ECONOMICS OF BCL PROCESS FOR BERAU AND MULIA COAL IN KALIMANTAN

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Abstract
BPPT dan Kobe Steel telah berhasil melaksanakan studi kelayakan (1999-2001) pencairan batubara untuk memproduksi bahan bakar bersih dari batubara BAnko Sumatera Selatan. Pada tahun fiscal 2002 lokasi pabrik dan bahan umpan sudah digantikan dengan lokasi tepi pantai. Tujuan utama studi untuk menginvestigasi pengaruh lokasi pabrik terhadap keekonomian proyek, dan identifikasi kelayakan proyek pencairan batubara secara langsung sebagai pabrik komersal priponir di Indonesia. Tuisan ini membahas secara ringkas analisa keekonomian pabrik. Ditemukan kualitas batubara Mulia dan Berau mempunyai karakteristik pencairan yang superior, pabrik pencairan pionir seharusnya dibangun di tepi pantai. Terdapat reduksi yang signifikan dalam biaya konstruksi, shipping, dan biaya transportasi produk. Analisis financial berdasarkan metode DCF merekomendasikan pabrik dengan kapasitas 12,000 ton per hari menghasilkan minyak batubara pada tahun 2011, pada tingkat harga US$ 23.3/bbl FOB Berau Lati and US$ 26.1/bbl FOB Mulia Satui. Minyak batubara hasil pencairan batubara Berau lebih murah dari Mulia karena batubara Berau kadar airnya lebih rendah dan struktur yield produk lebih baik. Pabrik pionir skala 3,000 ton per hari di Berau Lati mungkin layak jika diberikan insentif dapat menghasilkan harg ayang lebih rendah, bunga pinjaman lebih rendah dan lainnya.

Keywords: *batubara berau, batubara mulia, pencairan batubara, kasus dekat pantai, sensitifitas, analisis keekonomian*

1. INTRODUCTION

Rapid population and economic growth particularly in the Asian countries has driven sharp increase in oil demand. Because of resource limitation of conventional petroleum, there will be a worldwide shortfall in petroleum fuels in near future. This shortfall will impact the countries by constraining their ability to maintain their share of imports, and as a result, world is likely to experience a liquid fuels shortfall anytime between 2005 and 2030. Producing high quality fuels from coal is one option to alleviate this shortfall. If the coal conversion is to play a significant role in alleviating the liquid fuel supply problem, then the liquefaction technologies must be in the state of readiness for commercial deployment. Because lead times for the introduction of new energy technologies are on the order of 10 years after technologies are technically ready for commercial deployment, the countries must come to grips with this problem in no time.

The direct coal liquefaction technology has undergone very significant improvements over the past decade by continuing R&D and achieved a high level of technical readiness. Therefore, it is a good opportunity to evaluate the advanced technology applied in this country having huge amount of low-rank coal resources. BPPT and NEDO/Kobe Steel Ltd. (KSL) have conducted the feasibility study since 1999 for the production of clean fuels from Banko coal in South Sumatra .

The study has been fully supported by Nissho-Iwai Corporation, PT Arutmin in South Kalimantan and PT Berau Coal in East Kalimantan. This fiscal year of 2002, possible plant sites and feedstock coal have been altered to those at coastal location, according to the memorandum of understanding between NEDO and BPPT on May 13th 2002. The major objectives of this feasibility study are, first, to investigate the effect of plant location on the project economics, and then identify the potential feasibility of direct coal liquefaction project at a pioneer commercial plant in this country. This paper presents the summary of economical analysis of the pioneer plant. Some sensitivity Analysis is conducted to investigate the effect of changes in raw coal pricing and bank interest rate.

2. CONCEPT OF COMMERCIAL PLANT

Based on technical information acquired in the pioneer plant investigations, as well as the Indonesian situation, a concept of a pioneer plant is summarized in Table 1.

Table 1. Major Concept of Liquefaction Plant (Anon, 2003)

Plant Site	Satui, South Kalimantan & Berau Lati, East Kalimantan
Plant Scale	3,000t/d, 6,000t/d, 12,000t/d dafc basis
Feed Coal	Mulia Coal (moisture 35.0%wb, ash 5.1%db) Berau Coal (moisture 25.1%wb, ash 7.3%db)
Product	Synthetic Transportation Fuels, LPG, Chemicals
Process Applied	Improved BCL Process
Hydrogen Source	Coal Gasification by HYCOL Process
Shipping Terminal	Satui, South Kalimantan & Berau, East Kalimantan

2.1. Plant Scale

The pioneer plant was assumed to have capacity of 3,000 t/d, 6,000t/d and /or12, 000t/d on moisture and ash free coal basis. The relatively small capacity, 3,000 t/d scale was newly adopted in place of 30,000 t/d full capacity to reduce initial investment.

2.2. Plant Location

Because Mulia and Berau coal deposits are located near the Java Sea and Berau river, the plant locations were naturally sited near the mine mouth, and at the same time, near the coasts as mentioned in the Conceptual Design. Figure 1 shows possible plant sites for coal liquefaction.

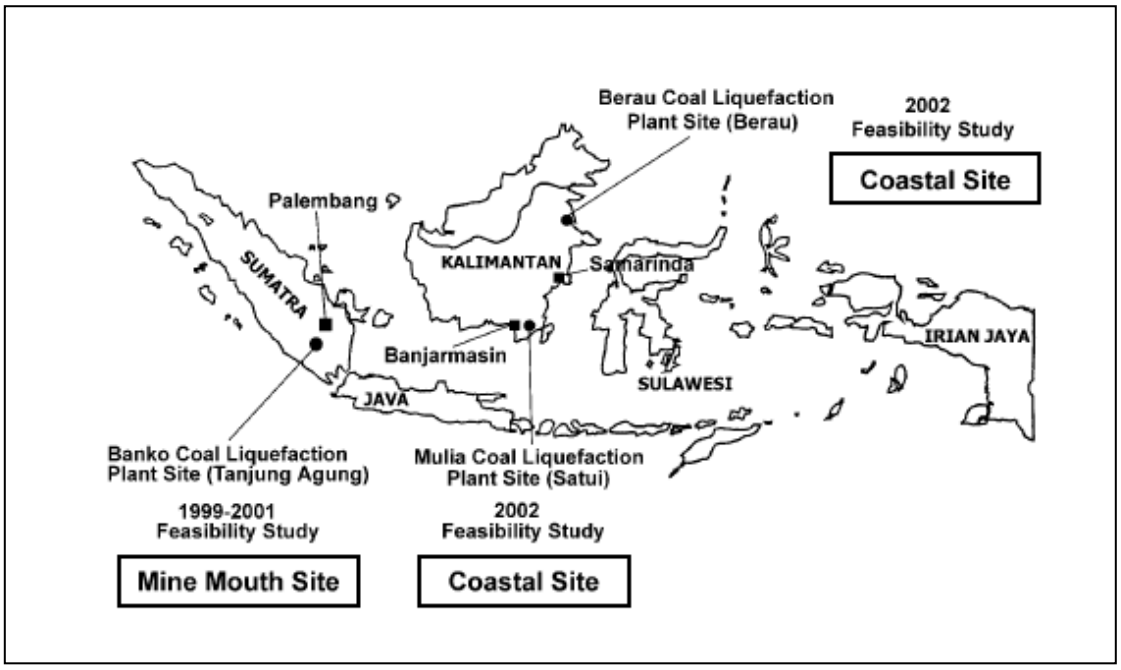

Figure 1. Possible Plant Site at Coastal Area for Coal Liquefaction

2.3. Hydrogen Source

There are the two sources for production of hydrogen gas, which is essential feedstock for the coal liquefaction. In this study, the entrained coal gasification (HYCOL) process using Mulia and Berau coal were adopted for hydrogen generation in view of difficulty of supply natural gas which generates hydrogen via steam reforming.

2-4. Shipping Terminal

Assuming that the liquefaction plant would be located adjacent to the coal mine mouth, the product oil must be transported to the existing crude petroleum oil refineries for further blending treatment. This study assumed to transport the product oil from the liquefaction plant by newly constructed shipping terminal as described in the Conceptual Design. One of advantages of coastal location of the plant is to shorten the

distance between the terminal and liquefaction plant, which brings significant reduction of shipping cost

2-5. Feed Stocks and Products

Feed stocks required and products from the pioneer plant are shown in Table 2. In the case of 6,000t/d plant, this plant would produce liquefied clean oil at approximately 27,000 barrels every day from the raw coals of approximately 15,300(Berau)–17,600(Mulia) tons which include coal for gasification and boiler sections.

Table 2. Feed Stocks and Products

Plant Scale			3,000t/d	6,000t/d	12,000t/d
Mulia Coal	Coal Consumption	t/d raw coal	8,800	17,000	35,200
	Oil Production	bbl/d	13,500	26,900	53,800
Berau Coal	Coal Consumption	t/d raw coal	7,640	15,300	30,600
	Oil Production	bbl/d	13,500	27,000	54,000

3. PROCEDURE OF ECONOMIC ANALYSIS AND LIQUEFIED OIL PRICE ESTIMATES

3.1 Estimated Selling Prices at Shipping Terminal

Based on the technical results obtained in this study, estimates were made as to the selling prices of product oils with fixed return on equity (ROE: 10%) ratio. The Discount Cash Flow Rate of Return (DCF) method was used to calculate the selling prices. The net cash flow of each year from the year of construction commencement to the last year of operation is converted to an equivalent in the first year of operation by using a discount rate. The oil selling price required in the first year of operation is determined on the assumption of fixed Return on Equity (ROE) so that the total of the discounted annual cash flow is zero.

3.2. ROE under the Market Price Mechanism

Indonesian government announced that the domestic fuel oil prices will be no longer subsidized in the year of 2004 which means the domestic fuel oil prices will follow the international prices. As inspected in the last feasibility study, ROE was checked against the recent international market prices.

4. MAIN CONDITIONS AND ASSUMPTION FOR FINANCIAL ANALYSIS

Financial analysis was carried out with the following major assumptions to estimate the liquefied oil selling prices.

4-1. Construction Cost

To obtain the construction cost estimates, the exponential method was generally applied. Scale-up or scale-down factors were set for each section by considering its specification and characteristics. The overall construction costs of the 3,000t/d, 6,000t/d and 12,000 t/d pioneer plant in Indonesia are presented in Table 3. These costs include not only for liquefaction plant but for pipeline and shipping terminal

Table 3. Construction Costs of Commercial Plant

Plant Scale	Mulia Satui		Berau Lati	
	MM US$	US$/ daily bbl	MM US$	US$/ daily bbl
Cost for 3,000 t/d single train	799.8	59,450	808.3	59,870
Cost for 6,000 t/d single train	1,342.1	49,880	1,357.7	50,280
Cost for 12,000 t/d double trains	2,368.2	44,010	2,399.3	44,430

The above construction costs include:

- coal gasification plants to generate hydrogen gas.
- pipeline and terminal for product transportation and
- shipping.
- construction cost divided by daily production oil makes
- another index of capital cost.

4.2. Exchange Rate

Currency exchange rates were assumed for 1US$=120¥=9,500Rp, that are annual average of year 2001 to compare the mine mouth case of the last study.

4.3. Land Price

Because of limited information from Indonesia side, an expected land unit price was set at 1.5US$/m2 for Mulia Satui case, which is same price, applied in the last study. The price includes land fee and cost for land cleaning and leveling. In case of Berau Lati case, land price will be free.

4.4. Plant Staffs and Unit Labor Cost

Personnel requirement for the both pioneer plants is shown in Table-4.

Table 4. Manpower Requirement and Cost

Plant Scale	Mulia Satui	Berau Lati
Cost for 3,000 t/d single train	524	512
Cost for 6,000 t/d single train	576	565
Cost for 12,000t/d double trains	973	963

These numbers were estimated by the experience of the pilot plant operation. Each number includes the staffs for the shipping terminal. Since the terminal at Berau Lati is located side by side with the liquefaction plant, the staff at the terminal can be reduced by the utilization of staff in the liquefaction plant. Their mean annual labor cost was also estimated at 9,800$/man.year by the information of Indonesian side.

4-5. Related Taxation

Related taxation was referred to Indonesian side information as shown in Table 5.

Table 5. Related Taxation

Tax	Indonesia
Municipal Property Tax	0.1%
Corporate Tax	30%

4-6. Coal Prices for Feed Stock

PT. Arutmin and PT. Berau supplied the typical coal prices as shown in Table-6. They recommended plural number of different prices in accordance with the amount of raw coal supply. The coal price varies from 11 $/t-raw coal (14.68 $/t-dry coal Berau) to 13 $/t-raw coal (20.00 $/t-dry coal Mulia) at the battery limit of the liquefaction plant.

Table 6. Raw Coal Prices for Feed Stock

Mulia Satui		
Plant Scale	Annual Demand	Coal Prices
3,000 t/d-dafc	2.73MMtons	13$/t-ROM
6,000 t/d-dafc	5.46MMtons	13$/t-ROM
12,000 t/d-dafc	10.93MMtons	12$/t-ROM
Berau Lati		
Plant Scale	Annual Demand	Coal Prices
3,000 t/d-dafc	2.37MMtons	12$/t-ROM
6,000 t/d-dafc	4.74MMtons	11$/t-ROM
12,000 t/d-dafc	9.48MMtons	11$/t-ROM

Note: ROM (Run of Mine), same as raw coal

4.7. Electric Power

In the last Applicability Study, the unit price of electricity from PLN was set at 0.05$/kWh, because 10% of the total electricity demand was planned to purchase from PLN. Although there is a small coal fired power plant at Asam Asam Dolam, South Kalimantan, it could not be expected to use their power in the liquefaction plant due to the shortage of supply. The main equipment such as hydrogen compressors and slurry boosting pumps in the liquefaction plant require high standard of power with no power dip and no frequency fluctuation. Therefore, whole (100%) power requirement shall be covered by the power plants of its own.

4.8. Transportation of Product Oil

The product oils must be transported and shipped for deliver. Because the plant site has moved to coastal area from the mine mouth, the distance between liquefaction plant sites and shipping terminals became drastically close. In the mine mouth case, the product oil has to be transported to Pladju (approx. 202 km) or Tanjung Api-Api (approx. 265 km) from the plant site at Tanjung Agung. Now the length of pipeline became less than 1km for Berau Lati case or 12km for Mulia Satui case, which derives significant reduction of shipping cost.

4-9. Crude Oil Equivalent (COE) Factor

The liquefied product oil prices are calculated by DCF method using the assumptions, and then the prices equivalent to petroleum crude oil values are calculated in order to compare with petroleum crude oil prices, because the liquefied product oil is defined as “Ultra Light and Clean Oil”. The liquefied oil is shipped after “In-line Hydrotreating” followed by the “Upgrading within the liquefaction process. The factor is obtained by dividing the product value of liquefied oils versus the value of petroleum crude oil. This is regarded as the price conversion factor usable to express the product value as an equivalent crude oil price. In the last study on Banko coal liquefaction, the factor of 1.3 was applied partially as COE, but no such factor is used in this study, therefore, the difference in quality of liquefied product oil must be always understood when comparing both oils at the same price.

4.10. Summary of Economic Assumptions

Summary of assumptions for financial analysis is shown in Table 7. In order to carry out the price estimate in US$, all prices in 2002 were converted to US$ and then calculation have been made using interest rates, inflation rates, etc. applicable to the USA.

5. RESULT OF ECONOMIC ANAYSIS

5-1. Estimated Selling Price at Shipping Terminal

The prices of the ultra-clean product oil, which will be sold from the years of operation commencement, were calculated. Table 8 shows the calculation results using the above conditions and assumptions (Base Case). The our product oil will be enthusiastically received, if the price calculated is at least same as the crude oil price at any time given. The results are expressed in terms of actual selling prices for a 10% return on equity.

Table 7. Summary of Main Conditions and Assumptions for Economic Analysis

Raw Coal Price $/t : -**Mulia**	13(6,000t/d) 12 (12,000t/d) 11(30,000t/d)
-Berau	12(6,000t/d) 11 (12,000t/d) 11(30,000t/d)
Crude Oil Equivalent Factor	1.00
Construction Period	4 years
Operating Period	25 years
Operation Factor	310days/year
Equity Ratio	25%
Maintenance Cost	3% per year on construction cost
Property Tax Rate	0.10% per year
Company Income Tax Rate	30% per year
Return on Equity (ROE)	10% per year
Bank Interest Rate -**Long term**	7.0% per year
-**Short term**	5.0% per year
General Inflation Rate	3.5% per year
Feed Coal Price Escalation	3.5% per year
Liquefied Oil Price Escalation	3.5% per year
Natural Gas Price Escalation	3.5% per year
Construction Cost Escalation	3.5% per year
Labor Wage Escalation	3.5% per year

For example, in the case where construction for a 12,000t/d pioneer plant will commence from 2007 based on the BCL process, and the products will be sold from 2011, the selling price at the shipping terminal will be varied from 23.3US$/bbl (Berau case) to 26.1US$/bbl (Mulia case) at a base of real value (excluding general inflation) condition. These prices are well lower than the price of mine mouth case. In fact, oil price from the 3,000t/d plant in Berau Lati become cheaper than that from the 6,000t/d plant in Banko Tanjung Agung. Furthermore, there is a difference of 6US$/bbl between “Berau” and “Banko” in the product oil selling prices under the same plant capacity (12,000t/d) (Anon, 1997; Anon, 2002). That is why everyone will be encouraged who intends to realize a coal liquefaction project in this country.

Table 8. Product Oil Selling Prices at Shipping Terminals (Anon, 2002; Anon, 2003)

Plant Sites	Mulia Satui	Berau Lati	Banko ref.
Product Oil Selling Price			Terminal Plaju
3,000t/d US$/bbl	33.4	29.3	-
6,000t/d US$/bbl	29.1	25.8	33.3
12,000t/d US$/bbl	26.1	23.3	29.3
30,000t/d US$/bbl	-	-	26.3

Notes
- Prices shown are actual value excluding general inflation.
- Construction starts in fiscal year of 2007, operation commencement in fiscal year of 2011

What is major cause to bring such difference? Following Figure 2 breaks down factors of the difference i.e., 2.8US$/bbl (47% of 6$/bbl) is resulted from the change of plant location and 3.2US$/bbl (53%) from the change of coal.

Figure 3 shows a correlation between the plant scale and the oil-selling price. If the recent trend of petroleum oil product prices (Ave. 30.3US$/bbl) will be continued, feasible plant scale will be 2,500t/d for Berau, 5,000t/d for Mulia and 1,1000t/d for Banko coal respectively. However, when the selling price will drop to around 25US$/bbl, feasible and smallest plant size increases to 7,500t/d for Berau, 15,000t/d for Mulia coal respectively. On the other hand, Banko coal liquefaction case may not be feasible even if the plant is extended to more than 30,000t/d (Anon,1997; Anon, 2002).

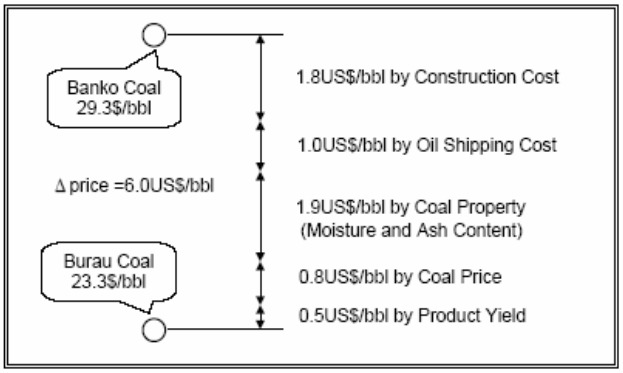

Figure 2. Effect of Major Project Conditions on Oil Selling Prices

5-2. Return on Equity under the Market Price Mechanism

Since Indonesia came up against the economy crisis occurred in the middle of year 1997, the

subsidy for the domestic fuels has increased significantly. Such high subsidy forced the government to increase the domestic fuel prices gradually from 1998 until 2004 where the fuel prices will be no longer subsidized. The amount of subsidy is estimated to decrease to Rp 53.8 billion in 2001 and Rp 32.3 billion in 2002. If the domestic fuel prices will follow the international prices in the year 2004, each type of oil based fuel (OBF) will be priced around Rp 2,000 (March 2002 base).

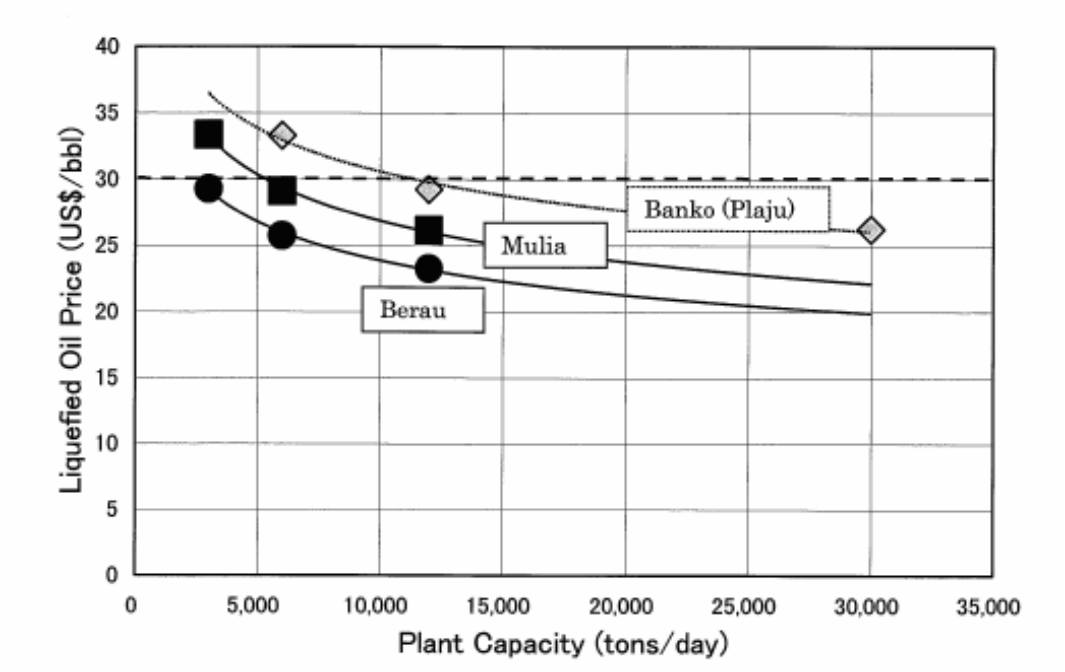

Figure 3. Correlation between Plant scale and Oil Selling Price

The above market prices consist of the price of basic material plus processing, distribution, transportation and overhead costs at Pertamina. According to the estimation results carried out by Pertamina, such cost varied Rp 190-240 range when they projected the subsidy for each fraction of 2001's selling price based on Presidential Decree No. 135/2000. If the liquefied oils can be sold at the price which deducts the above costs from the market price, the actual selling price of liquefied oil at the terminals would be Rp 1,809/liter or about 30US$/bbl (Table 9)

Table 9. Possible Selling Price of Liquefied Oil at Terminal (Anon, 2003)
(Mulia Coal Liquefied Oil)

Unit : Rp./liter

Type of OBF	Market Prices*1	Cost*2	Material Price	Liquefied Oil Yield %dafc	Selling Price □
Premium	2,057	240	1,817	LO 31.2	1,817
Kerosene	2,106	220	1,886	MO 26.2	1,862
Diesel Oil	2,047	210	1,837		
Fuel Oil	1,737	191	1,546	HO 6.1	1,546
Average	-	-	-	-	1,809

1,809/9,500 x 159 = 30.3 US$/bbl

(Berau Coal Liquefied Oil)

Unit : Rp./liter

Type of OBF	Market Prices*1	Cost*2	Material Price	Liquefied Oil Yield %dafc	Selling Price
Premium	2,057	240	1,817	LO 30.9	1,807
Kerosene	2,106	220	1,886	MO 22.2	1,862
Diesel Oil	2,047	210	1,837		
Fuel Oil	1,737	191	1,546	HO 10.6	1,546
Average	-	-	-	-	1,790

1,790/9,500 x 159 = 30.0 US$/bbl

Notes of table-9:

*1 Singapore market prices in early 2003, they change according to the international market price of oil.

*2 Processing, distribution, transportation and overhead costs total

Figure 4 compares the plant scale on the return on equity (ROE) under the standard economic condition mentioned in Table7. Although the selling price of the liquefied oil is subject to the international market, if the product oil could be sold at 30$/bbl in 2011, ROE of Mulia coal case varies from 6.5% to 14.5% depend on the plant size. In case of Berau coal case, project feasibility become more realistic. In fact, ROE is boosted up from 10.8% to 17.6%. It is certainly significant improvements in ROE upon the previous study. (see table 10)

Table 10. Comparison of ROE under Selling Price of 30$/bbl

Plant Sites	Mulia Satui	Berau Lati	Banko ref.
3,000t/d ROE %	6.5	10.8	-
6,000t/d ROE %	11.3	14.9	6.7
12,000t/d ROE %	14.5	17.6	10.7
30,000t/d ROE %	-	-	14.4

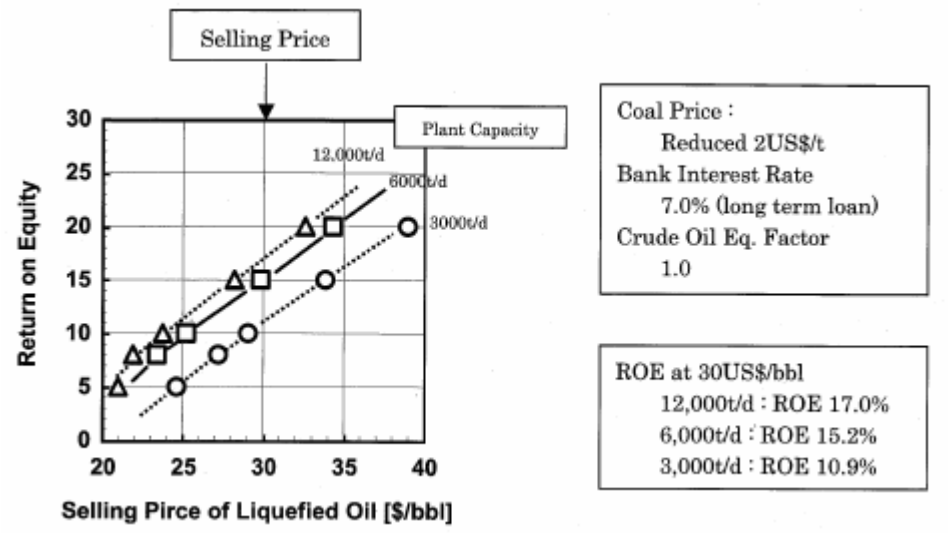

Figure 7. Effect of Coal Price on Return on Equity (Mulia coal case)

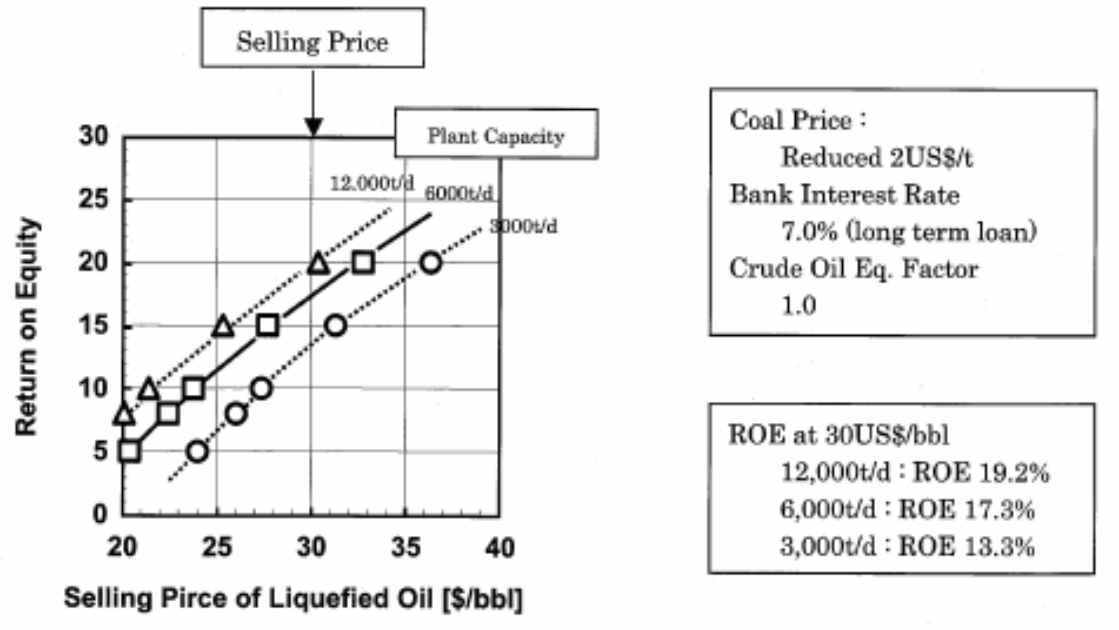

Figure 8. Effect of Coal Price on Return on Equity (Berau coal case)

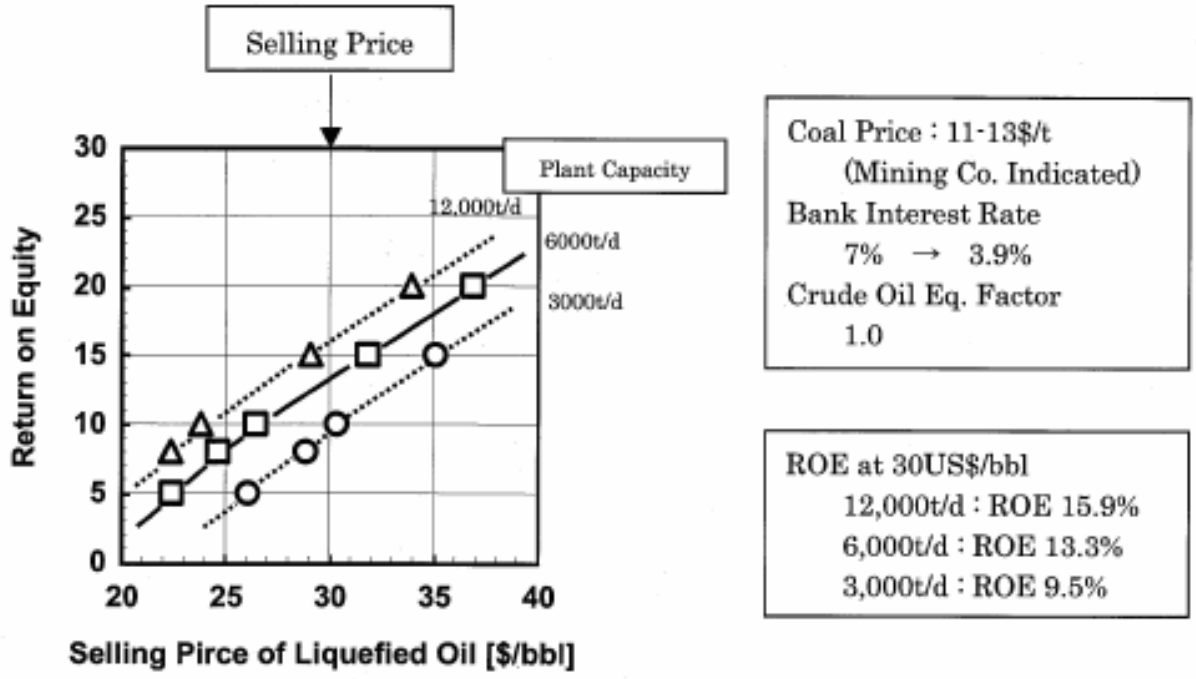

Figure 9. Effect of Bank Interest Rate on Return on Equity (Mulia coal case)

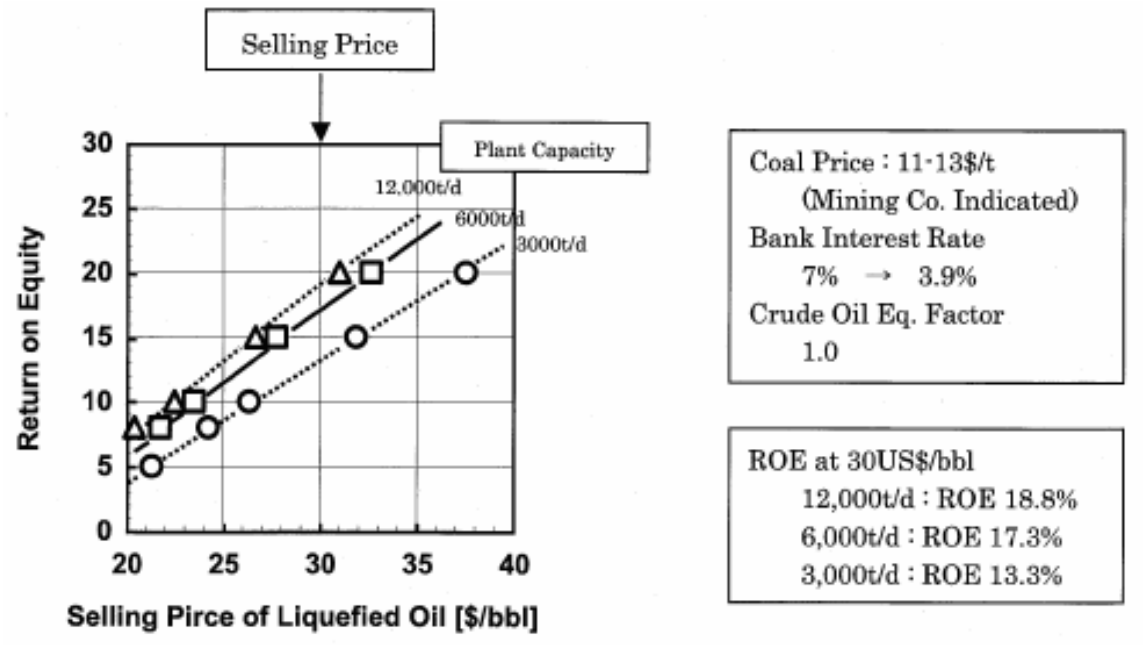

Figure 10. Effect of Bank Interest Rate on Return on Equity (Berau coal case)

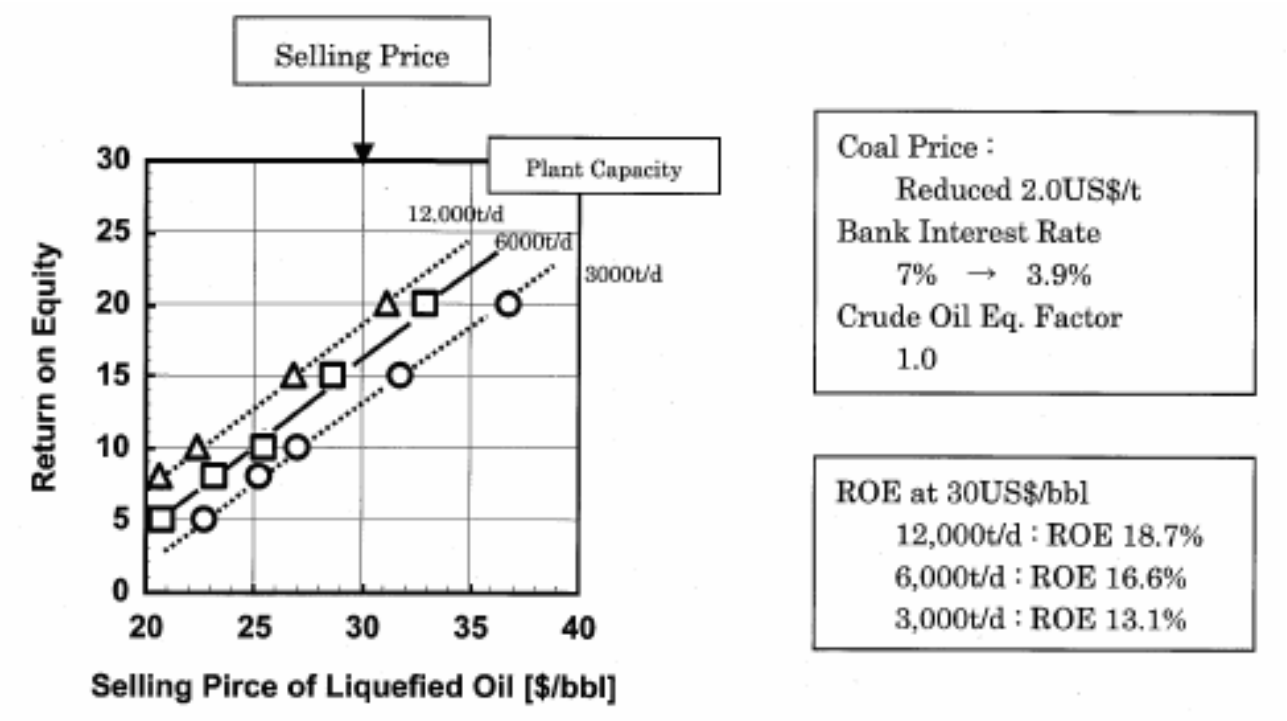

Figure 11. Effect of Coal Price and Bank Interest Rate on Return on Equity
(Mulia coal case)

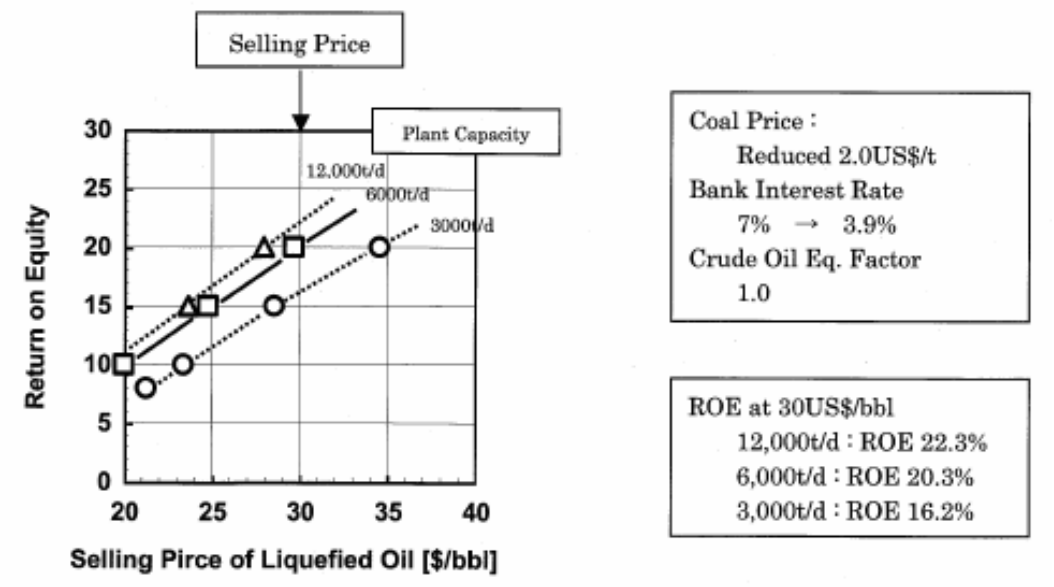

Figure 12 Effect of Coal Price and Bank Interest Rate on Return on Equity
(Berau coal case)

6. SENSITIVITY ANALYSIS

The economic sensitivity analysis was carried out to inspect the impact of changes in raw coal pricing and bank interest rate. Figure 5 and Figure 6 shows the effect of the plant scale on ROE under the standard condition (so called as Base Case). Figure 7 and Figure 8 present the effect of raw coal prices. For the 3,000t/d case, a change in raw coal price by 2US$/t-raw coal changes the ROE by 4.4% (6.5%→10.9%) for Mulia coal case while ROE of Berau coal case improves by 2.5% (10.8%→13.3%).

Another analysis was executed for bank interest rate as shown in Figure 9 and Figure 10. If the Japanese Environmental Yen Credit will be applied to this project by half of the total loan, the mean interest rate goes to 3.875%. From the figure, in the case of 3,000t/d plant scale, the decreasing bank interest rate by 3.125% (7%→3.875%) increases the ROE by 3.0%(6.5%→9.5%) for Mulia coal case and 2.5%(10.8→13.3%) for Berau coal case. This gives also a significant impact on the feasibility of the liquefaction project.

The third analysis is the effect of coal price and interest rate. Figure 11 and Figure show that the decrease in both important conditions will bring the highest ROE, 16.2% (3,000t/d), 20.3% (6,000t/d) and 22.3% (12,000t/d) respectively. These high ROE have never seen through the similar feasibility studies on the direct coal liquefaction. Several important technical innovations have been achieved over the last decade especially the development of the “Advanced BCL Process” followed by “Improved BCL Process”. Current configurations that include slurry-bed liquefaction stage and in-line hydrogenation stage can produce distillate products having low heteroatom content with high hydrogen content. It can be believed that the good process, good location and good coal will realize a pioneer plant in this country.

The governments can do much to encourage the establishment of a coal liquefaction industry not only for the expenditure of treasury funds, but also taxation, acceleration of plant depreciation etc. Such incentives could lead the additional opportunity of employment and the revenue collections, particular in the Kalimantan region.

7. CONCLUSION

The feasibility studies on the coastal location have been carried out to compare the in-land mine mouth case.

Because of the superior quality of Mulia and Berau coal in liquefaction characteristics, the possibility of construction for a pioneer liquefaction plant has been in progress by this study.

Comparing with the in-land case, the coastal case has advantages in saving construction cost and shipping cost

The financial analysis based on DCF method has brought perspective results that the proposed pioneer plant which has 12,000t/d capacity could produce liquefied oil in the year of 2011, at prices of: FOB at Berau Lati US$ 23.3/bbl at actual price (COE=1.0), FOB at Mulia Satui US$ 26.1/bbl at actual price (COE=1.0). Thus, Berau coal liquefaction has a clear advantage over Mulia

coal liquefaction by the low moisture content and better product yield structure. A small pioneer plant (3,000t/d) at Berau Lati may be feasible if some incentive could be expected such as lower coal price, lower interest loan and other.

The governments can do much to encourage the establishment of a coal liquefaction project not only for the expenditure of treasury funds, but also taxation, acceleration of plant depreciation etc. Such support could lead the additional opportunity of employment and the creation of new industrial sectors, particular in the east Kalimantan region.

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