FINANCIAL ANALYSIS ON DEVELOPMENT OF COAL LIQUEFACTION PLANT IN INDONESIA USING BROWN COAL LIQUEFACTION (BCL) TECHNOLOGY

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ABSTRACT

Financial analysis of Mulia coal liquefaction plant has been conducted in the year 2002 and up dated in the year 2007. However, the increase of coal price, currently, has promoted coal companies to export their coal rather than to allocate it as raw material for coal liquefaction. To maintain the stability of coal supply in a liquefaction plant, the use of stranded mining coal as raw material for the plant should be studied. This study was aimed to conduct financial analysis of stranded coal from South Sumatera (Pendopo Coal) and to update the financial analysis of Mulia coal liquefaction. Discounted cash flow was used as the method for the analysis. The result indicates that with the oil price higher than US$ 70/bbl and coal price below US$ 25/ton, the Internal Rate of Return (IRR) of Pendopo coal liquefaction plant achieved value higher than 10%. Reducing corporate tax from 30% to 15% increased IRR value of approximately 1%. Meanwhile, by enlarging the plant scale from 3,000t/d to 12,000 t/d will increase the IRR value as much as 5%. On the other hand, the IRR of Mulia coal liquefaction plant was less than 9% when the oil price was lower than US$ 70/bbl and coal price was above US$ 55/ton.

Keywords: coal liquefaction, financial analysis, BCL technology

1. INTRODUCTION

In the framework of coal liquefaction program, the government of Indonesia (GOI) in cooperation with the government of Japan (GOJ) have conducted several feasibility studies (F/S) of the construction of coal liquefaction plant in Indonesia. The technology applied is Brown Coal Liquefaction (BCL) technology, a Japanese Technology that is specially developed to liquefy low rank coal. Banko coal F/S was conducted in the year 2002 (BPPT, NEDO and Kobe Steel, 2002) while Mulia and Berau coals were in the year 2003 (BPPT, NEDO, and Kobe Steel, 2003). Banko coal liquefaction plant will be constructed in the mine mouth of Banko coal mine located in South Sumatera about 200 km from sea shore while Berau and Mulia coal liquefaction plant will be at the coastal site of East and South Kalimantan, respectively. The result of Mulia coal liquefaction F/S in the year 2003 had been updated in the year 2008 due to significant increase in the price of equipment and material for plant construction since 2003 (Kobe Steel and Sojitz, 2008). The result of financial analysis in the updated F/S showed that as the construction cost of coal liquefaction plant in the year 2008 was 40% higher than that in the year 2003 and the price of Mulia coal increases from US$ 12/ton in 2003 to US$ 25/ton in 2007, the production cost of BCL oil increases from US$ 20-30/barrel to US$ 40-50/ton subject to scales of the plant.

In the year 2008, coal price increases significantly following the hike of oil price to bring Mulia coal (calorific value about 5,000 kcal/kg) FOB (free on board) price of about US$ 40-50/ton (Widagdo,

2008). The increase of coal price has promoted coals mining companies to export their coals rather than to allocate them as a raw material for coal liquefaction. The use of a lower quality coals (calorific value < 5,000 kcal/kg) mined in the inland site or stranded coals, therefore un-exportable, is suggested for feedstock of coal liquefaction plant to assure the stability of coal supply for the liquefaction plant.

Stranded coals may be found mainly in Central Kalimantan and South Sumatera. Pendopo coal in South Sumatera is considered as stranded coal since it cannot be monetized, although coal price achieved its peak in the year 2008.

The purpose of this study was to conduct financial analysis of the construction of coal liquefaction plant using stranded coal (Pendopo coal) from South Sumatera as the feedstock; in addition the financial analysis of Mulia coal liquefaction plant will be updated to be used as reference. The result of this study may be used as a reference for the government to decide the appropriate policy to support the coal liquefaction plant program.

2. THE CONCEPT OF COAL LIQUEFACTION PLANT

The major concept of coal liquefaction plant including plant site, plant scale, hydrogen source, technology and shipping terminal is shown in Table 1.

Pendopo coal liquefaction plant is located in the mine mouth of PT. Pendopo Energi Batubara, Talang Ubi Subdistrict, Muara Enim Regency, South Sumatra Province. Mulia coal liquefaction plant to be constructed at mine mouth of PT. Arutmin, in Satui Subdistrict, Tanah Bumbu Regency, South Kalimantan Province. Figure 1 shows an outline map of Pendopo coal liquefaction plant. It close to the Lematang River and surrounded by a number of capped oil well to be used for carbon storage. Carbon Capture and Storage (CCS) may be performed in the location using the capped oil well since a liquefaction plant produce high concentration of carbon dioxide to result in low cost of carbon dioxide separation process. However, in this study the cost of CCS was excluded.

The scales of coal liquefaction plant are 3,000, 6,000 and 12,000 ton dry ash free (daf) coal/day. In general, the bigger the plant scale the more economical the plant is, however, since BCL technology experienced only at scale of 50 ton/day, it is required to construct smaller scale plant (3,000 t/d) to reduce the scale-up risk and to depress the investment cost.

The products of coal liquefaction plant are light oil, middle oil, heavy oil, LPG and chemicals. A 3,000 ton/day scale plant produces 7,150 bbl/day of light oil, 6,350 bbl/day of middle and heavy oil, 36 ton/day of ammonia, 0.5 ton/day of phenol, 38.5 ton/day sulfur, and 153 ton/day of LPG (Kobe Steel and Sojizt, 2008). The amount of above products is doubled in 6,000 ton/day scale plant. The BCL oil produced from this plant has experienced hydro-treating and upgrading process. Therefore, it contains a very low concentration of heteroatom. BCL oil with the above characteristic is usually priced 20-30% more expensive than that of petroleum crude. However, in this financial analysis, it is assumed that BCL oil has the same price of petroleum crude to avoid over estimation for the price of BCL oil.

The technology applied here is improved BCL technology, it is a single stage coal liquefaction technology equipped with inline hydro treater. The improved BCL technology requires lower investment cost; nevertheless, it has higher efficiency compared to proven BCL technology applied in the BCL

Table 1. Major concept of liquefaction plant

Plant Site	Pendopo, South Sumatra & Satui, South Kalimantan
Plant Scale	3,000 t/d 6,000t/d 12,000 t/d dry ash free (daf) basis
Product	Light oil, middle oil and heavy oil, LPG Chemicals
Process Applied	Improved BCL Process
Hydrogen Source	Coal Gasification by HYCOL (Japan)
Shipping Terminal	Tanjung Api-api, South Sumatra & Satui, South Kalimantan
Feed Coal	Pendopo & Mulia

pilot plant in Victoria Australia. Improved BCL is also suitable for Indonesian coal which releases more exothermic heat in the hydrogenation process than that of Victorian brown coal (BPPT, NEDO and Kobe Steel, 1999).

Oil shipping terminal will be constructed in Tanjung Api-api and Satui for Pendopo and Mulia coal liquefaction plant, respectively. The total construction cost of the coal liquefaction plant in both locations includes the construction cost of oil shipping terminal and pipe-line from liquefaction plant to shipping terminal. Pendopo coal liquefaction plant must construct product distribution pipe-line from Talang Ubi to Tanjung Api-api Terminal as long as 200 km, whereas Mulia coal liquefaction plant merely requires pipe-line as far as 5 km.

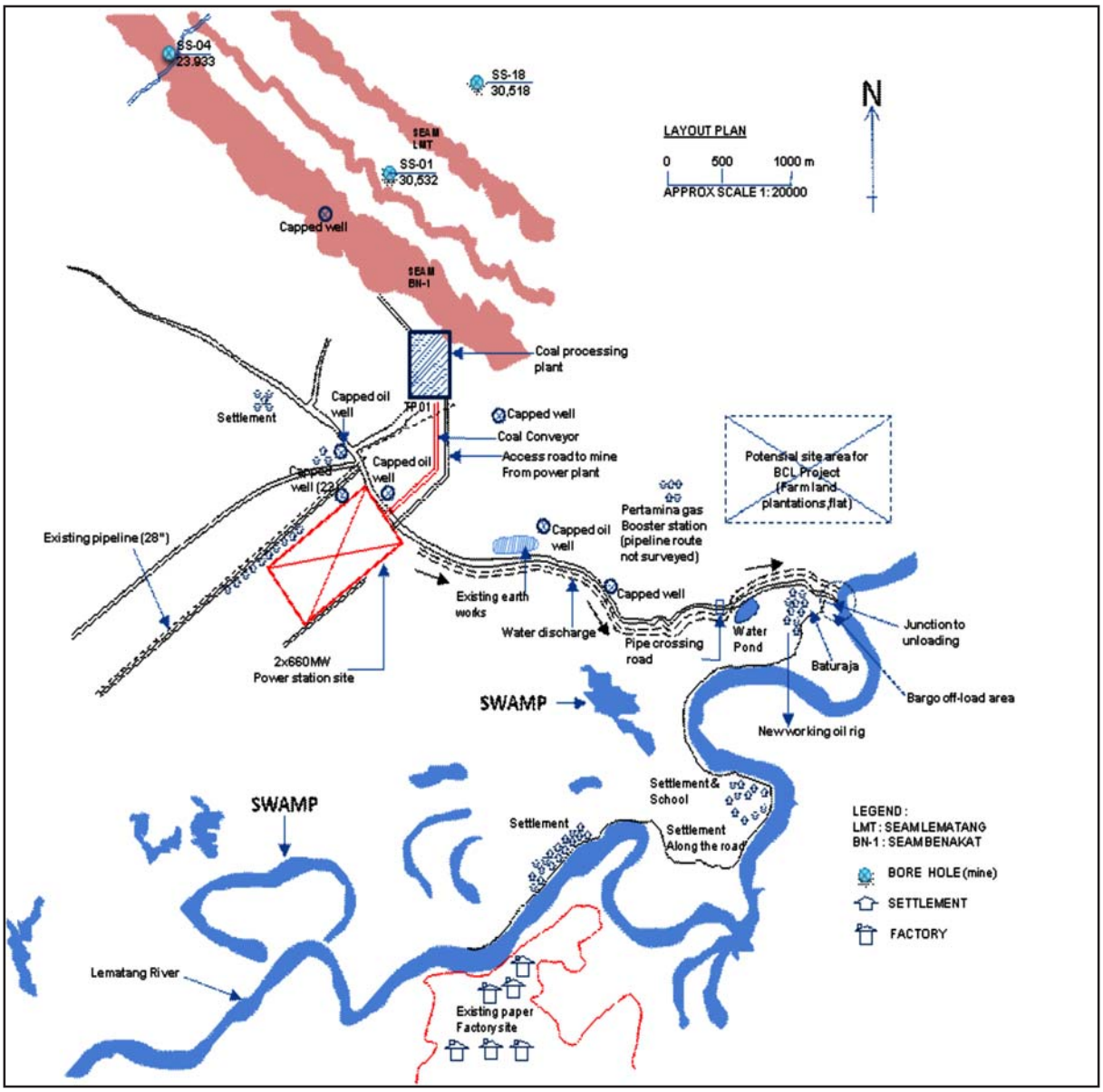

Figure 1. Coal liquefaction plant site in the work contract of PT. Pendopo Energi Batubara

Hydrogen required for coal liquefaction is obtained from coal gasification process using HYCOL Japan gasification technology. Other technology will be considered if the cost of hydrogen production from the technology is lower than that of HYCOL technology.

Table 2 shows results of proximate analysis of Pendopo and Mulia coala. Pendopo coal has higher total moisture (TM) and ash content than that of Mulia coal. As a result, Pendopo coal liquefaction plant requires larger amount of coal feed in as received basis than that of Mulia coal liquefaction plant. Coal consumption at scale of 3,000 ton/day in Pendopo and Mulia Coal liquefaction plant is 13,313 and 8,803 ton/day, respectively. The amount of coal needed for each of three different plant scales is shown in Table 3. Pendopo coal also has higher ash and volatile matter content than that of Mulia coal. Coal ash mainly contains inert material which reduces the volume of reactor for liquefaction reaction. Nevertheless, higher volatile matter of Pendopo coal is expected to yield higher carbon conversion and oil.

Table 2. Coal characteristics

Characteristic	Pendopo	Mulia
Total moisture (ar)	55%	35.0%
Proximate analysis (adb)		
Inherent moisture	15.9%	23.0%
Ash	7.8%	3.9%
Volatile Matter	44.8%	38.10%
Fixed Carbon	31.6%	35.10%
Total Sulfur	2.5%	0.15%

Note: ar is as received basis; adb is air dried basis

3. ASSUMPTIONS APPLIED

3.1. Fixed Cost and Running Cost

Fixed and running cost is calculated based on the assumptions in Tables 3 and 4. Running cost consists of coal, industrial water, catalyst and chemical costs. Fixed cost is influenced by construction cost, book value, and the main process cost. In this report, coal prices were to be used as variable to calculate IRR of the liquefaction plant.

Table 3. The needs of coal as received for liquefaction plant of 3,000 ton/day

Coal	Plant Capacity (ton/day) (daf)	Coal Consumption (ton/day) (ar)	Product (barrel/day)
PENDOPO	3,000	13,313	13,453
	6,000	26,625	26,905
	12,000	53,251	53,810
MULIA	3,000	8,803	13,453
	6,000	17,606	26,905
	12,000	35,212	53,810

Note: daf is dry ash free basis

Table 4. The assumptions for fixed cost and running cost calculation

	Units	Assumptions		
Plant Capacity	Ton/day	3,000	6,000	12,000
Number of Plant Employee	Persons	524	576	979
Mean Annual Wage per year	US $/person – year		9,800	
Fixed Property Tax	% (vs. book value)		0,1	
Property Insurance Rate	%(vs. book value)		0,63	
Maintenance Cost	%(vs. construction cost)		3	
Consumables Cost	%(vs. cost for main process)		0,5	
Plant Administrative Expense	%(vs. labour cost)		20	
Catalyst Cost	$/ton		4,755	
Chemicals Cost	$/ton		6,971	
Industrial Water Consumption	$/ton		4,99	
Cost for Industrial Water	$/ton		0,011	

3.2. Cash Flow Calculation

Table 5 shows the assumptions regarding cash flow. As much as 70% of investment fund comes from soft loan with 15 years repayment and 4% interest. Considering the technology risk, the operation day of the plant is assumed only 310 days a year to give enough time (56 days) for the maintenance of plant equipment.

Table 5. Assumptions for cash flow calculation

Items	Unit	Assumption
Construction Period	Year	4
Operation Period	Year	25
Depreciation	Year	20
Grace Period	Year	4
Interest and Loan Repayment	Year & %	15 & 4
Items	Unit	Assumption
Equity Ratio	%	30
Plant Operation	%	85
Corporate Tax	%	30

4. METHODOLOGY

The construction cost of Pendopo coal liquefaction plant was calculated by considering the site, which is inland site and the lower quality of Pendopo coal, while the construction cost of Mulia coal liquefaction plant was based on the feasibility study result in the year 2008 (Kobe Steel and Sojizt, 2008). Economic evaluation of the plant was calculated using discounted cash flow method, in which cash flow from the beginning of plant construction until the end of plant operation is converted into the present value.

5. RESULTS AND DISCUSSION

5.1. Construction and Operation Cost

Since Pendopo coal liquefaction plant requires a larger amount of feed coal than that of Mulia coal liquefaction plant (Table 3), Pendopo plant needs larger equipment for coal handling, de-watering and boiler than that of Mulia coal liquefaction plant. This increase of equipments volume requires additional cost approximately US$ 44 million. Besides, Pendopo coal liquefaction plant that is in inland site has to construct 200 km length of pipe line from liquefaction plant to shipping terminal which is estimated to cost about US$ 39 million. The cost was calculated based on Banko coal feasibility study year 2002 taking the price escalation of 3,5% per year. For those reasons, the EPC (Engineering Procurement and Construction) cost of Pendopo coal liquefaction plant is US$ 83 million higher than that of Mulia coal liquefaction plant. Table 6 illustrates the investment cost of Pendopo and Mulia coal liquefaction plant. The commissioning cost is 3% of EPC cost. Other cost is defined as the cost used by management office during the operation.

The construction cost of Mulia coal liquefaction plant was based on the result of Feasibility Study in the year of 2008. The construction cost were US$ 1,483; 2,476; and 4,356 million for 3,000; 6,000; 12,000 ton/day scales, respectively (Kobe Steel and Sojizt, 2008). The above construction costs consist of transportation and installation of

Table 6. Investment cost for Pendopo and Mulia

Investment Cost Components (million USD)	PENDOPO			MULIA		
	3,000 t/d	6,000t/d	12,000 t/d	3,000 t/d	6.000 t/d	12,000 t/d
Construction Cost (EPC)	1,379	2,258	3,921	1,296	2,175	3,838
Commissioning Cost	41	68	118	39	65	115
Other Costs	69	104	171	69	104	171
Interest during Operation	83	136	237	79	132	232
Total	1,572	2,566	4,447	1,483	2,476	4,356

equipments, commissioning cost of the plant, interest during construction and other costs as much as 5% from EPC (Engineering Procurement and Construction) .

Based on the data in Tables 3 and 6, and also applying the assumptions in Table 5, the operational cost (running cost and fixed cost) of coal liquefaction plant was calculated and presented in Table 7. At the same coal price (US$ 25/ton), the operation cost of Pendopo is higher (54 $/bbl) than that of of Mulia coal liquefaction plant (45 $/bbl). This fact is mainly due to larger amount of coal required for Pendopo coal liquefaction plant.

mouth of Pendopo coal mining remain attractive, since mining cost of Pendopo coal is projected to be very low due to its low stripping ratio. In addition up to present, there is no competitor to use Pendopo coal therefore the use of stranded coal such a Pendopo coal as feedstock for coal liquefaction plant will reduce coal supply risk to the plant.

Figure 3 illustrates the influence of coal price and oil price to the IRR value of Mulia coal liquefaction plant at scale of 6,000 ton/day. The IRR achieved higher than 10% if Mulia coal price is US$ 35/t or less and oil price higher than US$70/bbl. How-

Table 7. Operational cost for Mulia and Pendopo liquefaction plant at coals price of US$ 25/ton

Operational Cost	PENDOPO (US$/bbl)	MULIA (US$/bbl)
	Fixed Cost	
Raw Coal for Liquefaction	13,66	9,04
Raw Coal for Gasification	7,41	4,91
Raw Coal for Boiler Fuel	3,67	2,42
Industrial Water	0.013	0,013
Catalyst and Chemicals	2,76	2,76
	Running Cost	
Labour	0,68	0,68
Maintenance	9,23	8,91
Consumable Cost	0,54	0,52
Plant Admin Expenses	0,14	0,14
Fixed Property Tax	0,27	0,26
Property Insurance Rate	1,71	1,64
Depreciation	13,94	13,43
TOTAL	54,01	44,70

5.2. Financial Analysis

The effects of oil price and coal price towards the IRR value of Pendopo coal liquefaction plant at scale of 6,000 ton/day are shown in Figure 2. Generally, a project is considered to give viable return, if it reaches the IRR value of above 10%. Pendopo coal liquefaction plant economically is not viable if Pendopo coal price higher than US$ 25/ton and oil prices less than US$ 70/bbl. However, if the oil price higher than US$ 70/bbl and coal price less than US$ 25/ton, the plant's IRR value is always higher than 10%. Although the coal price less than US$ 25/ton is considered very cheap, the construction of coal liquefaction in mine

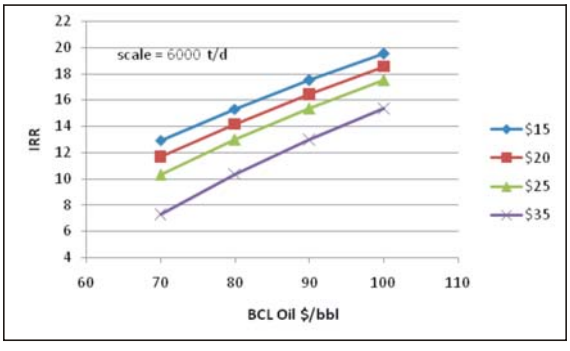

Figure 2. Correlation of coal price and BCL oil price to the IRR value of Pendopo coal liquefaction plant

ever, if the oil price is under US$70/bbl and coal price is US$ 45/t or higher the IRR value of Mulia coal liquefaction plant will achieve less than 10%. Considering the fact that Mulia coal can be sold at the price above US$ 45/t and there is no guarantee that the oil price will remain above US$ 70/barrel, the construction of Mulia coal liquefaction plant should be reconsidered.

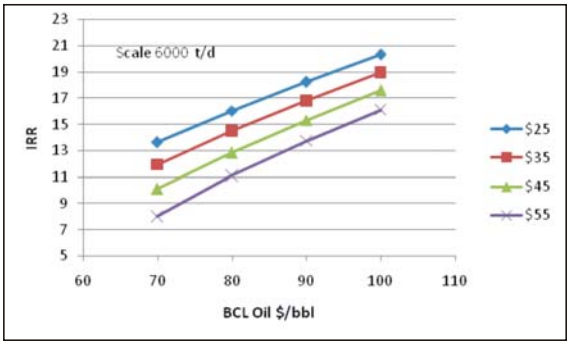

Figure 3. Correlation of coal price and BCL oil price to the IRR value of Mulia coal liquefaction plant

Based on Investment Law of the Republic Indonesia Number 25 of 2007 government of Indonesia may give incentives through reduction of income tax for pioneers industry such a coal liquefaction plant. Figure 4 shows the influence of income tax reduction on the IRR. Corporate income tax in Indonesia presently is 30%. Reducing of corporate tax from 30% to 15% will increase the IRR value of Pendopo coal liquefaction plant about 1% .

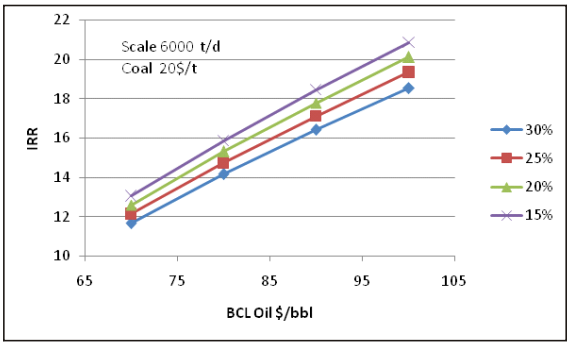

Figure 4. The effects of corporate income tax reduction to the IRR value of Pendopo coal liquefaction plant

Figure 5 shows the influence of plant's scales to their IRR value. Under plant's scale of 3,000 ton/day, the IRR value of Pendopo plant is less than 10% even the coal price was US$ 20/ton. On the other hand when the plant's scale is 12,000 ton/day the IRR value is expected to achieve higher than 10% even at oil price of US$ 60/bbl. The increasing plant scale 12,000 t/d has the IRR value of 5% higher compared it to 3,000 t/d plant scale. Thus, it is expected to construct larger scale of coal liquefaction plant to improve the economics of the plant. The detail financial analysis of Mulia coal liquefaction plant can be found elsewhere (Kobe Steel and Sojitz, 2008; Tamura, 2007).

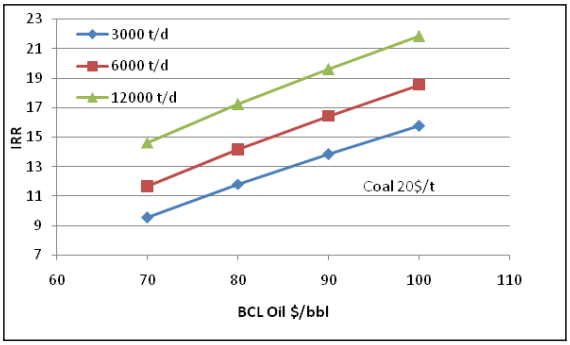

Figure 5. The effects of plant scales to the IRR value of Pendopo coal liquefaction plant

6. CONCLUSION

Financial analysis of coal liquefaction plant using two kinds of coal (Pendopo and Mulia coal) constructed in two different locations has been conducted. Mulia coal liquefaction plant does not give viable return if Mulia coal price of above US$ 55/ton and oil price of less than US$ 70/barrel (Figure 2). On the other hand, Pendopo coal with a very low quality (total moisture 55% adb, ash 7.8% adb) can be utilized as alternative feedstock for coal liquefaction plant. If the oil price above US$ 70/bbl and coal price less than US$ 25/ton, the plant's IRR value is always higher than 10%. Reducing corporate tax from 30% to 15% increase the IRR value around 1% while scaling up the plant from 3000 ton/day to 12,000 ton/day improve the IRR value about 5%.

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