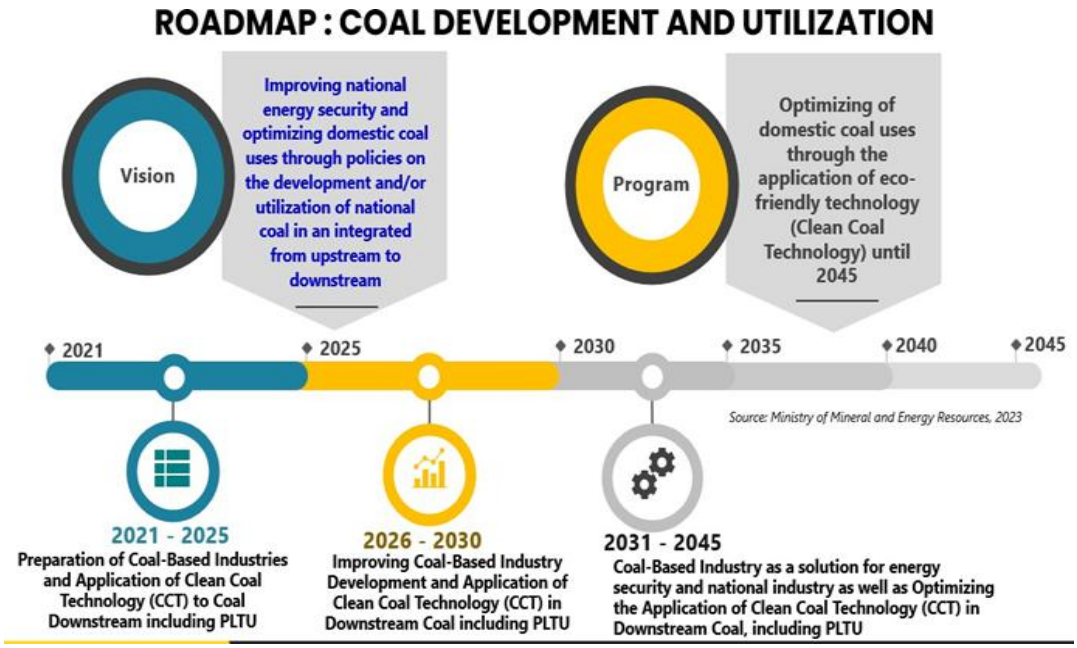



Fig. 2 . Roadmap: Coal development and utilization

### *3.1 Benefits*

Coal is produced through a series of processes, starting from excavation, then separated based on its characteristics and quality per layer, prepared (including washing if necessary), and blended to obtain coal with the desired market quality (Informant-3). Although Indonesia has relatively large overall coal resources and reserves, the country still imports coal, amounting to 8 million tons or equivalent to USD 4.902 million in 2020. The imported coal is predominantly bituminous coal, likely coking coal used in blast furnaces for iron and steel production. In aggregate, Indonesia still maintains a significant surplus from the massive export of coal. The trade balance also includes the value of some basic chemical industrial products, such as ammonium sulfate, ethylene (Handoko, 2023).

Additionally, coal is used as a source of heat and/or reductant in various industries such as the cement, metallurgy, fertilizer, and textile industries. Specifically, for the metallurgy industry, a special type of coal called coking coal is used for iron production in blast furnaces. However, coal utilization (iron making) for the production of basic chemical products like methanol, Dimethyl Ether (DME), ethylene, and propylene or their derivatives is processed through gasification (producing syngas) and liquefaction, which has increased in China (Manullang & Isnarti, 2023).

China, with its vast coal reserves compared to oil and natural gas, is trying to reduce its dependence on imported upstream petrochemical products, which serve as raw materials for many strategic industries like pharmaceuticals, textiles, food, lubricants, and plastics (Zhang et al., 2023). The shift in coal usage towards an alternative raw material for basic chemical products has the potential to create new market opportunities in the global and domestic coal industry. Data from the Central Statistics Agency (BPS) in 2020 showed that Indonesia exported 407 million tons of coal (HS Code: 27011100-27011900 and 27021000-27022000), valued at USD 16.4 billion (equivalent to IDR 238 trillion), which significantly contributed to the country's revenue. Meanwhile, domestic coal consumption reached 132 million tons, with about 80% used for electricity generation by *Perusahaan Listrik Negara* (PLN). The largest consumption of coal today is still in the Coal Fire Power Plants/*Pembangkit Listrik Tenaga Uap* (PLTU) as fuel for electricity generation. In 2016, the government introduced the Domestic Market Obligation (DMO) for coal to ensure domestic needs are met and prioritize coal producers, especiall for coal fire power plants. This policy was fully implemented in 2017. Figure 2 show coal demand forecast 2021-2030 based on *Rencana Usaha Penyediaan Tenaga Listrik* (RUPTL).

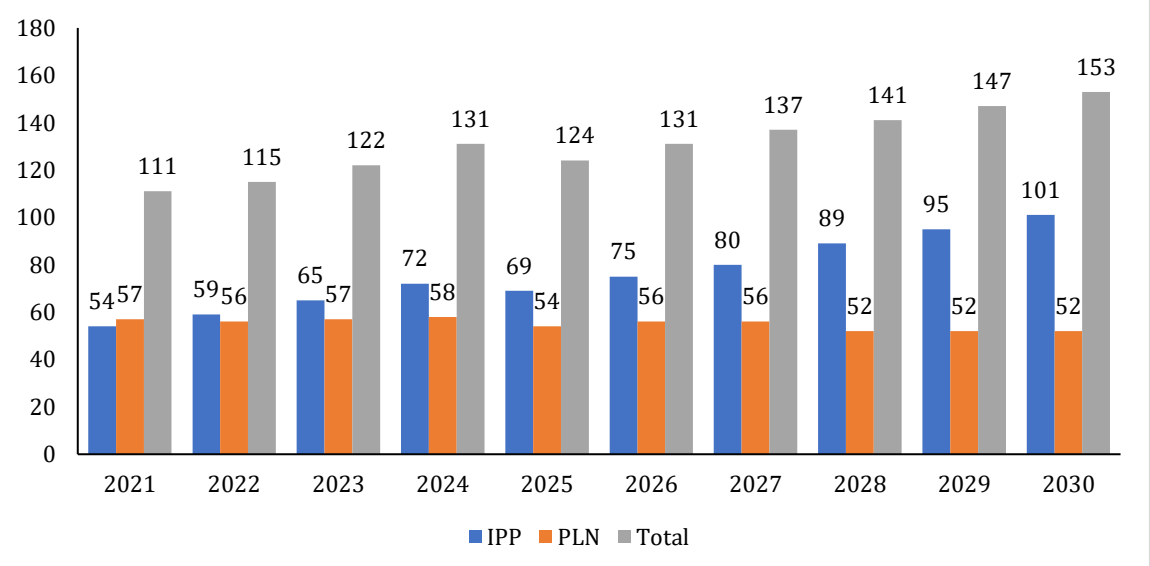



Fig. 3. Coal demand forecats 2021-2030 based on RUPTL (in million ton)
(PLN EPI, 2023)

Another use of coal is as a reductant or heat source to meet industrial and household needs. Additionally, there are coal drying and coal upgrading facilities aimed at reducing the moisture content in coal to increase its calorific value. From a national revenue perspective, coal contributes significantly through royalties, surpassing other mineral mining sectors. As of the 2023 PNBP target, according to Presidential Regulation No. 75 of 2023 on Budget Details for the Fiscal Year 2023, it reached IDR 94.6 trillion by December 11, 2023, exceeding the target of IDR 84.27 trillion (Saria, 2023). This contribution is higher than royalties from nickel, which amounted to IDR 12.79 trillion, copper at IDR 4.3 trillion, and gold at IDR 3.9 trillion. The total non-tax state revenue from the mineral and coal mining sector reached IDR 162.3 trillion, exceeding the target of IDR 146 trillion (Saria, 2023).

Coal also serves national interests by increasing investments, non-tax state revenue, and the added value of coal. It ensures the stability of electricity prices. According to Ministerial Regulation 139.K/HK.02/MEM.B/2022, the special price for coal for Domestic Market Obligation (DMO) is set at USD 70 per ton, guaranteeing stable electricity tariffs for both industries and households. In Indonesia, PLN is the largest consumer of coal for power generation. Based on data from PT PLN Energi Primer Indonesia, as shown in Table 2, coal used for PLN power generation reached 89.94 million tons until the third quarter of 2023. Compared to other energy sources, including renewable energy, coal has a high contribution.

Table 2. Generating electricity and energy mix in 2023 until q3

| Energy | Accumulated Generating (Mwh) | Fuel Volume | Fuel Volume Unit |
|---|---|---|---|
| Fuel Oil | 8,147,137.69 | 2,250,225 | Kiloliter |
| Coal | 159,129,292.29 | 89,838,308 | Ton |
| Gas | 40,274,406.91 | 296,320 | Ton |
| Geothermal | 12,702,754.54 | - | - |
| Hydro | 15,796,553.19 | - | - |
| Others (Solar & Biomass) | 1,517,945.56 | 692,701 (Biomass) | Ton |
| Total | 237,568,090.18 | | |

(PLN EPI, 2023)

The use of coal also impacts lower electricity sales costs per kilowatt-hour (kWh). Table 3 shows a comparison of average prices per kilowatt-hour for various fuel sources. It is evident that coal-generated electricity is relatively inexpensive, averaging IDR 705 per kWh, although hydroelectric power is the cheapest at an average of IDR 432 per kWh, but the development of hydroelectric power plants is costly (PLN EPI, 2023).

Table 3. Fuel cost comparison since 2018-2022 in Rp/Kwh

| Year | Hydroelectric Power Plant | Coalfire Power Plant | Diesel Power Plant | Gas Power Plant | Geothermal Power Plant | Steam Gas Power Plant | Solar Power Plant |
|---|---|---|---|---|---|---|---|
| 2018 | 352.39 | 831.46 | 2,228.71 | 5,781.99 | 2,350.98 | 1,298.72 | - |
| 2019 | 599.71 | 653.12 | 3,308.26 | 2,570.03 | 1,191.25 | 1,357.75 | - |
| 2020 | 43857 | 636.55 | 4,746.32 | 1,611.79 | 1,107.89 | 1,322.23 | 11,817.73 |
| 2021 | 3,988.28 | 667.88 | 5,905.80 | 1,247.92 | 107.15 | 126.09 | 1,284.44 |
| 2022 | 373.22 | 737.52 | 5,978.77 | 1,837.37 | 118.74 | 143.97 | 1,034.52 |
| Average | 432 | 705 | 4,434 | 2,610 | 2,610 | 850 | 4,712 |
| Total | 237,568,090.18 | | | | | | |

(PLN EPI, 2023)

The special DMO price for general electricity and industries such as fertilizer, cement, etc., aims to enhance the competitiveness of domestic industries by reducing production costs for products using coal as a fuel (Rosdyiad & Adachi, 2018). According to Ministerial Decree No. 58K/HK.02/MEMB/2022, the electricity selling price for industries outside of smelters is set at USD 90, which has a stabilizing impact on the selling prices of products produced using coal as fuel, such as cement, fertilizer, chemicals, textiles, etc. (Saria, 2023).

Coal also has a positive impact on community empowerment and development, in line with Ministerial Regulation of Energy and Mineral Resources No. 1824 K/30/MEM 2018 on Guidelines for Community Development and Empowerment. This includes aspects such as education, socio-cultural development, healthcare, economic self-reliance, real income or employment, community participation in sustainable environmental management, the formation of community institutions to support empowerment and development, and infrastructure supporting community empowerment and development (Muttitt et al., 2023; Saria, 2023).

According to Informant-7, the position of coal is very strategic because it plays a significant role in the state budget. Coal's contribution to the mining sector, particularly from coal, is substantial. Therefore, coal is of great strategic importance.

> *"The mandate of the Constitution, Article 33, should be carefully considered. It has been stipulated that the earth and its natural wealth belong to the people and should not remain unused beneath the earth's surface. Instead of hoarding it, it's better to use it. Over time, technology becomes more affordable. But if it's kept unused from the beginning, it's a waste. So, let's not waste what has been given to us. Many other countries envy Indonesia." (Informant-7).*

> Informant 3 said*, "Coal is a gift and blessing from God in abundance, so it must be used. In any way possible, it must be consumed. Coal should not be opposed, but the elements within it (emissions) should be captured."*

### *3.2 Challenges*

Unlike minerals, coal beneficiation is not an easy task (Informant-5). Large-scale coal beneficiation began when the government made it mandatory for Special Mining Business Permit holders as an extension of the Coal Mining Work Agreement to integrate coal beneficiation. Considering the significant foreign exchange (devisa) required for LPG imports, the Minister of Energy and Mineral Resources at that time wisely considered substitution through Dimethyl Ether (DME) as a direction for coal beneficiation. This decision was not only about securing foreign exchange but also related to investment value, job creation, and the optimal value for the government (ESDM), which is technically responsible for managing natural resources, including coal.

> *"However, the implementation of this is not easy, as it requires aligning technology selection, funding, and economic viability while balancing business interests and future energy resilience. From a technological standpoint, it must be acknowledged that Indonesia does not yet have processing and purification technology, let alone in-depth manufacturing and technological research in coal beneficiation. Without strengthening research and building manufacturing capabilities for coal beneficiation technology, it is certain that we will incur significant costs due to the consequences."* (Informant-5)

For certain reasons, Air Products and Chemicals Inc ultimately withdrew from the Dimethyl Ether (DME) project in Indonesia. This resulted in the plan to reduce the country's foreign exchange expenditure on LPG imports by producing DME domestically

and diversifying energy by the coal mining industry not proceeding as scheduled by the government.

> *"Considering that the goal of coal beneficiation should not be assessed solely on commercial aspects but as a strategic step to support energy resilience, independence, and the future supply chain of the petrochemical industry in Indonesia, solutions related to the project's economics, technology, and other aspects related to the DME project should be openly discussed between the government and the mandatory Special Mining Business Permit holders. Since legally, this mandate has been incorporated into the law, the intersection of government and investor interests should be discussed openly, considering various constraints on the DME project" (Informant-5)*

Currently, there is a perception of stagnation in the development of coal beneficiation. According to Informant 5, companies holding Special Mining Business Permits operate in the mining industry, which is vastly different from the chemical industry that develops DME (Dimethyl Ether). Moreover, investments in coal beneficiation, particularly DME, can exceed USD 2 billion.

> *"Mining companies will calculate separately from their mining business."* (Informant-5).

Even though the Job Creation Law *(UU Cipta Kerja)* has simplified matters by reducing royalties to 0% for coal used in beneficiation, it may still be perceived as insufficient (Informant-5).

However, the Job Creation Law mandates that this be implemented when Special Mining Business Permits are already operational. For owners of Special Mining Business Permits, the first 10 years of operating a mine involve projections of how large the production plan (RKAB) will be and how significant the profits will be.

> *"Furthermore, the projection of the future coal business (especially the export market) in terms of both market size and price will be established. This requires considering both the market and price aspects."* (Informant-5)

Therefore, beneficiation is not considered in relation to the mining industry when calculating investment value, human resources, and even efforts to obtain banking syndications to finance the project. The choice of technology, economics, projections of LPG import prices, and DME cost production must be carefully considered. However, it all comes down to the coal feedstock owned by the miners.

> *"In this situation, I believe that entering the DME project, although it is mandatory, demands ease of fiscal and non-fiscal policies on both the upstream (mining) and downstream (DME plant) sides, as well as in the market. This is reasonable for miners to realize a project worth over USD 2 billion. Since some Special Mining Business Permits have already been issued, and the mining operation phase of Special Mining Business Permits has begun, the projection itself is still in the feasibility study phase. Therefore, translating integration as required by the law must be a negotiation space between miners and the government (ESDM) to make it clear. The reason is that chemical industry projects are very different from mining industry projects. Calculations and commodity markets are different, so miners, although aware of the mandate, will seek a safe approach to executing a project worth over 2 billion US Dollars."* (Informant-5).

Compared to coal beneficiation projects in other countries, it's not just about economic calculations. There is a direction to prepare and realize energy sovereignty through currently utilizable technology.

*"For example, Sasol in South Africa was driven by the oil embargo in 1973, even though coal beneficiation research had been conducted well before that by South Africa."* (Informant-3).

Many countries have undertaken DME projects from natural gas and biomass, rather than coal. However, China has long focused on coal-based DME projects. India also directly operates DME projects through Coal India Limited (CIL) and Bharat Petroleum Corporation Limited (BPCL). South Africa has done the same with Sasol's project in Secunda.

> *"In 2027, worldwide, DME from coal accounts for almost a third, compared to DME from natural gas and biomass. Simultaneously, the global DME market grows by 10.1%, from 4.2 billion US Dollars to 9.98 billion US Dollars by 2030. Looking at the DME demand map, the Asia-Pacific region will become the world's largest DME market,"* (Informant-5).

The use and utilization of coal face many challenges. Informant-6 states that the challenge of coal beneficiation lies in expensive and unproven technology that is imposed on miners who do not have the ability to market the beneficiation products.

> *"Experts in mining should not be forced into other areas."* (Informant-6).

The main challenge in using coal is its environmental impact, given that coal is a significant source of $CO_2$ emissions. The use of clean coal technology in coal-fired power plants not only reduces emissions but also improves energy efficiency (Informant-2).

On the other hand, clean coal technology can also be applied to other coal beneficiation projects. Clean coal technology that can be used for optimizing coal utilization includes Carbon Capture and Storage (CCS)/Carbon Capture, Utilization, and Storage (CCUS) technology, Integrated Gasification Combined Cycle (IGCC), and the co-firing of biomass in coal-fired power plants (Informant-2).

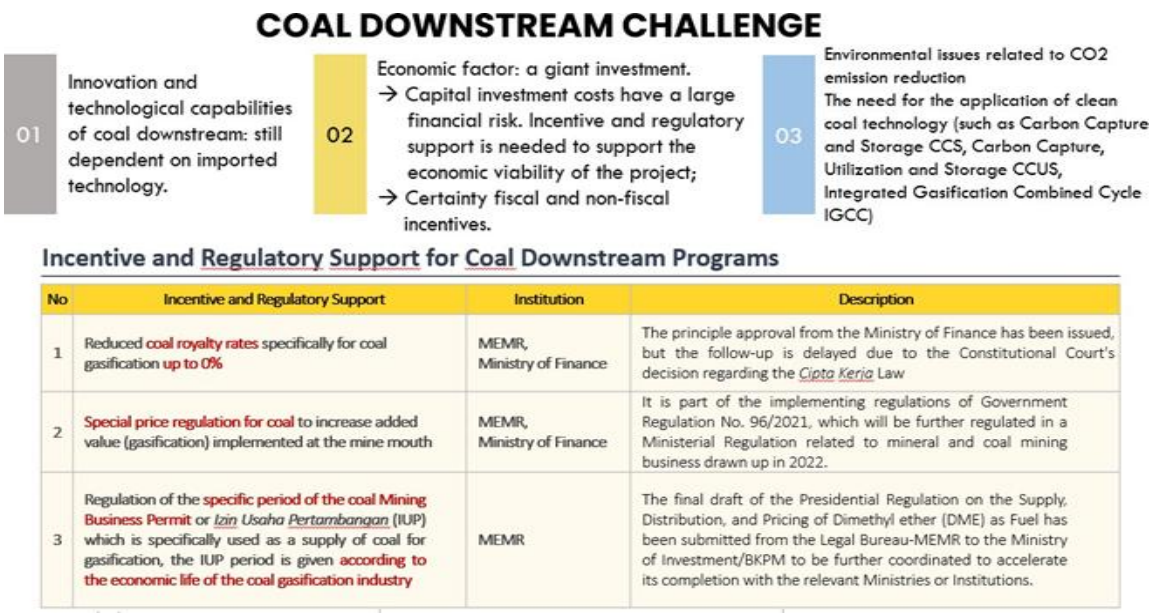
Economic factors are the main challenge in coal beneficiation because converting coal into other forms like petrochemicals, gas, etc., requires expensive technology investments. The products produced also require off-takers, parties that buy the coal conversion products. Not many countries have succeeded in converting coal into gas.

> *"Additionally, funding for coal-based projects is becoming increasingly difficult to obtain."* (Informant-1).

Coal conversion technology in Indonesia is also considered not yet mastered, and the technology is expensive. Funding is also difficult to secure, and finding off-takers is not easy. In the case of coal gasification to produce DME, the issue of selling price is one of the most critical factors.

> *"Regulatory consistency, considering that coal beneficiation/conversion projects are long-term in nature, is also very important."* (Informant-1).

Informant 2 also acknowledges several challenges in the implementation of coal beneficiation. Three key points are noted: technology and innovation related to coal beneficiation still depend on technology imported from other countries, the required capital investment has significant financial risks, and environmental issues, especially related to $CO_2$ gas emissions. Fig. 4 shows the challenges in coal downstreaming.




| No | Incentive and Regulatory Support | Institution | Description |
|---|---|---|---|
| 1 | Reduced coal royalty rates specifically for coal gasification up to 0% | MEMR, Ministry of Finance | The principle approval from the Ministry of Finance has been issued, but the follow-up is delayed due to the Constitutional Court's decision regarding the *Cipta Kerja* Law |
| 2 | Special price regulation for coal to increase added value (gasification) implemented at the mine mouth | MEMR, Ministry of Finance | It is part of the implementing regulations of Government Regulation No. 96/2021, which will be further regulated in a Ministerial Regulation related to mineral and coal mining business drawn up in 2022. |
| 3 | Regulation of the specific period of the coal Mining Business Permit or *Izin Usaha Pertambangan* (IUP) which is specifically used as a supply of coal for gasification, the IUP period is given according to the economic life of the coal gasification industry | MEMR | The final draft of the Presidential Regulation on the Supply, Distribution, and Pricing of Dimethyl ether (DME) as Fuel has been submitted from the Legal Bureau-MEMR to the Ministry of Investment/BKPM to be further coordinated to accelerate its completion with the relevant Ministries or Institutions. |

Fig. 4. Coal downstream challenge
(Informant-2, 2023)

The government is not idle in this regard, according to Informant-2. This is evident from the provision of several incentives for companies committed to coal downstreaming, including a special coal royalty tariff reduction for coal gasification to 0%, setting coal prices specifically to enhance the added value from coal gasification at the mine mouth, and the duration of the Special Coal Mining Business License for coal gasification is granted based on the economic life of the coal gasification industry. However, these incentives, in practice, are not sufficient to promote coal downstreaming in the country. Coal business stakeholders state that the implementation of coal downstreaming still requires various forms of support, both regulatory strengthening and fiscal and non-fiscal incentives, to make coal downstreaming projects financially attractive. There is a need for other forms of support such as tax incentives, import duty exemptions for raw materials and spare parts, easier access to financing from banks, off-taker certainty (buyers), and more (Informant-2).

### *3.3 Solutions*

Development in coal downstreaming is relatively not easy. There are many proposals to utilize coal optimally for the welfare of the people and increase state revenues without neglecting environmental aspects (Rosyid & Adachi, 2018). Informant-6 proposes that mining companies should be facilitated to collaborate with downstream companies or energy generation companies. Additionally, the government should provide even greater incentives to encourage coal downstreaming.

> *"The government should not give the impression of abandoning the coal commodity because this will make the financial sector uninterested in financing coal and downstreaming projects."* (Informant-6).

Support from stakeholders to make investments in coal downstreaming economically viable is also required. This includes supportive regulations, the presence of offtakers, competitive selling prices, long-term regulatory support, funding support, and more.

> *"Not many countries implement coal gasification projects due to economic factors."* (Informant-1).

According to Saria (2023), to anticipate global threats to coal, its future use must be balanced with environmentally friendly technology (Clean Coal Technology) to reduce $CO_2$ emissions and make coal a more environmentally friendly energy source. The government has already provided incentives for businesses planning to engage in coal downstreaming.

Other solutions come from officials in the Ministry of Energy and Mineral Resources. Several solutions can be applied to address the challenges of coal downstreaming. First, the use of Clean Coal Technology to meet the needs of coal downstreaming projects without causing environmental issues. Second, not building new coal-fired power plants, especially on Java Island. Third, technology transfer related to coal downstreaming from advanced countries. Fourth, to address the economic aspects of coal downstreaming projects, the government provides three incentives for companies committed to coal downstreaming, including (1) reducing coal royalty tariffs for coal gasification to 0%, (2) setting coal prices specifically for increasing value-added (gasification) carried out at the mouth of the mine, and (3) granting a coal mining IUP for gasification according to the economic life of the coal gasification industry. Fifth, the implementation of carbon pricing policies in Indonesia.

Informant-5 states that Indonesia's coal reserves of 36 billion tons are a blessing. Humans are empowered by their thoughts and intelligence. Therefore, blaming coal is entirely wrong.

> *"What needs to be built is how to reduce the negative impacts of coal usage through technology. It must be acknowledged that land clearing for mining and coal usage are directly related to environmental issues (emissions, carbon, methane, etc.)."* (Informant-5).

With this condition, to optimize coal utilization, mining companies should think not only in the mining area (upstream) but also downstream in the utilization area, especially for the largest users, namely coal-fired power plants. Various emission-reduction technologies such as CCUS should not only be the concern of PLN but should also be taken seriously by the coal mining industry. Various direct research on CCUS or CCUS research funding should be part of the coal mining industry's responsibility for energy transition. The results should strengthen the coal mining industry to extend the mining production life and optimize resources, even elevating resources to reserves (Informant-5).

Another solution is suggested by Informant-4, namely: First, the Government, with the support of the House of Representatives, must establish clear and firm regulations related to environmentally friendly coal utilization, both for electricity and non-electric energy needs. These regulations could be in the form of amendments to the Mining Law, Energy Law, Electricity Law, or could be included in the New Renewable Energy Bill. Second, there is a need to develop environmentally friendly coal conversion technology through collaboration with universities and research institutions to produce better technology. Third, continuous techno-economic studies related to coal conversion as secondary and tertiary energy are needed to fulfill the energy trilemma: availability, affordability, and environmental sustainability. Fourth, the government should provide attractive incentives for the private sector that has proven capable of developing environmentally friendly coal.

As for recommendations, Informant-7 said that considering the significant potential, it should be considered whether we can use coal beyond 2060 because coal plays an important role. The cost of energy transition is substantial, and we must carefully consider it so as not to burden future generations with excessive debt. The energy transition of coal-fired power plants should focus on improving quality and gradually reducing emissions. The issue lies in carbon, not coal itself. Many people benefit from coal, including communities around mining areas.

> "*The government should consider both short-term and long-term programs for the clean use of coal in power plants while gradually transitioning to renewable energy. In*

*essence, it's about clean coal. If possible, the government should consider reducing emissions in this context. It's essential not to burden the state's finances and not to rush the transition, allowing us to make the most of what we have. We should strive to leave a clean environment for our future generations."* (Informant-7).

Another solution is that banks should make it easier to provide loans to the coal industry. Additionally, government incentives should be made even more attractive.

*"When coal prices are very high, taxes and fees from large coal companies are requested to be even larger, which benefits the government."* (Informant-3).

## 4. Conclusions

The downstreaming of coal in Indonesia faces various challenges that slow down its progress. Despite the government providing incentives, several factors such as financial constraints, technological complexity, and unclear regulations remain major obstacles. Facilitating collaboration between mining companies and downstream or energy production companies is necessary to enhance coal utilization efficiency. Furthermore, there is a need for even more substantial incentives to drive coal downstreaming, and it is crucial for the government to demonstrate commitment to the coal commodity to attract financial support for downstreaming projects. Sustained technical and economic studies regarding coal conversion as secondary and tertiary energy sources are essential to meet the three energy aspects: availability, affordability, and environmental sustainability.

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