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Implementation of Coal Blending as an Effort to Improve Security of Coal Supply: A Case Study of XYZ SPP

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ABSTRACT:
PT ABC, a sub-holding of a state-owned company that manages all aspects of electricity in Indonesia, is facing difficulties in obtaining suppliers willing to sell Middle Rank Coal (MRC) that meets the specifications required by the XYZ Steam Power Plant (SPP). The aim of this research is to analyze and determine the coal blending ratio between High Rank Coal (HRC) and Low Rank Coal (LRC) to achieve MRC that meets the specifications required by the XYZ SPP, as an effort to enhance security of supply. Additionally, the research aims determine the minimum total landed cost for implementing this coal blending. The methodology used includes data collection and analysis, calculation of the coal blending ratio system of linear equations in two variables using the substitution method by carrying out repeated experiments, selection of the appropriate Coal Blending Facility (CBF) and transportation mode, and calculation of the total landed cost for the coal blending supply to the XYZ SPP, which includes Freight On Board coal prices plus blending facility and transportation costs. The research results show 52 MRC coal blending compositions from HRC and LRC coal suppliers in East Kalimantan with the minimum price at a calorific value specification of 4,400 kcal/kg GAR, using a sea base (floating) independent CBF A provider at Muara Berau Anchorage and a panamax vessel transportation mode. This research is expected to contribute to enhancing security of supply to the XYZ SPP, and PT ABC is expected to obtain a shortlist of suitable suppliers for implementing coal blending deliveries to the XYZ SPP.
Keywords: Security of Supply, Coal Blending, Total Landed Cost

INTRODUCTION

PT ABC is a subholding of a state-owned company that manages all aspects of electricity in Indonesia which was established to secure the primary energy supply of power plants in Indonesia, improve cost efficiency, and mitigate risks due to fluctuating primary energy prices. Primary energy supplied by PT ABC for power plants includes coal, natural gas, fuel oil, and biomass. In supplying coal energy, PT ABC acts as a service provider for the owners of Steam

Power Plants (SPP) and Independent Power Producers (IPP) which provide electricity for the public interest, where PT ABC conducts the coal procurement process to coal suppliers to deliver coal to coal-fired power plants. An overview of the supply chain of PT ABC primary energy supply can be seen in Figure 1. below:

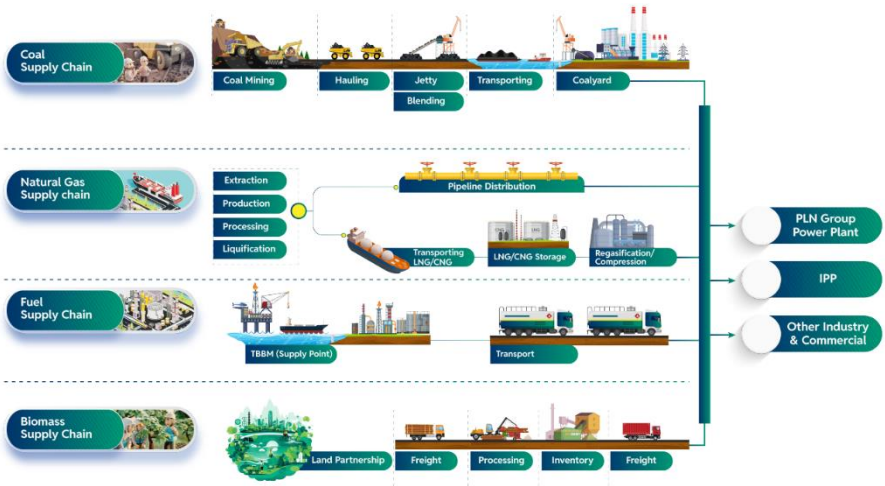

Figure 1. Primary Energy Supply Supply Chain (Source: Company Profile of PT ABC)

One of the IPP coal-fired power plants that provides electricity for the public interest and the supply of coal is XYZ SPP which will operate commercially in 2025 with a capacity of 2x1,000 MW, located in Cilegon. The coal quality specifications needed by the XYZ SPP are included in the Middle Rank Coal (MRC) category, where the quality of this coal is in great demand in the export market and is widely used by other coal-fired power plants in Indonesia so that currently its availability in the domestic market is limited.

In procuring coal for the XYZ SPP, referring to government regulations, namely the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 267.K/MB.01/MEM.B/2022 dated November 21, 2022 concerning the Fulfillment of Domestic Coal Needs and its amendments contained in the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 399.K/MB.01/MEM.B/2023 dated November 17, 2023 concerning Amendments to the Decree of the Minister of Energy and Mineral Resources number 267.K/MB.01/MEM.B/2022 concerning the Fulfillment of Domestic Coal Needs. In the Ministry of Energy and Mineral Resources 267.K/MB.01/MEM.B/2022 stipulates a maximum selling price limit for domestic coal for the provision of electricity for the public interest of USD70 (seventy US dollars) per metric ton (USD70/MT) Free On Board (FOB) Vessel, which is based on reference specifications at 6,322 kcal/kg GAR calories, Total Moisture 8% (eight percent), Total Sulphur 0.8% (zero point eight percent), and Ash 15% (fifteen percent). The determination of this selling price limit has a much lower disparity compared to the export Coal Price Reference (CPR) that has been in the market since 2021 until now, as seen in the following Figure 2:

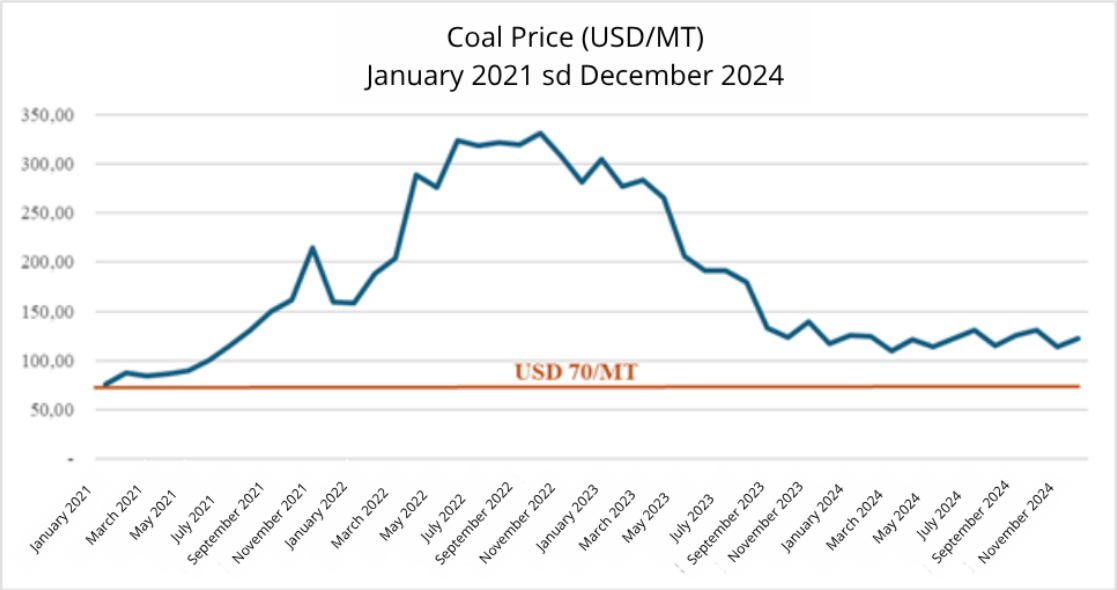

Figure 2. World Benchmark Coal Price Trends (USD/MT) (Data obtained from https://www.minerba.esdm.go.id)

With the high disparity between export CPR compared to the maximum domestic coal price limit for the provision of electricity for the public interest of USD70/MT, coal suppliers who have MRC coal specifications according to the needs of the XYZ SPP tend to export coal, so that PT ABC has difficulty in obtaining coal suppliers for the XYZ SPP. Even in the Ministry of Energy and Mineral Resources 399.K/MB.01/MEM. B/2023 has set a minimum percentage of coal sales for domestic purposes (Domestic Market Obligation (DMO)) to coal suppliers of 25% (twenty-five percent) of the government-approved annual coal production plan, but the fulfillment of this DMO is not specifically for the provision of electricity for the public interest, but can also be fulfilled by suppliers through the provision of electricity for their own interests and raw materials/fuel for the industries that are not subject to the maximum selling price limit of USD70/MT. This condition causes PT ABC to have more difficulties in obtaining MRC coal supply that is in accordance with the needs of the XYZ SPP. On the other hand, there are still suppliers who have High Rank Coal (HRC) with Low Rank Coal (LRC) who are willing to supply to XYZ SPP, so in this research, we will study the implementation of coal blending of HRC and LRC as an effort to obtain MRC coal specifications in accordance with the needs of XYZ SPP in Table 1 below:

Table 1. Specifications of XYZ SPP

Element	Unit	Typical	Limit Range	
			Minimum	Maximum
Gross Calorific Value (ar)	kcal/kg GAR	4600	4400	5200
Total Moisture	%, ar	29	20	35

Ash Content	%, ar	5	1.74	10
Total Sulphur	%, ar	0.76	-	1.2

In this study, an analysis was carried out to obtain the ratio of coal blending from HRC coal suppliers to LRC that meets the needs of the MRC coal specification of XYZ SPP as an effort to increase the security of supply of XYZ SPP, as well as to obtain the minimum total landed cost. Total Landed Cost is the cost until the coal arrives at the destination coal-fired power plant, not related to the costs incurred by coal ownership after arriving at the destination coal-fired power plant. Total Landed Cost includes the Freight On Board (FOB) coal price component (rupiah per metric ton (Rp/MT)) plus the cost of coal blending facility (Rp/MT) and coal transportation costs (Rp/MT) to the destination coal-fired power plant as explained in Figure 3 below:

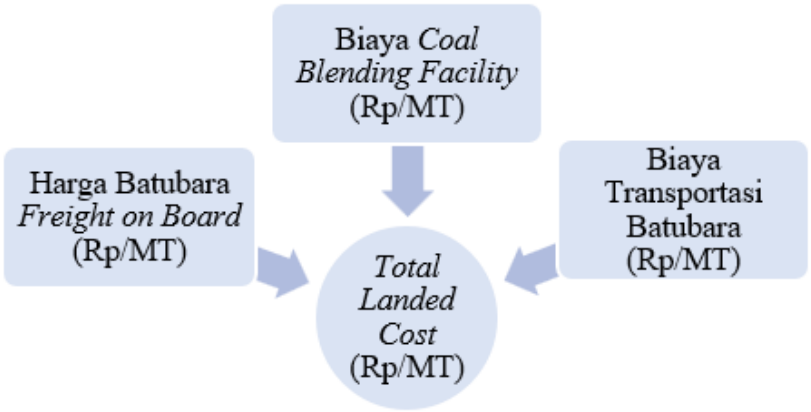

Figure 3 Total Landed Cost Components of Coal Blending

The purpose of this study is to obtain the right coal blending ratio between HRC and LRC coal suppliers in accordance with MRC's coal demand specifications, in order to improve the security of supply for the XYZ SPP. In addition, this study aims to determine the minimum total landed cost for the implementation of coal blending between the two types of coal at the coal-fired power plant. The expected benefits of this study include PT ABC's understanding of the appropriate coal blending ratio, so that it can optimally meet MRC coal specifications. This coal blending is also expected to help XYZ SPP in obtaining coal specifications that are in accordance with boiler needs. With the existence of a coal blending facility (CBF) that is closer to the mine source, coal-fired power plants will get a sense of security both in terms of quality and quantity of supply. In addition, this study will provide PT ABC with a list of suppliers who have coal specifications according to coal blending needs, as well as information about the minimum total landed cost for the coal blending implementation plan at XYZ SPP.

RESEARCH METHODS

The data collection and identification stage in this study consists of several important steps that aim to plan the coal blending process for the XYZ SPP. First, the supplier data used is the supplier assigned by the Directorate General of Mineral and Mineral Resources, which has the availability of volumes for the domestic market as well as the corresponding HRC and LRC coal specifications. The criteria for coal specification required include Calorific Value (CV) of 4,600 kcal/kg GAR, Total Moisture 29%, Total Sulphur 0.76%, and Ash 5%. The data required includes typical coal specifications, mine locations, volume availability, and other additional information. Furthermore, after data collection, HRC and LRC suppliers for coal blending were identified.

After that, the next step is the collection and identification of CBF that is suitable for coal blending shipments. The CBF chosen must be located close to the source of the mine, operate without additional investment, and have made an offer to PT ABC. The information collected includes the location of the CBF, the type of CBF, the handling capacity, the tariff, and the information technology system that supports data management. After the CBF data is collected, the most suitable CBF is identified for the XYZ SPP.

Furthermore, the identification of the most efficient mode of transportation to transport coal from CBF to coal-fired power plants is carried out by considering the load capacity, type of mode, and mileage. Interviews with the person in charge are also conducted to ensure the technical and regulatory aspects that need to be complied with. This process is then followed by the calculation of the coal blending ratio using a mathematical model to determine the composition of HRC and LRC coal that meets the specifications of the coal-fired power plant, with various quality parameters that must be checked to match the set range.

After obtaining the appropriate ratio, the calculation of the total landed cost is carried out by adding the price of FOB coal, coal blending facility costs, and transportation costs. This is all done to produce a list of recommended supplier mine sources that will provide the optimal composition of coal blending, which includes specifications of coal blending parameters, ratios, CBF, and modes of transportation, so that PT ABC can have a shortlist of the right suppliers in the procurement process.

The research method used in the description is descriptive research with a quantitative approach. This study aims to collect specific data and information about the source of coal supplier, CBF conditions, and modes of transportation, as well as to calculate the ratio and total landed cost in the coal blending process. Thus, the focus is on data collection and analysis to provide a clear picture of the processes and variables involved in coal blending for the XYZ SPP.

RESULTS AND DISCUSSION

Data collection and identification.

1) Collection and identification of supplier mine source data.

In determining HRC and LRC suppliers for coal blending, consider the suitability of typical coal specifications. Supplier data collection is carried out based on a list of supplier mining sources in the East Kalimantan region that have been assigned by the Directorate General of Mineral and Mineral Resources and have permits to carry out coal mining activities, namely Coal Mining Concession Agreement permits and Production Operation Mining Business Permits. The consideration of collecting data on the source of the supplier mine in East Kalimantan is because its location is close to the sea area where the ship is docked to load coal, namely Muara Berau Anchorage. At this location there is a Coal Blending Facility Sea Base (Floating) – Independent which can be used for coal mixing. Based on the identification of supplier data, 10 (ten) HRC suppliers and 7 (seven) LRC suppliers were obtained according to the following table.

Table 2. List of High Rank Coal (HRC) Suppliers

No.	High Rank Coal *(HRC)* Supplier Name	Typical Quality of Coal				Location
		CV (kcal/kg GAR)	TM (%,ar)	TS (%,ar)	Ash (%,ar)	
1	HRC 1 SUPPLIER	5,430	19.3	4.6	0.,4	Berau
2	HRC 2 SUPPLIER	5,500	20	0,8	6	Kutai Kartanegara
3	HRC 3 SUPPLIER	5,333	22.1	1.1	5.4	Kutai Kartanegara
4	HRC 4 SUPPLIER	5,500	20	0.8	6	Kutai Kartanegara
5	HRC 5 SUPPLIER	5,500	20	0.3	6	Kutai Kartanegara
6	HRC 6 SUPPLIER	5,596	17.7	0.8	5.5	Berau
7	HRC 7 SUPPLIER	5,541	20.3	2.7	0.1	Kutai Kartanegara
8	HRC 8 SUPPLIER	4,925	24.5	1.1	7.7	West Kutai
9	HRC 9 SUPPLIER	5,700	17	0.6	6	Berau
10	HRC 10 SUPPLIER	5,600	17	0.6	6	Kutai Kartanegara

Table 3. Low Rank Coal (LRC) Supplier List

No.	Low Rank Coal *(LRC)* Supplier Name	Typical Quality of Coal				Location
		CV (kcal/kg GAR)	TM (%,ar)	TS (%,ar)	Ash (%,ar)	
1	LRC 1 SUPPLIER	3,810	42.00	4.10	0.20	Kutai Kartanegara
2	LRC 2 SUPPLIER	3,800	39.00	0.20	3.50	Berau
3	LRC 3 SUPPLIER	3,855	37.10	0.40	6.20	Kutai Kartanegara
4	LRC 4 SUPPLIER	3,773	41.00	2.90	0.40	East Kutai
5	LRC 5 SUPPLIER	3,800	39.00	0.20	4.00	Kutai Kartanegara
6	LRC 6 SUPPLIER	3,800	39.00	0.20	4.00	Kutai Kartanegara
7	LRC 7 SUPPLIER	3,663	37.70	0.30	6.80	Kutai Kartanegara

2) Coal Blending Facility Data Collection and Identification

The Coal Blending Facility data collection is carried out based on the following criteria:

a. It has been operating in Indonesia.
b. Willing to do a partnership without investment and commitment fee.
c. Has the capacity to load and or unload tugs and barges and vessels.
d. It has submitted the CBF price offer to PT ABC.

Based on the criteria mentioned above, the CBF floating data in Muara Berau, Anchorage, East Kalimantan, which is 876 Nautica Miles (NM) from XYZ SPP, is obtained as follows:

Table 4. Floating Coal Blending Facility (CBF) in Muara Berau, Anchorage

No	Description	Penyedia CBF A (*Floating*)	CBF B (*Floating*) Provider
1.	Year of Manufacture	2010	2024
2.	Capacity	8,500,000 *Metric ton per annum* (Mtpa)	12,000,000 Mtpa
3.	*Loading Rate*	80,000 *Ton per day* (Tpd)	30,000 Tpd
4.	*Storage Capacity*	*Up to* 6,600 MT	80,000 MT
5.	Location	Muara Berau Anchorage	Muara Berau Anchorage
6.	*Quality Control*	*Metal Detector, Magnetic Separator, Automatic Sampling, Belt Scale*	*Metal Detector, Magnetic Separator, Automatic Sampling, Belt Scale*
7.	*Information Technology System*	*Cargo Scheduling Apps*	*Orbit Apps*

3) Collection and Identification of Transportation Mode Data

4) After identifying suppliers and CBF, then identification was carried out to get the most suitable mode of transportation to transport coal from the CBF location to the XYZ SPP. The identification of coal transportation is carried out based on the type of transportation mode that can carry out the docking process at the dock/port of the XYZ SPP with the maximum load for each mode of transportation as follows:

Table 5. Types of Transportation Modes with Maximum Load that Can Dock at the XYZ SPP Port

No.	Types of Transportation Modes	Maximum Payload (MT)	*Bill of Lading* Volume Limitation (MT)
1	*Tug and Barge* ukuran 300 feet (ft)	7,500	6.000 MT < 300 ft ≤ 7.500 MT
2	*Vessel* Panamax	65,000	60.000 MT < Panamax ≤ 65.000 MT

The following is an overview of the transportation modes that can be docked at the XYZ SPP port.

Figure 4. Tug and Barge (Barge) 300ft at the Port XYZ SPP Port

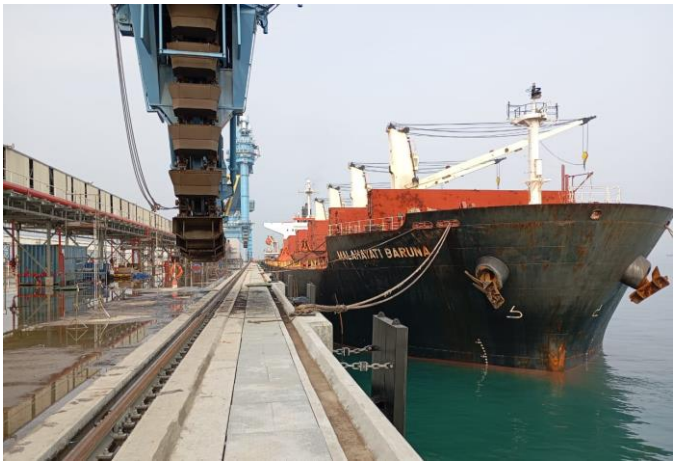

Figure 5. Panamax vessel at the Port XYZ SPP Port

Determining the Coal Blending ratio of HRC and LRC Suppliers

After identifying 10 HRC mine sources (Suppliers HRC1 to HRC10) and 7 LRC mine sources (Suppliers LRC1 to LRC7) that can be used in the implementation of coal blending to produce MRC, the coal blending ratio was calculated. The results of these calculations indicate that there are 52 coal blending ratio compositions that meet the coal specification range for the XYZ SPP, as well as 18 other ratio compositions that do not meet the specifications due to high total sulfur (TS) and ash content. Of the 52 ratios that meet the specifications, based on the typical Calorific Value (CV) values, the calculation results are presented in Table 6 below.

Table 6. Coal Blending Ratio Calculation Results

No	*Calorific Value* (kcal/kg GAR)	The number of compositions of *the coal blending* ratio included in the *specification* range
1	4,400 (*range*)	4
2	**4,600 (typical)**	**40**
3	4,900 (*range*)	2
4	5,000 (*range*)	1
5	5,100 (*range*)	1
6	5,200 (*range*)	4
Total		52

Based on the table above, it is known that from the initial experiment by inserting a CV of 4,600 kcal/kg, 40 compositions of HRC and LRC coal blending ratios were obtained with all the parameters in accordance with them. Furthermore, for the composition of HRC and LRC suppliers whose parameters are not suitable, further experiments were carried out with CV inputs sequentially and the results for CV 4,400 kcal/kg there were 4 suitable coal blending ratio compositions, CV 4,900 kcal/kg obtained 2 suitable coal blending ratio compositions, and for caloric values of 5,000 kcal/kg and 5,100 kcal/kg each obtained 1 suitable coal blending ratio composition. As for the caloric value of 5,200 kcal/kg, 4 compositions of the corresponding coal blending ratio were obtained.

Calculating the total landed cost of coal supply using coal blending.

After obtaining the coal blending ratio from each supplier, the total landed cost is then calculated consisting of the FOB price of coal plus the price of CBF and the price of transportation (freight).

1) Calculating the price of FOB blending coal

In calculating the price for each HRC and LRC coal specification, the formula specified in ESDM Decree 267.K/MB.01/MEM.B/2022 is used, as explained previously. In this study, the FOB Barge coal price is equated with the FOB Vessel price because no deduction is made to the Total Adjustment Cost Value in the Adjustment Cost Verification Report (LHVBP). This is due to the transhipment process at CBF, which involves both barge and vessel transportation modes in coal blending activities. The exchange rate from dollars to rupiah uses an assumption of Rp16,000 per USD1, following the assumption applied by PT ABC in the preparation of the current estimated price. Based on the calculations, the lowest FOB coal price was obtained from the coal blending composition with a Calorific Value (CV) of 4,400 kcal/kg GAR, at the price of Rp698,594/MT, Rp709,848/MT, and Rp712,176/MT, respectively.

To obtain the total landed cost, the next step is to calculate the CBF price and coal transportation costs.

2) Calculating CBF Prices

After obtaining the FOB coal price for each coal blending, the CBF price is then calculated. The calculation of the CBF price is based on offers from CBF providers that have been submitted to PT ABC and are willing to cooperate without commitment fees. Based on the offer from the CBF provider, the following prices are obtained:

Table 7. Floating CBF Price Used for Coal Blending.

Description	Penyedia CBF A (*Sea Base Floating - Independent*)	Penyedia CBF B (*Sea Base Floating - Independent*)
Tarif (USD/MT)	Blending cost: 2.5	Blending cost: 2.35
	Port Business Entity Fee: 0.82	Port Business Entity Fee: 0.82
Rate (Rp/MT) [1)] before VAT	53.452	51.037
Fare (Rp/MT) after VAT	59.332	56.651

1) The rate of Rp/MT includes the cost of coal blending plus the cost of Port Business Entity Fee assuming the exchange rate conversion of Rp16,000 = USD1.

Based on the price above, it is known that the total CBF cost from Provider B is lower than the price from Provider A, where the price of CBF for Provider A is Rp59,332/MT after VAT and CBF for Provider A is Rp56,651/MT after VAT.

3) Calculating Coal Transportation Prices

In this sub-chapter, the cost of coal transportation will be calculated for the types of transportation modes that can dock at the XYZ SPP port, namely the Panamax Vessel with a maximum capacity of 65,000MT and the 300ft Tug and Barge (barge) with a maximum capacity of 7,500MT. The transportation cost calculated is the cost of transporting coal from the CBF location, namely in Muara Berau, Anchorage to the unloading port (unloading port) at the XYZ SPP pier which is 876 Nautical Miles (NM). The assumptions used in the calculation of coal transportation are as follows:

a. Convert the value of dollars to rupiah using the exchange rate of IDR 16,000 per USD1.
b. The High Speed Diesel (HSD) price before VAT and Motor Vehicle Fuel Tax based on the HSD B35 Industrial Diesel Price set by Pertamina for the period of December 15-31, 2024 for Region 2 (Sumatra, Java, Bali, Madura, and Kalimantan) is Rp18,900/liter.
c. The Marine Fuel Oil (MFO) price before VAT and Motor Vehicle Fuel Tax is based on the MFO Industrial Diesel Price set by Pertamina for the period of December 15-31, 2024 in Region 2 (Sumatra, Java, Bali, Madura, and Kalimantan) of Rp18,150/liter.

d. The loading rate at CBF is in accordance with the specification information submitted in the offer of the CBF A provider and the CBF B provider, namely 80,000 Tpd at CBF A and 30,000 Tpd at CBF B.
e. The unloading rate at the unloading port (XYZ SPP) is 20,000MT/day for vessels and 10,000MT/day for barges.

Based on the above assumptions, the results of the calculation of freight costs for panamax vessels and 300ft barge are obtained as follows:

a. The cost of the panamax freight vessel from Muara Berau, Anchorage to XYZ SPP using the CBF Provider A is Rp 163,844 /MT including VAT and if using the CBF B Provider is Rp171,175/MT including VAT (including VAT).
b. The cost of a 300ft freight barge from Muara Berau, Anchorage to XYZ SPP using CBF Provider A is Rp 480,221/MT including VAT and if using CBF Provider B is Rp479,151/MT including VAT (including VAT).

Based on the results of the calculation above, the cost of transportation by vessel if using a CBF B provider is Rp171,175/MT including VAT is more expensive than the price of transportation by vessel if using a CBF A provider of Rp163,844/MT including VAT. This is because the loading rate of the CBF B provider is lower than the CBF A provider, so that the total trip time in coal delivery if you use the CBF B provider is longer which results in high vessel rental costs and fuel oil consumption.

The results of the calculation of the cost of transporting coal with a 300ft barge if using a CBF B provider of Rp480,221/MT including VAT are slightly more expensive than the cost if using a CBF A provider of Rp479,151/MT including VAT. The cost difference for barge transportation modes between CBF A providers and CBF B providers is relatively small when compared to the price difference in the calculation of vessel modes. This is because the difference in loading rate between CBF A and CBF B providers does not have much effect on the total trip time because the load capacity of 7,500 MT of 300ft barge is much smaller than the cargo capacity of 65,000 MT of the panamax vessel, so the difference in loading rate does not have much effect on the cost of barge rental and fuel oil consumption.

From the results of the calculation of coal transportation costs for vessels and barges, it can be seen that the cost of coal transportation using vessels is much lower than the cost of transportation using barges, this is due to the larger vessel load capacity of the barge so that the price of rupiah per metric ton (Rp/MT) of vessels becomes more efficient.

4) Calculating the total landed cost

After obtaining the FOB blending coal price, CBF price and coal transportation price, then the total landed cost can be calculated which is the sum of the FOB blending coal price, CBF price and coal transportation. In the calculation of the total landed cost, each coal blending

composition will be calculated using the CBF price from the CBF A provider and the CBF B provider as well as the following modes of vessel and barge transportation:

a. Total Landed Cost for coal blending using CBF Provider A and vessel transportation mode is obtained based on the results of the calculations that have been carried out.
b. Total Landed Cost for coal blending using CBF Provider B and vessel transportation mode is obtained from the results of the calculations that have been carried out.
c. Total Landed Cost for coal blending using CBF Provider A and barge transportation mode is obtained based on the available calculation results.
d. Total Landed Cost for coal blending using CBF Provider B and barge transportation mode is also determined through calculations that have been carried out previously.

Based on the results of the calculation of the total landed cost above, when compared to the ratio and quality of the same parameters, the minimum price for coal blending is to use CBF from the CBF A provider and the mode of transportation is to use the panamax vessel, this is because the transportation cost using the panamax vessel from the CBF A provider is the minimum cost. Based on caloric value, coal blending with the minimum price is found at CV 4,400 kcal/kg GAR.

Determining the Recommended List of Supplier Mine Sources for Coal Blending XYZ SPP.

Based on the results of the calculation of total landed cost in above, the minimum price for coal blending is to use CBF from CBF provider A and mode of transportation using panamax vessels, so that the list of recommendations for coal blending suppliers based on total landed cost is made according to the table below:

Table 8. List of Supplier Recommendations for XYZ SPP Coal Blending.

Number (*Ranking*)	Composition of *Coal Blending Suppliers*	Rasio *Coal Blending*		Specification of Coal *Blending*				*Total Landed Cost (Rp/ MT)*
		LRC	HRC	CV (kcal/kg GAR)	TM (%, ar)	TS (%,ar)	Ash (%,ar)	
1	LRC3 - HRC7	68%	32%	4,400	31.67	1.14	4.23	921,770
2	LRC5 - HRC7	66%	34%	4,400	32.56	1.06	2.66	933,024
3	LRC6 - HRC7	66%	34%	4,400	32.56	1.06	2.66	933,024
4	LRC2 - HRC7	66%	34%	4,400	32.56	1.06	2.33	935,351
5	LRC3 - HRC8	30%	70%	4,600	28.33	0.89	7.24	978,625
6	LRC7 - HRC8	26%	74%	4,600	27.90	0.89	7.47	982,301
7	LRC5 - HRC8	29%	71%	4,600	28.69	0.84	6.63	983,990
8	LRC6 - HRC8	29%	71%	4,600	28.69	0.84	6.63	983,990
9	LRC2 - HRC8	29%	71%	4,600	28.69	0.84	6.49	985,016
10	LRC3 - HRC3	50%	50%	4,600	29.54	0.75	5.80	989,655
11	LRC7 - HRC3	44%	56%	4,600	28.95	0.75	6.01	997,168

Number (*Ranking*)	Composition of *Coal Blending Suppliers*	Rasio *Coal Blending*		Specification of Coal *Blending*				*Total Landed Cost (Rp/ MT)*
		LRC	HRC	CV (kcal/kg GAR)	TM (%, ar)	TS (%,ar)	Ash (%,ar)	
12	LRC5 - HRC3	48%	52%	4,600	30.18	0.67	4.73	998,924
13	LRC6 - HRC3	48%	52%	4,600	30.18	0.67	4.73	998,924
14	LRC2 - HRC3	48%	52%	4,600	30.18	0.67	4.49	1,000,622
15	LRC3 - HRC2	55%	45%	4,600	29.36	0.58	6.11	1,003,808
16	LRC3 - HRC4	55%	45%	4,600	29.36	0.58	6.11	1,003,808
17	LRC3 - HRC6	57%	43%	4,600	28.80	0.57	5.90	1,013,881
18	LRC7 - HRC2	49%	51%	4,600	28.67	0.56	6.39	1,013,981
19	LRC7 - HRC4	49%	51%	4,600	28.67	0.56	6.39	1,013,981
20	LRC5 - HRC2	53%	47%	4,600	30.06	0.48	4.94	1,014,624
21	LRC5 - HRC4	53%	47%	4,600	30.06	0.48	4.94	1,014,624
22	LRC6 - HRC2	53%	47%	4,600	30.06	0.48	4.94	1,014,624
23	LRC6 - HRC4	53%	47%	4,600	30.06	0.48	4.94	1,014,624
24	LRC2 - HRC2	53%	47%	4,600	30.06	0.48	4.68	1,016,504
25	LRC2 - HRC4	53%	47%	4,600	30.06	0.48	4.68	1,016,504
26	LRC3 - HRC9	60%	40%	4,600	28.98	0.48	6.12	1,017,998
27	LRC3 - HRC5	55%	45%	4,600	29.36	0.35	6.11	1,019,894
28	LRC3 - HRC10	57%	43%	4,600	28.52	0.49	6.11	1,021,849
29	LRC5 - HRC6	55%	45%	4,600	29.51	0.47	4.67	1,025,623
30	LRC6 - HRC6	55%	45%	4,600	29.51	0.47	4.67	1,025,623
31	LRC7 - HRC6	52%	48%	4,600	28.01	0.54	6.17	1,025,917
32	LRC2 - HRC6	55%	45%	4,600	29.51	0.47	4.39	1,027,593
33	LRC5 - HRC9	58%	42%	4,600	29.74	0.37	4.84	1,030,433
34	LRC6 - HRC9	58%	42%	4,600	29.74	0.37	4.84	1,030,433
35	LRC7 - HRC9	54%	46%	4,600	28.18	0.44	6.43	1,031,186
36	LRC5 - HRC5	53%	47%	4,600	30.06	0.25	4.94	1,031,339
37	LRC6 - HRC5	53%	47%	4,600	30.06	0.25	4.94	1,031,339
38	LRC7 - HRC5	49%	51%	4,600	28.67	0.30	6.39	1,032,099
39	LRC2 - HRC9	58%	42%	4,600	29.74	0.37	4.55	1,032,489
40	LRC2 - HRC5	53%	47%	4,600	30.06	0.25	4.68	1,033,219
41	LRC5 - HRC10	56%	44%	4,600	29.22	0.38	4.89	1,033,939
42	LRC6 - HRC10	56%	44%	4,600	29.22	0.38	4.89	1,033,939
43	LRC7 - HRC10	52%	48%	4,600	27.69	0.45	6.41	1,034,970
44	LRC2 - HRC10	56%	44%	4,600	29.22	0.38	4.61	1,035,913
45	LRC1 - HRC8	2%	98%	4,900	24.89	1.17	7.53	1,040,240
46	LRC4 - HRC8	2%	98%	4,900	24.86	1.14	7.54	1,040,585
47	LRC4 - HRC5	29%	71%	5,000	26.08	1.05	4.38	1,095,679
48	LRC1 - HRC5	24%	76%	5,100	25.21	1.20	4.63	1,125,367
49	LRC4 - HRC2	17%	83%	5,200	23.65	1.16	5.03	1,133,338
50	LRC4 - HRC4	17%	83%	5,200	23.65	1.16	5.03	1,133,338

Number (*Ranking*)	Composition of *Coal Blending Suppliers*	Rasio *Coal Blending*		Specification of Coal *Blending*				*Total Landed Cost (Rp/ MT)*
		LRC	HRC	CV (kcal/kg GAR)	TM (%, ar)	TS (%,ar)	Ash (%,ar)	
51	LRC4 - HRC9	26%	74%	5,200	23.23	1.20	4.55	1,149,628
52	LRC4 - HRC10	22%	78%	5,200	22.25	1.10	4.77	1,161,210

Based on the price in Table 8 above, the minimum total landed cost is obtained for CV 4,400 kcal/kg GAR, which is in the price range of Rp921,770/MT to Rp935,351/MT at number 1 to number 4, but this must be accompanied by risk mitigation to maintain the caloric value not to fall below 4,400 kcal/kg GAR during the delivery process from CBF in Muara Berau Anchorage to XYZ SPP, so that when coal quality measurements are carried out at the XYZ SPP unloading port, is not rejected because it is below the minimum limit of CV 4,400 kcal/kg GAR. In addition, the total sulphur (TS) specification must also be maintained so that it does not exceed the maximum TS limit of 1.2% ar.

In the event that PT ABC prioritizes the conformity of typical quality in accordance with the needs of XYZ SPP, namely CV 4,600 kcal/kg GAR, PT ABC can choose 40 (forty) blending ratio compositions with a range of total landed cost between IDR Rp978,625/MT to IDR Rp1,035,912/MT according to numbers 5 to 44 in the table above. For CV quality above 4,600 kcal/kg GAR, CV values of 4,900 kcal/kg GAR, 5,000 kcal/kg GAR, 5,100 kcal/kg GAR and 5,200 kcal/kg GAR in sequence numbers 45 to 52 were obtained, where the total landed cost was higher than the total landed cost for CV 4,400 kcal/kg GAR and CV 4,600 kcal/kg GAR.

CONCLUSION

Based on the results of the research conducted, it was concluded that the blending of High Rank Coal (HRC) and Low Rank Coal (LRC) in the East Kalimantan region produced 52 compositions of coal blending ratios for Middle Rank Coal (MRC) that meet the coal specifications of the XYZ SPP, so as to increase the security of coal supply for the coal-fired power plants that have difficulty obtaining MRC in the domestic market. The total minimum landed cost was obtained from four compositions of the coal blending ratio, with a Calorific Value (CV) value of 4,400 kcal/kg GAR, namely: LRC3 and HRC7 suppliers with an LRC ratio of 68% and HRC of 32%, the total landed cost of Rp921,770/MT; LRC5 and HRC7 suppliers with an LRC ratio of 66% and HRC of 34%, a total landed cost of Rp933,024/MT; Suppliers of LRC6 and HRC7 with the same ratio, total landed cost of Rp933,024/MT; and LRC2 and HRC7 Suppliers with an LRC ratio of 66% and HRC of 34%, with a total landed cost of Rp935,351/MT. In addition, there are 40 compositions of coal blending ratios with typical quality CV 4,600 kcal/kg GAR, with a total landed cost between Rp978,625/MT to Rp1,035,912/MT. It was also found that the higher the CV coal blending, the

higher the total landed cost, so that the supply of coal to XYZ SPP is more economical using blending results with CV 4,400-4,600 kcal/kg GAR compared to CV above 4,600 kcal/kg GAR. To achieve the minimum total landed cost, CBF A providers are used which have a higher loading rate than CBF B providers, and the mode of transportation used is a panamax vessel with a larger load capacity than the 300ft barge mode.

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