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Economic evaluation of the existing and potential Indonesian coal utilization

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Abstract: The whole efforts of the Indonesian Government in diversifying the available domestic coal reserves in the forms of solid, liquid (synthetic oil) and gaseous fuel is made possible to overcome the depleted domestic oil reserves. Within the coming few years Indonesia will become net oil consumer after as the net oil importer in 2003. Within the current forty years Indonesian energy consumption was heavily depending on oil fuel. To meet the increasing domestic energy demand, the large quantity of domestic coal reserves should be diversified into briquette, synthetic oil and synthetic gas, and also as other non-fuel or chemical products. All these diversified products are expected to be competitive economically as well as environmental friendly by using clean coal technology. This article is as result of evaluation of the existing commercial scale utilization and the research results compilation of the Indonesian coal utilization and diversification within the last 15 years.

Keywords: Coal Diversification, Economic Benefit, Clean Coal Technology

1. Introduction

The Indonesian oil reserves are still able to produce crude oil up to 10-15 years to come. Since 2003 Indonesia has been a net oil importer country, and in 2016 it is predicted to be the real oil fuel net consumer. The other alternate is coal. Indonesia owns the coal reserves of about 28.17 billion tons (of 161.34 billion tons of coal resources) (Sukhiyar, 2010; Agency for Geology, Ministry of Energy and Mineral Resources (MEMR), 2011). At the level of 400 million tons of annual coal production, the life time would reach around 100 years based on the extraction recovery of 75%, so that the Indonesian people is given for another 100 years of energy survival. As a whole, either direct or indirect utilization of coal within that period would be able to be in function as bridge of energy from the present era of oil and gas toward the future era of new and renewable energy (nuclear, bio, etc) from the current era of fossil fuel.

The national primary energy mix in the year of 2010, coal consumption is of about 26.4% (or 281.4 million BOE) out of the total national primary energy demand of 1,066.8 million BOE (Anonymous (k), 2011) and is projected to be around of 22.0%-34.6% (or 627.44 – 1,487.8 million BOE) out of the total national primary energy demand of 2,852 – 4,300 million BOE in the year of 2025. (Suhala,, 2011, 2012; Ariyono, 2010). The projection of the energy demand 2011-2020 based on its respective original unit could be seen on Table 1. (Anonymous (l), 2011).

Coal resource potential in Indonesia is mainly distributed in two islands i.e. Sumatera island and Kalimantan island. It is amounted to 161 billion tons, where 49.2% is mainly located in eastern and southern Kalimantan and 50,5% in southern Sumatera area (Figure 1). The remainder is distributed in other areas of the country. The characteristics of the coal reserves can be seen that 12% is high calorific value of coal and the remainder is mostly low and moderate calorific value of coal or low rank coal.

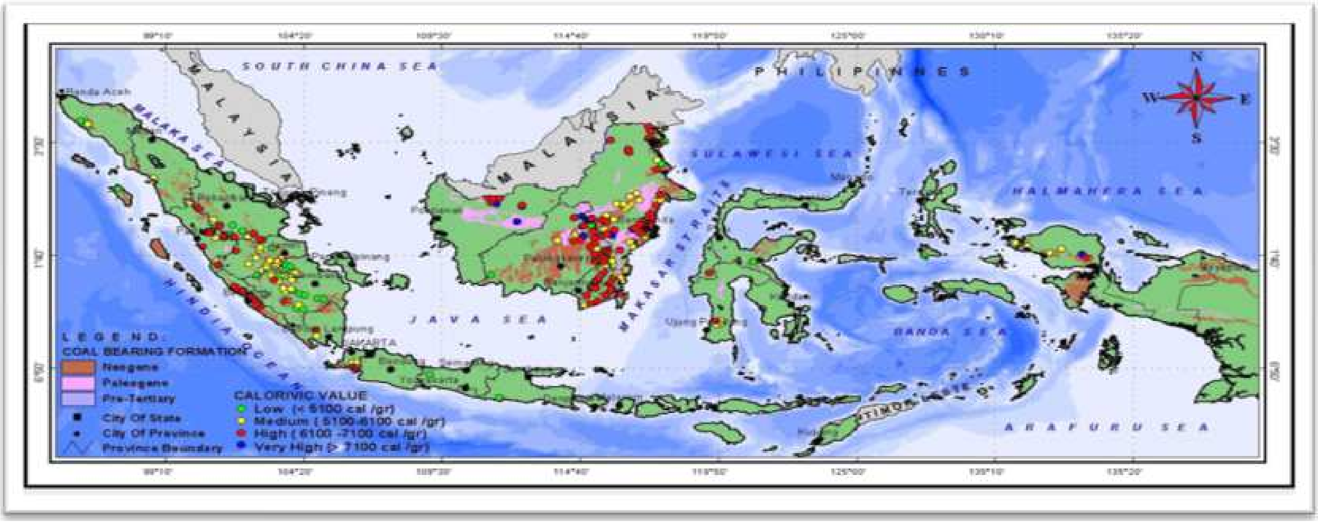
The development program of Indonesia coal diversification is based on several considerations such as the limited reserves of oil in Indonesia facing the ever increasing demand for oil fuel annually. In 2003, Indonesia had been the net oil importer, then the supply of synthetic oil should be anticipated, especially for the transportation sector. The successfulness of the national efforts of energy diversification and conservation should be extensively enlarged and intensified. The existing transportation sector will still badly be depending in on fuel oil.

The aim and scope of the evaluation may include the following items, a. o., to evaluate the results of coal diversification effort that may include coal as direct and indirect fuel, and also as non-fuel purposes; the financial aspects of the feasibility study (FS) results of indirect coal utilization; the effects of substitution; the multiplying effects of the project on the regional development; and the comparability of inter-fuel, such as on its price and availability.

Table 1. *The Trend of Fuel Demand in Indonesia, 2011-2020*

No.	Fuel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	HSD (x 10^3 kl)	7,464.3	4,610.8	2,274.8	131.8	833.5	595.2	545.7	550.8	589.3	833.0
2	MFO (x10^3kl)	1,604.7	1,190.3	577.3	159.7	34.1	37.3	36.9	39.5	44.8	39.8
3	Gas (bcf)	329.8	337.8	358.4	365.3	344.3	341.4	277.1	197.7	211.1	227.2
4	LNG (bcf)	-	59.6	47.9	90.8	120.4	122.1	170.7	240.7	248.2	263.7
5	Coal (10^3Tons)	47,794.7	59,325.4	73,788.3	82,954.0	88,754.9	96,002.2	101,422.6	109,263.6	116,691.0	125,737.7SS
6	Biomass (10^3Tons)	49	49	49	49	49	49	49	49	49	49

Sources: Anonymous (1), 2011.



Sources: Agency for Geology, Ministry of Energy and Mineral Resources, 2011. Coal resources 161 billion tons (120 billion tons open pit & 41 billion tons underground). Coal reserves 28 billion tons.

Figure 1. *Distribution of Coal Resources in Indonesia*

The methodology used in this study is among others based on the historical results of investigation carried out by the Indonesian Government (MEMR, and the Agency for Assessment and Application of Technology/BPPT) in cooperation with the Government of Japan (NEDO), and then analyzed by using micro-and macro-economic models substantially. Moreover, then it can be reviewed how far the role of the coal diversification effort to the Indonesia economy and energy spectrum in the future.

Diversification of coal utilization may include several processes as the followings, direct and indirect utilization. In direct utilization, coal could be used as direct fuel in industry for instance steam generating power plant, cement industry, steel plant, drying oven, small industry. Indirect coal utilization could be carried out in several processes, such as coking process, coal briquette, bio-coal, cokes, UBC, producer gas, coal gasification (Anonymous (a), 2007; Anonymous (d), 2000; Anonymous (e), 1980); coal liquefaction. (Anonymous (e), 1980; Anonymous (f), 2002; Anonymous (g), 2003); besides also as industrial materials such as activated carbon, etc. The efforts of increasing the Indonesian coal added value has been carried out since long time ago, since the years of 1950s investigation on making blast furnace coke carried out by the GOI in cooperation with Wedexro Germany. Within 1970s and 1980s up to the present investigation on making coal briquette in the purpose of substituting fire wood, kerosene and IDO. In the mid 1990s up to the present, intensive investigation on coal liquefaction and gasification in cooperation with the Government of Japan (NEDO and JICA).

2. Results Analysis and Discussion

2.1. Results of Coal Utilization

2.1.1. At the Existing Commercial Scale

2.1.1.1. Utilization of Coal as Direct Fuel for Producing Electricity, Cement, Steel, Pulp and Paper, Textile, Metallurgical Industries and Others

Utilization of coal in the steam power plant is to produce steam to generate electricity. In this country, presently there are of about 27,000 MW electrical power plant consisted of hydro-electrical power plant, steam power plant (by gas, oil fuel and coal fired), and geothermal power plant. Indonesia has developed steam electrical generating plant of about 20,500 MWs in the year of 2000 up to 9,452 MWs in 2010. Presently, this steam power plant mostly consumes coal as fuel of around 40 million tons of coal per year. The increasing projection of electricity production in Indonesia would be doubling within 2011-2020 from 185,197 GWh (114.67 million BOE) up to 371,374 GWh (229.95 million BOE), that can be seen on Table 2.

Table 2. *Composition of Electricity Production Based on Types of Fuel in Indonesia (GWh), 2011-2020*

No.	Fuel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	HSD	29,846	17,346	8,658	4,331	2,549	2,466	2,316	2,261	2,428	2,635
2	MFO	10,037	4,807	2,385	556	44	56	51	65	85	65
3	Gas	32,017	42,691	46,158	46,002	43,441	43,118	35,657	25,992	28,331	30,879
4	LNG	-	7,578	6,113	10,970	14,817	15,068	20,874	29,394	30,088	31,541
5	Coal	93,049	110,043	134,578	151,524	163,311	178,749	193,084	207,868	221,392	238,432
6	Hydro	11,149	11,204	12,363	12,791	13,841	16,292	17,704	19,349	20,429	21,429
7	Solar/Hybrid	2	4	4	5	6	6	6	6	7	7
8	Biomass	63	63	63	63	63	63	63	63	63	63
9	Imports	-	-	-	709	721	733	737	738	314	317
10	Geothermal	9,033	8,650	9,828	11,939	19,814	23,078	29,406	36,302	42,828	46,005
	Total	185,197	202,387	220,150	238,891	258,606	279,628	299,897	322,038	348,964	371,374

Sources: Anonymous (l), 2010.

Table 3. *Domestic Coal Consumption by Type of Industry (Tons)*

Year	Iron &Steel	Power Plant	Ceramics &Cement	Pulp & Paper	Briquette	Others	Total
2000	30,893	13,718,285	2,228,583	780,676	36,799	5,545,609	22,340,845
2005	221,309	25,669,226	5,152,162	1,188,323	28,216	9,091,501	41,350,736
2009	256,605	36,570,000	6,900,000	1,170,000	61,463	11,336,932	56,295,000
2010	335,000	34,410,000	6,308,000	1,742,000	80,400	24,124,600	67,000,000

Others may include industry of textile, small industry (lime, tile, brick), food, chemical, metal casting, rubber tire, foundry, etc.
Source: Directorate General of Mineral and Coal, 2012

To meet the increasing demand for electricity, within the coming 10-15 years the development plan there would be two stages of additional power plant, i.e., stage I of 10,000 MW coal fired power plant that will require about 32 million tons of coal per year, and stage II of 10,000 MW power plant that will require around 8.37 million tons of coal per annum for 2,616 MW of coal fired power plant, and the remainder consisted of 1,440 MW gas fired power plant, 4,730 MW geothermal power plant, and 1,174 MW hydro power plant. (Anonymous (j), 2011). Based on PT PLN data, certain quantity of the new coal fired power plant (CFPP) amounted to 11,725 MW in Java would be initially operated within 2010-2014. While in Sumatera within the same period, the additional supply would be of 2,916 MW, Kalimantan 914 MW, and Sulawesi of 822 MW. The demand for coal of the power plant in Indonesia in 2010 is 34.4 million tons and in 2012 would reach 54 million tons, that increase 25.5% greater than that of in 2011 of 43 million tons. Indonesia has developed cement industry by using coal as fuel since 1970-s, amounted to 38.6 million tons of cement production per year. In 2010 the demand for coal of the cement industry amounted to 6.31 million tons (Directorate General of Mineral and Coal, 2011). Other industries, among others, are iron and steel, textile, paper and pulp, few small industries consume coal of around 14 million tons of coal per annum (Pusdatin, MEMR 2011). Many other industries that will consume coal as fuel in their production processes, among others, are the industry of food, chemical, metal casting, rubber tire etc. The other sectors has consumed coal as direct fuel amount 24.1 million tons per annum, and it is expected to continuously increase in the coming years significantly (Table 3).

The total domestic consumption of coal is about 60 million tons per annum, even though the domestic production reaches about 360 million tons of coal in 2011, but mostly for export of around 70%. This national coal production will be projected up to around 560 million tons of coal in 2025. It is expected that he domestic consumption in 2025 would be around 60-70% of the coal production, and it is projected that 2 percent of the national energy consumption would be in the form of liquefied coal or synthetic oil.

2.1.1.2. Utilization of Coal as Indirect Fuel for Producing Cokes and Producer Gas

a. Coke and semi coke

The aim of producing domestic foundry coke (coke briquette) is to reduce or substitute the imported foundry coke and to empower the utilization of domestic coal. Several semi commercial coking plants have been developed such as at Tanjung Enim of PT Bukit Asam coal mine (the capacity of 10,000 tons semi coke briquette/year), Lampung (3,000 tons coal briquette/year), and Gresik (3,000 toward 150,000 tons coal briquette/year). And the semi coke product (semi coke briquette) has been domestically consumed especially by the small and home industries. So that if this program of domestic foundry coke production is realized, then it could substitute the imported foundry coke and it could save foreign exchanges of about US$ 238,000 per annum, where the price of the imported foundry coke is of US$ 1.21 per ton and the domestic foundry coke would be approximately of US$ 0.53 per ton.

b. Producer gas

1). Producer gas for drying tea leaf in the tea plantation.

Successful investigation of utilization of producer gas at the tea plantation shows that it could reduce 40-50% cost of fuel compared with if using oil fuel (Suprapto, 2008). The investment of coal gasification semi commercial plant is of IDR 200 million with the capacity of 50 kg of coal per hour.

2). Substitution HSD oil with producer gas in Diesel Engine

The effort of producing producer gas from coal substituting diesel engine oil fuel for diesel generating power plant has been developed at semi commercial plant scale. Based on diesel power plant of PT PLN amounted to 2,800 MW will save production cost of electricity of around US$ 2.74 billion per annum approximately. Based on the assumption that the price of the gas of US$ 5.62/MMBTU (at the time of trial run), price of coal of US$ 60/ton, HSD oil of IDR 7,500/liter, and the dollar rate of IDR 10,000/US$, then the average production cost of electricity is IDR 2,368/kWh (by using 100% of HSD oil) and IDR 1,248/kWh (dual fuel), and the average savings of electricity production cost is of IDR 1,119/kWh or 47,26% (Suprapto, 2008, 2009). Dual fuel combustion system is slower, if it is compared with 100% HSD oil.

3). Other sectors.

Besides the utilization of coal gasification in diesel power plant, utilization of coal gasification in the wider spectrum is for other various usages such as for producing fertilizer of PUSRI Palembang combined with natural gas or as substitute for natural gas, heating of boiler to produce steam at the various plants for instance textile.

2.1.2. On Going Investigation of Making Coal Briquette, UBC, Bio-Coal, Synthetic Oil, and Coal Water Fuel (CWF)/Coal Water Mixture (CWM)

These stages of on going investigation have been carried out by tekMIRA mostly at the batch test as well as at the pilot and or semi commercial plant scale.

a. Coal briquette

The huge burden of subsidy allocated to the oil fuel makes the government has to subsidize kerosene, that is mainly for rural households, amounted to 82.3 million barrels of oil equivalent (BOE). This amount of kerosene will require subsidy of about IDR 17.62 trillion. The amount of the required coal briquette equals with the value of kerosene if it is exported valued about US$ 1.81 billion or IDR 17.3 trillion a year. If half of the demand for kerosene in Indonesia of about 5.67 million kilolitres could be substituted by coal briquette, then the substituted kerosene could be exported and this substitution will value US$ 784 million a year in terms of export earnings. The government is ought to do optimal breakthrough of both the coal briquette production and the firm effort of socializing this commodity toward its utilization, prior to the reality of eliminating the oil fuel subsidy in the near future. (Soelistijo, 2003).

b. UBC

Indonesia is the second largest coal-supplying country after Australia. Still, the ratio of high-rank bituminous coal in the coal reserve in Indonesia is only 12%, and the majority of coal is moderate- and low-rank coal. The Government of Indonesia has the policy to work with the increasing domestic energy consumption while sustaining a certain level of coal export. The technology to utilize moderate- and low-rank coal will become extremely important in realizing this policy. Multiple coal upgrading technologies besides UBC are now under development toward commercialization. However this technology is superior to others for the fact that it can process lignite with 50% or higher moisture content and that it can withstand long-distance and long-hour transportation. In addition, the UBC technology is superior for the fact that the product can be immediately used at existing power plant facilities (Anonymous (m), 2011).

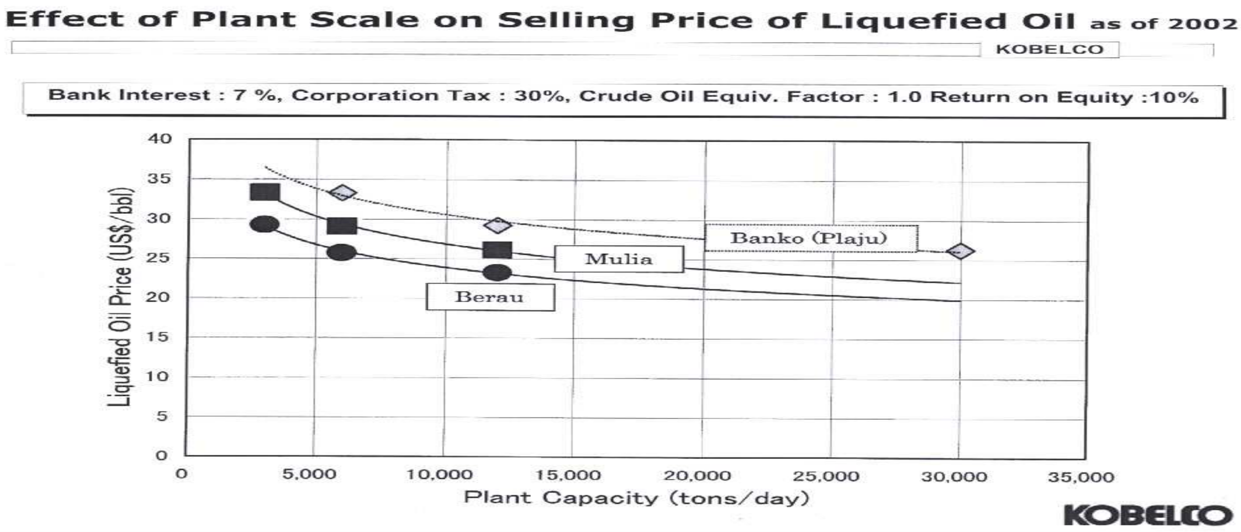
c. Bio-coal

Palimanan Bio-coal Plant which has production capacity of 5 tons/hour normally uses saw dust as biomass, bituminous coal for raw materials and a small quantity of quicklime as sulphure absorbent. Historically, in 2006, the optimized prize of coal briquette at the consumer is of IDR 575 per kg, the subsidized price of kerosene at the consumer is IDR 2,300 per liter, and the price of the nonsubsidized diesel fuel if of IDR 5,400 per liter. Then it is assured that coal briquette is competitive to kerosene, and also in addition to diesel oil as well. Moreover, within 2010-2012, actually the subsidized kerosene is lower than in 2006 of IDR 4,500/liter, it is assured that coal briquette is more competitive.

d. Synthetic oil

Besides direct liquefaction, indirect liquefaction program is also willing to develop under MOU between Indonesia and SASOL. Even though, both processes have not been continued yet. While, the present Presidential Instruction has been issued to realize that program.

The result of simulated feasibility study by using Banko coal (South Sumatera) at the designed capacity of 6,000, 12,000 and 30,000 tons of dry coal per day with 25 years life time, shown that among those designed capacities, the capacity of 30,000 tons of coal per day by using the coal price around US$ 13/ton would be able to produce crude synthetic oil (CSO) be competitive with the crude oil (CO), where the price of crude oil of about US$ 22/bbl in 2003 (Figure 2). To get price of coal as cheap as possible, "a unified coal mining and liquefaction plant unit" based on profit sharing is required to be developed. The lower the price of coal used, the more promotion the liquefaction process will be. It is most likely that CSO as an alternative energy requires certain level of incentives such as tax holiday and or soft or green loan at least at the beginning of the project.



Sources: Anonymous (f), 2002; Anonymous (g), 2003.

Figure 2. *The effect of plant scale on the production cost of Synoil (Ex Banko, Mulia and Berau Coal Samples)*

Table 4. *The required investment to produce CSO for the transportation sector*

	2015	2025	2035	2050
MMbbl	354.69	485.95	1,249.79	3,214.27
Investment, Units of 30000 tdc/d	9	12	31	78
Investment, MMM US$	52.02	69.22	178.81	449.91

Sources: Soelistijo, 2002, 2003.

Moreover, financial analysis on the development of coal liquefaction in Indonesia using brown coal liquefaction (BCL) technology can be reviewed as follows. (Huda, ,2011):

"…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."

Furthermore, the required investment to produce CSO mainly for the transportation consumption could be seen on Table 4. (Soelistijo, 2002)

e. Coal water fuel (CWF) or coal water mixture (CWM) *(Umar, 2006, 2011).*

CWM technology of low rank coal through upgrading process is able to produce a relative stable fuel, easy to flow it and high efficiency of combustion. CWM constitutes coal base liquid fuel that could be used for boiler fuel substituted oil fuel, mainly heavy oil, by using the existing available boiler to produce steam such as electrical power plant, textile, food and beverage. Preliminary investigation resulted that composition of CWM is consisted of 80% -200 mesh of coal size, plus additives of Polystyrene sulfonate (PSS, 0.5% by weight) and Carboxymethyl cellulose (CMC, 0.01% by weight), with viscosity of less than 1000 cP. 1 kiloliter of oil fuel equals 2 kiloliter of CWM. The production cost of CWM is of about US$ 25/ton. The development of CWM from LRC is heavily depending on the development of coal upgrading technology.

2.1.3. Utilization of Coal as Non-Fuel Products such as Activated Carbon and other Chemicals

Activated carbon (Monika, 2011) is a porous carbon substance with large surface so that it is very effective absorbent used in various industrial refining process either in a liquid or gaseous phase. In Indonesia, activated carbon is usually produced by using coconut shell. Coal activated carbon is from imports. Up to the year of 2000 is about 13 enterprises available, while in 2006 19 enterprises are available with the capacity of production of about 44,000 tons per annum. The increasing demand of activated carbon industry in Indonesia could not be met by the limited supply of coconut shell as the main raw materials. The result of tekMIRA investigation has resulted the quality of activated carbon made from coal that is suitable for the market demand. Domestic consumption of activated carbon is consisted of 42 industries, among others, petrochemical, water refining, medicine and food, sugar plant, catalyst, flue gas refining, gas purification, shrimp husbandry (breeding). It needs about 36,000 tons of activated carbon per annum.

2.2. Economic and Environmental Analysis

a. Economic results

1). Effect of inter-fuel substitution

i. Effect of synthetic oil-oil fuel substitution on the national economy

Every consumer utilizing 1 barrel CSO would gain surplus of 0.27 barrel equivalent of crude oil, economically. The effect of substitution of CSO on CO (An example: The plant capacity of 30,000 tons dry coal/day): In 2011, of every 1 bbl of CSO utilization (12000 t/d), the consumer would gain the *surplus* of about 0.27 bbl of CO equivalent.

ii. Effect of dual fuel producer gas HDO (IDO).

The PLN-owned diesel power plant amounts around 3,307.16 MW which consumes oil fuel, if it utilizes dual fuel of producer gas-HDO, it would save the fuel cost of about US$ 3.24 billion per year (3,307,160 kW x 8760 hour/year x IDR 1,119/kWh x 1 US$/IDR 10,000). This has not included yet the private diesel power plant in the country.

iii. Effect of briquette-oil fuel or imported cokes substitution.

Several positive effects of briquette-oil substitution could be summarized as follows (Soelistijo, 2003). Coal briquette versus kerosene: The consumer gains substitution surplus amounted to 2.3 kgs of coal briquette per liter of kerosene. Coal briquette versus IDO indicates that the consumer gains substitution surplus of 0.5 kg of coal briquette per liter of IDO. Coal briquette versus the imported cokes indicates that the domestic briquetted coke could compete with the imported cokes if it is used in foundry industry (iron casting).

2). Impact of implementation of coal diversification on macroeconomic

The domestic consumption of energy in Indonesia: in 2005 is 864.60 million BOE (Biomass of 270.04 million BOE); and of 1,081.43 million BOE (Biomass of 288.44 million BOE) in 2010. The total oil fuel consumption in 2005 was around 338.52 million BOE, and in 2010 is of about 363.52 million BOE approximately. The total commercial energy is consumed by the four main sectors, i.e. transportation, industry, household, amounted to 792.99 million BOE in 2010. (Anonymous (k), Center for Data and Information on Energy and Mineral Resources, 2011). Besides oil fuel, the sectors of industry, commercial and households also consume gas, coal and other kinds of energy sources. If in the transportation sector, the consumed total oil fuel of about 264.80 million BOE, and in the industrial sector is of around 55.09 million BOE, so that the consumed total oil fuel in these two sectors of around 319.89 million BOE that could be substituted by CSO valued US$ 25.59 billion a year. More specific potential substitution of the heavy diesel oil (HSD oil) into CWM, the HSD consumed by the transportation sector of around 68.50 million BOE and by the industrial sector of around 42.76 million BOE or the total HSD oil that could be substituted by CWM is of around 111.26 million BOE. Then, the total savings would be US$ 8.9 billion as CWM substitution benefit in these two main sectors. If the national total consumption of fuel oil in 2010 is about 363.52 million BOE, then it would save US$ 29.08 billion per year (the price of oil fuel of US$ 80/bbl), if it is substituted by CSO.

3). The price trend of coal

Actually within the last 15 years, the price world trend of steam coal tended to increase with 20.93% average growth rate per year from US$ 30.07/ton in 1996 up to US$ 129.59/ton in 2011 (Figure 3). This trend up to the year of 2025 would be around US$ 240-260/ton. Of course, the price trend of coal would affect the price of synoil as well as the price of producer gas or other products of coal diversification in lieu with the price trend of crude oil and natural gas.

4). The multiplying effects on the regional development

The economic multipliers and the backward and forward linkages of the CMS (coal mining sector), OGMS (oil & gas mining sector) and ORS (refinery sector), 2001 and 2011 can be summarized as follows (Table 5). Based on the above results can be indicated that he more downstream the sector, the higher the multiplier and the stronger the backward and forward linkages will be. In 2001 and on the multiplying effects of the coal liquefaction to the regional development will be positively greater and greater.

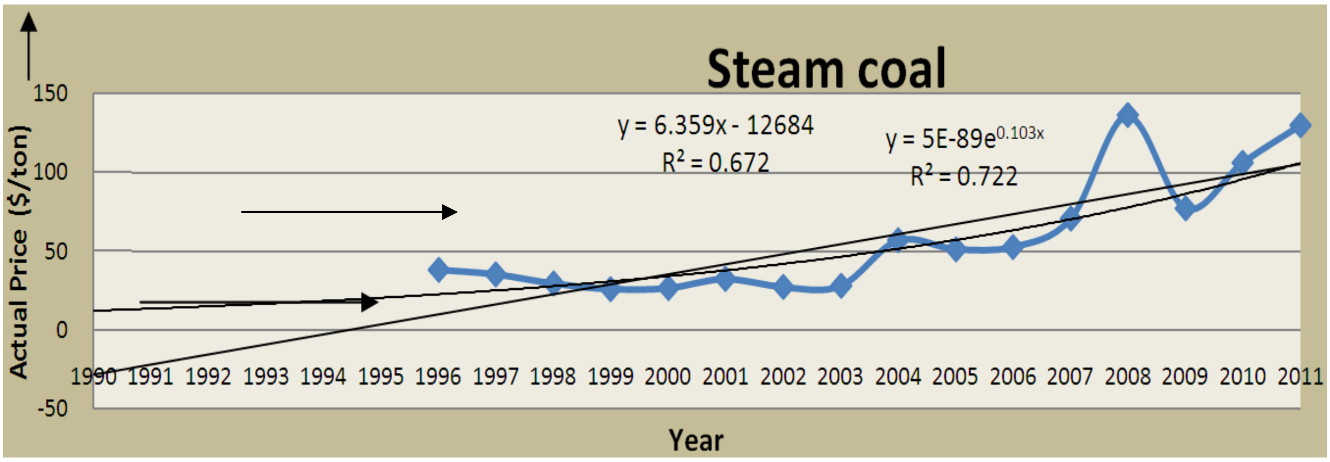


Figure 3. *Graph of world coal price trend, 1996-2011*

Table 5. *The Multiplying and linkages effects of the regional development due to the development effort of coal liquefaction*

	CMS (Coal Mining)	OGMS (Oil & Gas Mining)	ORS (Refinery)
A. 2001			
1. The multipliers*):			
a. Employment	1.12	2.21	2.10
b. Investment	1,09	1.17	2.92
c. Added value	1,13	1.07	3.68
2. The linkages **):			
a. Backward	0.78	0.74	1.23
b. Forward	1.00	1.71	1.58
B. 2011			
1. The multipliers *):			
a. Employment	1.08	3.67	5.69
b. Investment	1.11	1.13	3.41
c. Added value	1.22	1.05	2.50
2. The linkages **):			
a. Backward	0.84	0.75	1.20
b. Forward	0.80	1.40	1.36

*) It is computed by using formulas of economic multipliers and the inversed Leontief matix of the 1994 regiona Input-Output Table of South Sumatera Province then updated to the year of 2001 and 2011.
**) It is computed by using formulas of backward and forward linkages and the inversed Leontief matrix of the regional I-O table of South Sumatera Province.
Source: Soelistijo, 2002.

b.Environmental aspects

Several environmental tests on the ambient and emission air resulted the following results.

1). Quality of flue gas of CFPP in Indonesia

For example, the content of SO_2 in flue gas of the CFPP Suralaya in Indonesia is of 600-700mg/m3 by using coal with 0.4% sulfur content of coal (The Environmental Quality Standard: 750 mg/m^3, Regulation Men LH No 21/2008), but it is of 1400-1500 mg/m^3 SO_2 at Tanjung Jati power plant (Central Java) by using 0.9% sulfur content of coal, even though they has installed FGD (Anonymous (n), 2012). The Environmental Quality Standard based on Minister of Environment Regulation No. 21/2008 is that Particulate matter 100 mg/m^3, SO_2 750 mg/m3, NOx as NO_2 750 mg/m^3, and Opacity of 20%.

2). Quality of ambient air, environmental air and emission air of diesel power plant.

The quality of ambient air is much lower than ambient air quality standard (the quality standard of NO_2 150 µg/Nm^3, SO_2 365 µg/Nm^3, SO_2 10,000 µg/Nm^3, particulates 230 µg/Nm^3, the GOI). The concentration of each pollutant is still far below the working environmental air standard quality decided by the Ministry of Manpower and Transmigration, 1997. The air quality of off-take emission gas of diesel machine using dual fuel is still lower than the quality standard of air quality of unmoved source emission (Anonymous (i), 1995) (Suprapto, 2009).

3). Waste gases and particulates resulted from briquette combustion

The research results show that the disposal gas emission of the several types of fuel, such as biomass briquettes, coal briquettes and charcoal, have similar pattern, i.e. within the first twenty minutes at the temperature of 150-600^{o}C the gas emission are still below the EQS (300 mg/m^3). The effort of controlling of air pollution could be carried out towards preserving the environmental quality through, among others, planting several types of plants that could be able to absorb the polluter gases, and the efforts of REDD that should be necessarily encouraged as far as possible. (Soelistijo, et al, 2011).

The domestic consumption of primary energy in Indonesia in 2005 is 864.60 million BOE or about 1,081.43 million BOE (including biomass of 288.44 million BOE) in 2010. The total fossil fuel consumption in 2005 was around 792.99 million BOE. The emission of carbon would be 144.7 million tons per annum or equal to 530.63 million tons of CO_2. 61.02 million tons of CO_2 emissions came from coal combustion in power generations, cement, and biomass combustion from small industries and rural households. The biomass fuel consumption of small industry and rural households might be substituted into briquette (of coal and biomass or mixed).

Indonesia constitutes an archipelago with widespread tropical forest and vegetation. The total area covers 5.2 million km^2 (consisted of 1.9 million km^2 of land and 3.3 million km^2 of ocean or sea). The forest area is estimated to be about 119.7 million Ha. On Java island (the densest population in Indonesia) the forest area is of about 3.01 million Ha less than 30% of the Java area of land (the required minimum percentage area of forest).

3. Concluding Remarks

The effort of substitution of coal and its diversification product into oil fuel would result substantial economic gain besides certain level of regional economic benefit to overcome the declining less and less reserves of domestic oil faced by the Indonesian people within the coming few years. If the national total consumption of oil fuel in 2010 is about 363.52 million BOE, then it would save US$ 29.08 billion per year, if it is substituted by CSO. The producer gas-IDO in the diesel power plant through dual fuel system would save US$ 3.24 billion in 2011 if all diesel power plant in Indonesia using dual system. Of course utilization of coal as direct fuel in the coal fired power plant has gained of billion dollars substituted for oil fuels since several tens years ago. And this trend requirements should be carried out into several stages of implementation based on the strong government policy.

Upgrading technology, either UBC process, carbon-tech drying, HWD or SD provides the ability of increasing calorific value of low rank coal through decreasing the moisture content. The upgraded coal has prominent stability of water content stability, so that it could be utilized for long distance transportation such as for exports. The efforts of coal utilization both through direct and diversification ones affect employment creation and increasing income for the people, so that these efforts should be encouraged within the coming years and on as well.

It is necessary to continue in the cases of:

- Acceleration of applied technology investigation of bio-energy utilization facing the post of coal era as the end of fossil fuel era to look the sustainable future Indonesia energy path.
- Besides the efforts of utilization of the total domestic gas potentials such as coal bed methane, shale gas and the remainder of natural gas should be well encouraged and enlarged.
- Application of environmental technology and or environmental friendly coal diversification technology should be prioritized. Various efforts of increasing the carrying capacity of the environment are required to phase the population pressure.

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