

Analyzing the LCOE of Suralaya Coal-Fired Power Plant under Coal DMO and Market Price Scenarios

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Abstract

Coal-fired power plants remain an important part of Indonesia's electricity system because they provide large-scale and reliable baseload supply. However, the perceived low cost of coal-fired electricity is partly influenced by domestic coal pricing policy, particularly the Domestic Market Obligation (DMO) scheme. This study aims to estimate and compare the Levelized Cost of Electricity (LCOE) of the Suralaya coal-fired power plant under two coal price scenarios: the DMO price and the market price. A quantitative case study approach was applied using 2024 operational and financial data. The LCOE was calculated using an annualized cost approach by combining annualized capital cost, operation and maintenance cost, and fuel cost, then dividing total annual cost by annual net electricity generation. The results show that the LCOE based on the DMO coal price is IDR 1,008.58/kWh, while the LCOE based on the market price is IDR 1,049.52/kWh. The use of market price increases the LCOE by IDR 40.94/kWh, or 4.06%, compared with the DMO scenario. These findings indicate that coal pricing assumptions affect the financial interpretation of coal-fired power generation costs. Therefore, generation cost assessment should clearly distinguish between actual financial cost under domestic pricing policy and economic cost based on market price.

INTRODUCTION

The electricity sector is an essential input for economic activities because electricity supports households, industries, services, and public-sector operations. In Indonesia, electricity supply remains highly dependent on coal-fired power plants. Coal continues to play a dominant role in the national electricity mix and the broader Southeast Asian energy system (ASEAN Centre for Energy, 2023; IEA, 2023). In Indonesia, coal accounted for approximately 69% of electricity generation in 2023 (IEA, 2024). This condition indicates that coal-fired power plants still have a strategic role in maintaining electricity supply reliability, particularly as baseload generators in the national power system (Smith 2019; Zhang *et al.* 2020; Bugarić dan Biserčić 2021). In Indonesia's electricity planning framework, existing coal-fired power plants remain important assets that need to be managed within the context of system reliability and energy transition (PT PLN, 2021).

The continued role of coal-fired power generation is closely related to the perception that coal-based electricity is relatively inexpensive compared with other generation technologies (Shao *et al.* 2024). This perception is commonly based on financial cost indicators such as the *Levelized Cost of Electricity* (LCOE). LCOE is widely used to measure the average cost of electricity generation per unit of electricity produced over the economic life of a power

plant. It considers capital cost, operation and maintenance cost, fuel cost, discount rate, economic lifetime, and electricity generation (IEA, 2020; IRENA, 2024; Kabeyi & Olanrewaju, 2023). However, LCOE is highly dependent on the assumptions used, especially for thermal power plants, where fuel cost is one of the most important cost components (Robalo-Cabrera et al., 2025).

For coal-fired power plants, fuel price is a key determinant of generation cost. A higher coal price directly increases fuel cost and consequently affects the LCOE. In Indonesia, coal prices for the electricity sector are influenced by the *Domestic Market Obligation* (DMO) policy. This policy allows coal prices for power generation to differ from market prices. As a result, DMO-based generation cost can appear lower than the cost that would be obtained if coal were valued using market prices (Kementerian ESDM, 2020; Institute for Essential Services Reform, 2024). Therefore, the low financial cost of coal-fired electricity should be interpreted carefully because it is partly shaped by domestic energy pricing policy (Karkour et al., 2020; Wang et al., 2020).

The difference between the DMO price and the market price is important because both represent different cost perspectives. The DMO price reflects the actual financial cost paid by the power plant under domestic pricing policy. In contrast, the market price can be interpreted as a proxy for the *opportunity cost* of coal, namely the economic value of coal if it is traded or allocated according to market conditions. In natural resource economics, *opportunity cost* is relevant for assessing the economic value of a resource when alternative uses or market-based allocation exist (Tietenberg & Lewis, 2016). Therefore, using DMO and market prices in the LCOE calculation may produce different interpretations of coal-fired power plant economics. This study uses the Suralaya coal-fired power plant as a case study because it is one of the largest coal-fired power plant complexes in Indonesia and plays an important role in the Java–Bali electricity system. Based on the research data, PLTU Suralaya has an installed capacity of 4,025 MW and generated 17,079,480,984 kWh of net electricity in 2024, with annual coal consumption of 11,244,829 tons (PT PLN, 2024). Given its large generation scale, changes in coal price assumptions are relevant because they can affect the estimated generation cost per kWh. The use of 2024 operational and financial data also allows this study to reflect recent operating conditions.

Despite the importance of this distinction, most existing studies on Indonesian coal-fired power generation costs either implicitly accept DMO-based fuel costs or do not explicitly compare the two pricing scenarios. Previous research has focused on the technical and financial feasibility of new power plants, the impact of coal pricing on electricity tariffs, or the broader energy transition outlook (Rokhmawati et al., 2023; Sugiyono et al., 2024; Institute for Essential Services Reform, 2024). However, a systematic comparison of LCOE for an existing large-scale coal-fired power plant under DMO versus market coal prices remains limited. This gap is particularly relevant given the recent volatility in global coal prices and ongoing policy debates about coal subsidy reform and carbon pricing.

This study addresses that gap by using the Suralaya coal-fired power plant as a case study. Suralaya is one of the largest coal-fired power plant complexes in Indonesia and plays a pivotal role in the Java–Bali electricity system. Based on 2024 operational data, PLTU Suralaya has an installed capacity of 4,025 MW, generated 17,079,480,984 kWh of net electricity, and

consumed 11,244,829 tons of coal (PT PLN, 2024). Its large scale makes it an ideal case for examining how coal price assumptions affect generation cost estimates.

Based on this background, this study aims to estimate and compare the LCOE of the Suralaya coal-fired power plant under two coal price scenarios: the DMO price and the market price. The main contribution of this study is to distinguish between the actual financial generation cost under the DMO policy and the economic generation cost based on market coal pricing. This distinction is expected to support a clearer interpretation of coal-fired power generation costs and the role of domestic coal pricing policy in electricity cost assessment.

RESEARCH METHOD

This study applied a quantitative descriptive approach using a case study of the Suralaya coal-fired power plant. The method was used to calculate and compare the *Levelized Cost of Electricity* (LCOE) under two coal price scenarios: the *Domestic Market Obligation* (DMO) price and the market price. The comparison is intended to examine how different coal price assumptions affect the estimated electricity generation cost per kWh. Therefore, this study does not evaluate the financial feasibility of a new power plant project, but estimates the average generation cost of an existing power plant based on operational and financial data.

The object of this study is the Suralaya coal-fired power plant located in Banten Province, Indonesia. The analysis uses 2024 data because this period provides recent and internally consistent operational and financial information. The main data used in this study include annual net electricity generation, annual coal consumption, operation and maintenance cost, capital value, discount rate, economic lifetime, DMO coal price, and market coal price. Annual net electricity generation is used as the denominator in the LCOE calculation, while annual coal consumption and coal price are used to estimate annual fuel cost.

Based on the research data, the Suralaya coal-fired power plant generated 17,079,480,984 kWh of net electricity in 2024. Annual coal consumption reached 11,244,829 tons, with a *specific coal consumption* of 0.658 kg/kWh. The plant recorded 5,356 operating hours and a capacity factor of 48.44% (PT PLN, 2024). These operational parameters are summarized in Table 1.

Table 1. Operational Data of Suralaya Coal-Fired Power Plant in 2024

No	Parameter	Unit	Value
1	Net Electricity Generation	kWh/year	17.079.480.984
2	Coal Consumption	tons/year	11.244.829
3	Specific coal consumption	kg/kWh	0,658
4	Operating Hours	hours/year	5.356
5	Capacity Factor	%	48,44

Source: PT PLN (2024)

The LCOE in this study is calculated using an *annualized LCOE* formulation. This approach is selected because the available data are annual cost and annual electricity generation data. In this approach, the capital value is annualized using the *capital recovery factor* (CRF), then added to annual operation and maintenance cost and annual fuel cost. The total annual cost is then divided by annual net electricity generation. The LCOE is formulated as follows:

$$LCOE = \frac{(I \times CRF) + O\&M + FC}{E} \quad (1)$$

where $LCOE$ is the *Levelized Cost of Electricity* (IDR/kWh), I is the capital value used in the analysis (IDR), CRF is the *capital recovery factor*, $O\&M$ is annual operation and maintenance cost (IDR/year), FC is annual fuel cost (IDR/year), and E is annual net electricity generation (kWh/year).

The *capital recovery factor* is calculated using Eq. (2):

$$CRF = \frac{r(1+r)^n}{(1+r)^n - 1} \quad (2)$$

where r is the discount rate and n is the economic lifetime or analysis horizon of the power plant. In this study, r is used as the discount rate to annualize capital cost through the CRF. The use of discount rate is important in generation cost modeling because the cost of capital can influence the estimated economics of power generation (Steffen, 2020). The discount rate used in this study is 5.96%, while the analysis horizon is 40 years. Based on these parameters, the CRF used in this study is 0.06613.

The capital value used in the calculation is IDR 56,047,282,168,242. With a CRF of 0.06613, the annualized capital cost is IDR 3,706,226,686,748 per year. Annual operation and maintenance cost is IDR 1,060,820,598,803 per year. These parameters are kept constant in both scenarios so that the difference in LCOE mainly reflects the change in fuel cost. The general parameters used in the LCOE calculation are presented in Table 2.

Table 2. General Parameters for LCOE Calculation

No	Parameter	Unit	Nilai
1	Capital value (I)	IDR	56.047.282.168.242
2	Discount rate (r)	%	5,96
3	Economic lifetime / Analysis horizon (n)	Years	40
4	Capital recovery factor (CRF)	-	0,06613
5	Annualized capital cost ($I \times CRF$)	Rp/tahun	3.706.226.686.748
6	Annual operation and maintenance cost ($O\&M$)	Rp/tahun	1.060.820.598.803
7	Annual net electricity generation (E)	kWh/tahun	17.079.480.984

Source: PT PLN (2024)

The calculation is conducted under two scenarios. The first scenario is the LCOE based on the DMO coal price. This scenario represents the actual financial cost paid by the power plant under the domestic coal pricing policy. The formulation is as follows:

$$LCOE_{DMO} = \frac{(I \times CRF) + O\&M + FC_{DMO}}{E} \quad (3)$$

where $LCOE_{DMO}$ is the LCOE based on the DMO coal price (IDR/kWh), and FC_{DMO} is the annual fuel cost based on the DMO price (IDR/year).

The second scenario is the LCOE based on the market coal price. This scenario represents the generation cost when coal is valued using the market price as a *shadow price* or proxy for *opportunity cost*. The formulation is as follows:

$$LCOE_{Pasar} = \frac{(I \times CRF) + O\&M + FC_{Pasar}}{E} \quad (4)$$

where $LCOE_{Market}$ is the LCOE based on the market coal price (IDR/kWh), and FC_{Market} is the annual fuel cost based on the market coal price (IDR/year).

In this study, the calculation structure for both scenarios is the same. The main difference lies in the fuel cost component, namely FC_{DMO} for the DMO scenario and FC_{Market} for the market price scenario. Under the DMO scenario, the annual fuel cost is IDR 12,458,912,043,845. Under the market price scenario, the coal market price used is IDR 1,170,157/ton. With annual coal consumption of 11,244,829 tons, the annual fuel cost based on the market price is IDR 13,158,220,870,953. The coal market price used in this study is an adjusted value representing coal quality between the official HBA I and HBA II categories issued by the Ministry of Energy and Mineral Resources (Kementerian ESDM, 2024). The fuel cost scenarios are summarized in Table 3.

Table 3. Fuel Cost Scenarios in the LCOE Calculation

No	Component	Unit	Scenario DMO	Scenario Market Price
1	Annual coal consumption	tons/year	11.244.829	11.244.829
2	Annual fuel cost	IDR/year	12.458.912.043.845	13.158.220.870.953
3	Price basis	-	DMO price	Market price/shadow price
4	Interpretation	-	Actual financial cost	Economic fuel cost

Source: PT PLN (2024), Kementerian ESDM (2024)

The analysis is carried out in four steps. First, the annualized capital cost is calculated from the capital value using the CRF. Second, annual fuel cost is calculated under both the DMO and market price scenarios. Third, the LCOE for each scenario is calculated by adding annualized capital cost, operation and maintenance cost, and fuel cost, then dividing the total by annual net electricity generation. Fourth, the two LCOE values are compared to estimate the cost difference in IDR/kWh and the percentage increase caused by using the market coal price.

The LCOE difference is calculated using Eq. (5):

$$\Delta LCOE = LCOE_{Pasar} - LCOE_{DMO} \quad (5)$$

The percentage change in LCOE is calculated using Eq. (6):

$$\% \Delta LCOE = \frac{LCOE_{Pasar} - LCOE_{DMO}}{LCOE_{DMO}} \times 100\% \quad (6)$$

Through this method, the study shows how the coal DMO pricing policy affects the

interpretation of electricity generation cost at the Suralaya coal-fired power plant. The results should not be interpreted as an estimate of social cost or environmental valuation, but as a comparison of financial generation cost under two different fuel price assumptions.

RESULTS AND DISCUSSION

The LCOE calculation shows that different coal price assumptions produce different electricity generation costs for the Suralaya coal-fired power plant. In this study, all cost components other than fuel cost are kept constant in both scenarios. Therefore, the difference between the DMO-based LCOE and the market-price-based LCOE reflects the effect of changing the coal price basis, rather than changes in technical or financial parameters.

The results of the two scenarios are presented in Table 4. Table 4 shows that the difference in annual fuel cost changes the total annual cost and the final LCOE, while annualized capital cost, operation and maintenance cost, coal consumption, and annual net electricity generation remain constant across both scenarios.

Table 4. LCOE Calculation of Suralaya Coal-Fired Power Plant under DMO and Market Price Scenarios

No	Component	Unit	DMO Scenario	Market Price Scenario
			56,047,282,168,2	
1	Capital value	IDR	42	56,047,282,168,242
2	Discount rate	%	5.96	5.96
3	Economic lifetime / analysis horizon	years	40	40
4	Capital recovery factor (CRF)	-	0.06613	0.06613
5	Annualized capital cost	IDR/yea r	3,706,226,686,74 8	3,706,226,686,748
6	Annual operation and maintenance cost	IDR/yea r	1,060,820,598,80 3	1,060,820,598,803
7	Annual coal consumption	tons/year	11,244,829	11,244,829
8	Annual fuel cost	IDR/yea r	12,458,912,043,8 45	13,158,220,870,953
9	Total annual cost	IDR/yea r	17,225,959,329,3 96	17,925,268,156,504
10	Annual net electricity generation	kWh/yea r	17,079,480,984	17,079,480,984
11	LCOE	IDR/kW h	1,008.58	1,049.52

Source: PT PLN (2024), Kementerian ESDM (2024)

Based on Table 4, the DMO-based LCOE of the Suralaya coal-fired power plant is IDR 1,008.58/kWh, or approximately IDR 1,009/kWh. This value represents the actual financial generation cost under the domestic coal pricing policy. In this interpretation, the DMO-based LCOE reflects the cost faced by the power plant when fuel cost follows the domestic pricing arrangement. Therefore, this value is relevant for assessing the private financial cost of generation under the current policy framework.

Meanwhile, the market-price-based LCOE is IDR 1,049.52/kWh, or approximately IDR 1,050/kWh. This value represents the generation cost when coal is valued using the market price as a *shadow price* or proxy for *opportunity cost*. Under this interpretation, coal is not only viewed as an input purchased under a domestic price policy, but also as an energy commodity with an alternative economic value in the market. Therefore, the market-price-based LCOE is more suitable for interpreting the economic cost of fuel use, rather than the actual financial cost paid by the power plant.

The comparison between the two scenarios indicates that the use of market coal price increases the LCOE by IDR 40.94/kWh compared with the DMO scenario. In relative terms, this increase is equivalent to 4.06%. In addition, the use of market coal price increases annual fuel cost by IDR 699,308,827,108. Since annualized capital cost, operation and maintenance cost, and annual net electricity generation remain unchanged across the two scenarios, the entire difference in total annual cost is driven by the fuel cost component. The summary of the LCOE difference is presented in Table 5.

Table 5. Comparison of LCOE between DMO and Market Price Scenarios for Suralaya Coal-Fired

No	Indicator	Unit	Value
1	LCOE based on DMO price	IDR/kWh	1,008.58
2	LCOE based on market price	IDR/kWh	1,049.52
3	LCOE difference	IDR/kWh	40.94
4	LCOE increase	%	4.06
5	Additional annual fuel cost	IDR/year	699,308,827,108

Source: PT PLN (2024), Kementerian ESDM (2024),

Table 5 shows that the market price scenario increases the LCOE of the Suralaya coal-fired power plant by IDR 40.94/kWh, or 4.06%, compared with the DMO scenario. The increase comes from the additional annual fuel cost of IDR 699,308,827,108, while the other cost components are held constant. Thus, the LCOE difference directly reflects the effect of changing the coal price basis on electricity generation cost.

These findings show that coal price is an important parameter in the LCOE of coal-fired power generation. The DMO-based LCOE of IDR 1,008.58/kWh represents the actual financial cost under the domestic pricing policy, while the market-price-based LCOE of IDR 1,049.52/kWh represents the generation cost when coal is valued based on its economic or *opportunity cost*. Therefore, these two values have different interpretative functions and should not be used interchangeably without clearly stating the fuel price assumption. The importance of transparent cost assumptions is consistent with LCOE studies on other power generation technologies, which show that cost per kWh is strongly influenced by cost structure, technological assumptions, and financial parameters (Ahm Ahmad Ludin et al., 2021; Song et al., 2024).

In the context of energy policy, the findings indicate that the DMO policy helps limit the exposure of coal-fired power generation costs to market coal price increases. This policy can keep the financial cost of coal-fired electricity lower than it would be under market-based coal pricing. However, the use of DMO price can also make coal-fired electricity appear less costly than when coal is valued using market price. Therefore, the economic assessment of

coal-fired power plants should explicitly distinguish between actual financial cost under policy intervention and economic cost based on market price. For coal-fired power plants, this distinction is important because fuel and operation cost components can determine the relative economic position of coal generation compared with other technologies (Yuan et al., 2021).

The results are consistent with the view that LCOE is highly sensitive to technical and financial assumptions, particularly fuel cost in fossil fuel-based power plants (IEA, 2020; IRENA, 2024; Kabeyi & Olanrewaju, 2023; Robalo-Cabrera et al., 2025). The findings are also in line with Rokhmawati et al. (2023), who show that the economic assessment of coal-fired power plants in Indonesia is sensitive to the cost structure used. Furthermore, Institute for Essential Services Reform (2024) argues that domestic coal pricing policy can make coal-fired power plant operating costs appear lower than under market price assumptions. In the case of the Suralaya coal-fired power plant, this difference is reflected in the 4.06% increase in LCOE when market price is used. In the Indonesian context, Sugiyono et al. (2024) also show that the interpretation of generation cost in the transition from coal to solar power is influenced by the analysis horizon and cost structure. In addition, Woo et al. (2023) show that investment decisions related to coal-fired power plant supporting infrastructure should be assessed through economic cost-benefit considerations, indicating the importance of transparent cost structure in generation cost analysis.

Nevertheless, the results of this study should be interpreted within its scope. First, the analysis is conducted only for the Suralaya coal-fired power plant, so the results cannot be directly generalized to all coal-fired power plants in Indonesia without adjusting technical and cost parameters. Second, the 40-year economic lifetime is used as an aggregate analysis horizon, not as an estimate of the actual remaining lifetime of each generating unit. Third, this study only compares financial LCOE under two fuel price scenarios and does not include environmental externalities or social costs. Therefore, the results should be understood as a financial generation cost analysis, not as an estimate of the social cost of coal-fired electricity. Overall, this discussion confirms that the coal price assumption should be explicitly stated in LCOE calculations for coal-fired power plants. In the case of the Suralaya coal-fired power plant, the DMO price produces a lower LCOE than the market price. This result indicates that domestic coal pricing policy affects the interpretation of coal-fired power plant economics, particularly when LCOE is used as an input for generation cost assessment and energy policy discussion.

CONCLUSION

This study estimates and compares the *Levelized Cost of Electricity* (LCOE) of the Suralaya coal-fired power plant under two coal price scenarios: the *Domestic Market Obligation* (DMO) price and the market price. The results show that the DMO-based LCOE is IDR 1,008.58/kWh, while the market-price-based LCOE is IDR 1,049.52/kWh. The use of market price increases the LCOE by IDR 40.94/kWh, or 4.06%, compared with the DMO scenario. The difference between the two LCOE values is fully driven by fuel cost because annualized capital cost, operation and maintenance cost, and annual net electricity generation are kept constant in both scenarios. Annual fuel cost increases from IDR 12,458,912,043,845 under the DMO scenario to IDR 13,158,220,870,953 under the market price scenario, resulting in an additional annual fuel cost of IDR 699,308,827,108. These findings indicate that coal

price is an important parameter in determining the generation cost of coal-fired power plants. Substantively, the results show that the DMO policy affects the financial interpretation of the Suralaya coal-fired power plant's generation cost. The DMO-based LCOE represents the actual financial cost faced by the power plant under domestic pricing policy, whereas the market-price-based LCOE represents the generation cost when coal is valued based on its economic or *opportunity cost*. Therefore, electricity generation cost assessment should clearly distinguish between actual financial cost under policy intervention and economic cost based on market price. The policy implication of this study is the need for transparency in fuel price assumptions when LCOE is used to evaluate coal-fired power plant economics or to compare generation costs across technologies. This study is limited to a single case study, applies a 40-year aggregate analysis horizon, and does not include environmental externalities or social costs. Future research may expand the analysis to several coal-fired power plants, apply dynamic coal price scenarios, or integrate external cost components to provide a more comprehensive assessment of electricity generation cost.

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