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Strategy for Technology Energy Selection to Achieve Coal Value Added in PT. Bukit Asam (Persero), Tbk.

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Abstract

The role of coal in providing national energy has already increased nowadays, and still taking an important subject. Government obligation to support added value is not really encouraged industry player to applied technology energy that has been developed widely in South Africa, China, and other developing country. The purpose of this research is to estimate coal resources, quality range and to select technology energy that can be potentially developed in PT. Bukit Asam (Persero), Tbk. Coal Resources and coal quality in each mining licenses area becomes the basic strength for developing technology energy as part of SWOT Analysis. Based on the SWOT Analysis from 5 technology energy then the scope limited into 3 highest technology energy that is Coal Gasification, Coal Liquefaction, and Coal Bed Methane as the most potential technology energy to develop in PT. Bukit Asam (Persero), Tbk.

Keywords: SWOT Analysis, Strategy, Coal Gasification, Coal Liquefaction, Coal Bed Methane

Abstrak (Indonesian)

Peranan batubara dari tahun ke tahun masih menjadi bagian penting dalam penyediaan energi nasional. Kebijakan pemerintah untuk mendorong peningkatan nilai tambah batubara dirasa belum banyak mendorong pemain industri pertambangan untuk mengaplikasikan teknologi energi yang sudah banyak berkembang di Afrika Selatan, Cina dan negara berkembang lainnya. Tujuan dilakukannya penelitian adalah untuk mengestimasi sumberdaya batubara, sebaran kualitas dan pemilihan teknologi yang berpotensi dikembangkan di PT. Bukit Asam (Persero), Tbk. Parameter sumberdaya dan kualitas batubara, dalam masing-masing IUP menjadi dasar kekuatan pengembangan diversifikasi batubara. Berdasarkan analisis SWOT dari 5 teknologi tersebut dipilih 3 teknologi energi yang paling berpotensi untuk dikembangkan di PT. Bukit Asam (Persero), Tbk., yaitu Gasifikasi Batubara, Pencairan Batubara dan *Coal Bed Methane*.

Kata Kunci: Analisis SWOT, Strategi, Gasifikasi Batubara, Pencairan Batubara, Coal Bed Methane

INTRODUCTION

Energy as a fundamental aspect that needed in economic growth is a basic need in human life that also impacts the people life's quality. World consumption of energy has been projected increased by 56% between 2010 until 2040 with the highest demand comes from developing country. Coal which is one of the exhaustible resources and vital assets for global energy security on the recent update has concerned the government to secure its utilization by coal diversification, conservation and adding value. This is related to the limitations of its quantity and its low-rank coal in quality. Based on the data from Ministry of Economic and Mineral Resources [1], Indonesia's coal total production is 434 million tons with Domestic Market Obligation is 91 million tons and export is 369 million tons. In 2017, the government set Domestic Market Obligation (DMO)

to 121 million tons (increased 33.7% from 2016) as the impact of new power plant project.

National primary energy mix with diversification target in 2025 for coal as a primary energy with consumable up to 33%. In the Blueprint of National Energy Management 2006–2025, there are several research programs and development technology as a strategic coal policy to increase and develop the role as well as maintain the energy security for Example:

a. Upgraded Brown Coal-UBC
b. Coal Liquefaction
c. Integrated Coal Gasification
d. Coal Bed Methane

PT. Bukit Asam (Persero), Tbk as a public listed company as the six largest producer in Indonesia, still selling coal mainly as a raw material even its already take a diversification to the mine mouth power plant and also coal blending product. Gasification and liquefaction programs are still being studied (not yet in commercial stage). Based on this fact, it is needed to make a comprehensive strategy to analyze the coal utilization based on technology energy that has been developed recently in world scale.

LITERATURE REVIEW

Coal Resources and Coal Value Added

Indonesian coal resources by the end of 2015 are 127 milliard tons and the coal reserve is 32.3 milliard tons which are dominate by low rank coal. Regulation for adding coal value is based on regulation from Undang-Undang Nomor 4 tahun 2009.

Upgraded brown Coal which is the diversification technology to increase the quality of low rank coal by decreasing total moisture content. The scale laboratory research has successfully experiment to increase the quality from low rank coal [2]. By adding residual oil to cover up coal pore and prevent water to being re-adsorb. Coal gasification can convert coal into gas by the process in surface reactor or underground facilities with the reactant of air or steam. Gasification can also combine with palm as biomass mix with coal [3]. Coal liquefaction that can be divided into direct non direct coal liquefaction is also an alternative of coal diversification that converts coal into final product as liquid phases or gas phases. By using catalyst palladium in alumina or cobalt molybdate, temperature 200 – 5000C, pressure 500 – 5,000 p.s.i.g and microwave energy, coal can be converted into liquid from 80 – 85% with solvent added [4]. Coal Water Mixture is also diversification coal that is made of coal and converts to liquid phases by adding homogenous suspension for the stability during transport and firing [5]. Another technology energy that has been developing today is Coal Bed Methane that comes from the usage of gas methane stored in coal pore. Coal bed methane is characterized by coal rank, cleats, porosity and permeability parameters form the coal itself. South Sumatra is a region with the largest Coal Bed Methane resources around 183 Tcf [6].

Table 1. Chemical reactions in underground coal gasification [7]

Process	Reaction	Enthalpy (ΔH)
Volatiles Oxidation	O_2+CO,H_2,CH_4,HC'S* = CO_2+H_2O	ΔH = - strongly exothermic
Char Oxidation	C+O_2=CO_2	ΔH = - 406.0 kJ/mole+
Water Evaporation	H_2O_1=H_2O_g	ΔH = - 40.68 kJ/mole+
Pyrolysis	Coal + Heat → Char + Ash + HC's* + CH4+H2+H2) + CO+CO_2	Endothermic
Gasification	C+ H_2O= H_2+CO	ΔH = + 118.5 kJ/mole+
Boudouard Reaction	C+CO_2=2CO	ΔH = + 159.9 kJ/mole+- (slow)
Water Gas Shift	CO+H_2O=H_2+CO_2	ΔH = - 42.3 kJ/mole+
Methanation	CO+3H_2=CH_4+H_2O	ΔH = - 206 kJ/mole+
Hydrogenating Methanation	C+2H_2=CH_4	ΔH = - 87.5 kJ/mole+

kJ/mole = kilo Joules per mole, *HC's = Hydrocarbon Compound and their potential breakdown products

SWOT Analysis

A SWOT analysis is a tool that can be useful for strategic decision making which can be the classified by two categories that are Internal factors and External factors. Internal factors are the strength and weakness of the organization. External factors are the opportunities and threats from outside of the organization which can give impacts to the organizations. Strategy is an action to allocate resources in facing the future challenges, to make a competitive advantage and to reach company goals. SWOT OT can be used as a management tools to

choose the appropriate strategy planning and has successful applied to design energy regional planning system [8].

METHODOLOGY

Estimation of coal resources refers to the radius of space with the specific geological classification [9] and [10].

A SWOT Analysis will be carried out in order to identify strength and weakness as well as threats and opportunities. From the SWOT analysis the complementarity, needs and synergies will be identified. This analysis then will set the basis for the development of a strategic future visions in terms of achieving coal value added. Scoring system is set base on 3 steps [11]:

- Step 1. Identify strengths, weakness, opportunities and threats
- Step 2. Prioritize parameter define in step 1 (1 until 4, which 4 is the most important). Relative parameter score is the total number of internal factor divided by number of parameters, as the same with the external factor.
- Step 3. Give the rating and score number. Rating is the value of its identified in the internal company or another competitor. Score number is relative number parameter multiply with score number.

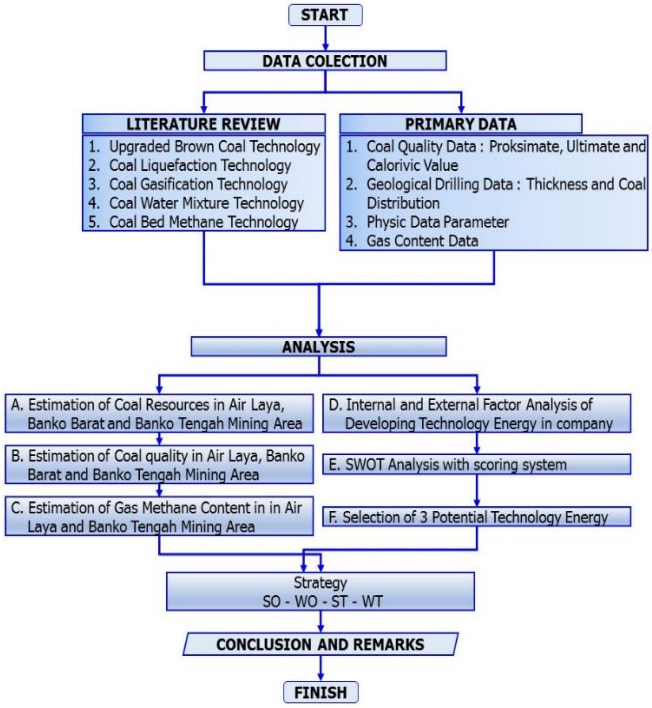

Figure 1. Methodology

RESULT AND DISCUSSION

Coal Resources

Coal resources are estimates based on the calculation made on the parameter basis by the end of 2016. There are 706.8 million tons of coal resources in Air Laya, 493.05 million tons in Banko Barat and 2,617.25 million tons in Banko Tengah.

Table 2. Coal Resources in studied area

IUP	Measured	Indicated	Inferred
Air Laya	187.15	283.1	236.55
Banko Barat	297.35	122.55	73.15
Banko Tengah	404.7	1235	977.55

Coal Quality

Based on the borehole database distribution for each area, coal quality can be range differently for each area studied. The statistic quality analysis has been made using the borehole data from Air Laya (1,293 borehole), Banko Barat (522 borehole) and Banko Tengah (258 borehole). For CV distribution, can be assumed that Air Laya has a wide range value due to the effect of geological conditions that is intrusion. The effect of intrusion that made contact with coal is can upgrade the maturity of the coal and increasing CV instantly. Sulphur content for Air Laya and Banko Tengah is below 4% (Air Dried Basis) Adb, while in Banko Barat has more narrow distribution from 0.1 – 1.6 % Adb.

Table 3. Coal Resources in studied area

IUP	Air Laya	Banko Barat	Banko Tengah
Ash (% Adb)	4,82 - 18	0,9 - 11,7	3 - 33,42
TM (% Ar)	12,74 - 29,9	16 - 33.7	12,74 - 45,2
CV (kcal/kg Ar)	4.472 - 8.293	3.765 - 6.269	2.701 - 5.163
TS (% Adb)	0,4 - 3,8	0,1 - 1,6	0,15 - 3,8

SWOT Analysis

The internal factors for PT. Bukit Asam are strongly related with the abundance of coal resources as the basic requirements to build a sustainable plant facility for each technology energy, the internal research and

development availability and also the research marketing opportunity. As the weakness identification, PT. Bukit Asam has limited skilled professional's human resources for each technology energy, dependently to the export market and still using conventional coal product as raw material.
The opportunities as a part external factors identifications are mainly focused on the research and development of each technology that has been developed nowadays, government policy and prospective industrial area as a market target. Meanwhile the threats are the lack of transportation and infrastructure development, fluctuation of coal price, and another company as a competitor that has already develops technology energy and the limited usage of final product for each technology energy. From the graphic of IFA and EFA for each technology energy can be concluded 3 top potential to be develops in PT. Bukit Asam (Persero), Tbk which are Coal Gasification, Coal Liquefaction and Coal Bed Methane.

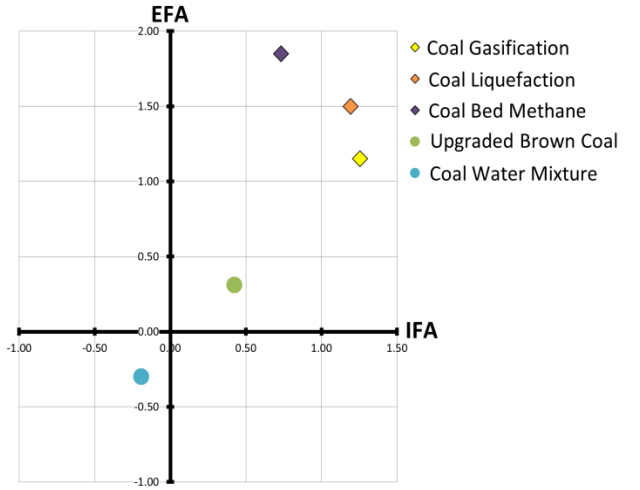

Figure 2. IFA and EFA for Technology Energy

Strategy Development for Coal Gasification
Coal gasification as a fuel can be converted from solid carbon to gas product with caloric value, with the stage of pyrolysis, hydrogenation and partial oxidation. Gasification product can be gas fire, syngas and SNG product. Based on the literature review and the development of coal gasification technology it can be summarize to implement KBR or SHELL technology energy. The strategy development for Coal gasification that can be developed in PT. Bukit Asam (Persero), Tbk is surface coal gasification in Banko Tengah. For Banko Tengah area also can be integrated with palm plantation as the overlapping in Banko Tengah land use. Meanwhile for Underground coal gasification technology energy can be developed in Air Laya mine to extract seam D and E that is not economic using conventional surface mining method.

Strategy Development for Coal Liquefaction
Coal liquefaction is affected with time, temperature, pressure, speed of heating, solvent type, coal quality, grain size distribution, catalyst and addictive [12]. Based on the characterization of coal liquefaction in PT. Bukit Asam (Persero), Tbk can be applied with direct stage because coal quality for ash content is not so high. Coal liquefaction can be developed in Banko Tengah with the collaboration from palm as a biomass product.

Strategy Development for Coal Bed Methane
Coal bed methane is already in exploration stage and pilot project which is already set in 5 pilot well and 3 coring well. Based on calculation the methane gas content resources are 1006.2 Bcf [13]. The calculation of gas methane content in Air Laya [14] is 770.3 million ft^3. The author has made a calculation on estimate the methane gas content in Banko Tengah with the equation:

$$V = \frac{100 - \%\,IM - \%\,Ash}{100} 0.75[ko(0.096)^{no} - 0.14(\frac{1.8d}{100}) + 11]$$

$$ko = \frac{0.8FC}{VM} + 5.6$$

$$no = 0.315 - 0.01\frac{FC}{VM}$$

Where:
V = methane gas content in coal in situ (ft3/ton)
IM = Inherent moisture (% adb)
Ash = ash content (%adb)
d = kseam coal depth (feet)
FC = Fixed Carbon (% adb)
VM = Volatile Matter (% adb)
ko and no = constants

Table 4. Coal Quality parameters

Coal Seam	Ash (% adb)	IM (% adb)	d (feet)	FC (% adb)	VM (% adb)
A2	9,63	17,96	80,69	32,54	37,83
B1	9,02	17,96	69,00	31,82	37,04
B2	13,31	19,24	126,40	29,88	33,04
C	9,41	17,78	159,00	33,23	35,67

Table 5. Constanta parameters for gas content estimation

Coal Seam	ko	no
A2	6,29	0,31
B1	6,29	0,31
B2	6,32	0,31
C	6,35	0,31

Table 6. Methane Gas Content estimation

Coal Seam	Methana Gas Content (ft^3/ton)	Coal Resources (million ton)	Methane Gas Resources (million ft^3)
A2	0,31	211,23	65,52
B1	0,03	381	9,96
B2	1,14	7,8	8,89
C	1,75	238,98	417,21
Total		839,01	501,58

Strategy development for CBM can be divided into middle term and Long-term planning such as:

- Explore the sweet spot area more active
- Build network for research development to the final product marketing in electrical industry (as the power plant project of South Sumatra 8, 9 and 10 has already launch)
- Identify drilling method that can suitable with the characteristic of Muara Enim Formation in order to get maximal gas recovery)

CONCLUSION

1. The estimation of coal resources from IUP Air Laya is 706.8 million tons, from Banko Barat is 493.05 million tonnes and from Banko Tengah is 2,617.25 million tons
2. Coal quality parameter from IUP Air Laya for ash is 4.82 – 18 % Adb, TM is 12.74 – 29.9 % Ar, CV is 4,472 – 8,293 kcal/kg Ar and TS is 0.4 – 3.8 % Adb. Meanwhile from IUP Banko Barat for ash is 0.9 – 11.7 % Adb, TM is 16 – 33.7 % Ar, CV is 3,765 – 6,269 kcal/kg Ar and TS is 0.1 – 1.6 % Adb. Banko Tengah for ash is 3 – 33.42 % Adb, TM 12.74 – 45.2 % Ar, CV is 2,701 – 5,163 kcal/kg Ar and TS is 0.15 – 3.8 % Adb.
3. Analysis SWOT has determined 3 potential technology energy to develop in study area is Coal Gasification, Coal Liquefaction, and Coal Bed Methane
4. The general strategy to developing those 3 technology energy is :

a. Developing infrastructure from plant area to consumer
b. Build network with another industry parties
c. Coal gasification and liquefaction can be collaborate with palm as biomass
d. Build transportation and infrastructure to nearest potential market area as a final consumer
e. Make programs that can be set into Short term, middle term and long term

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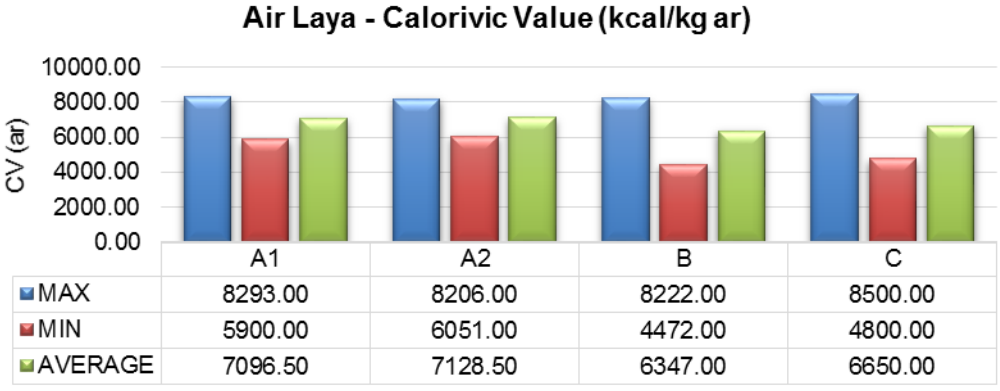
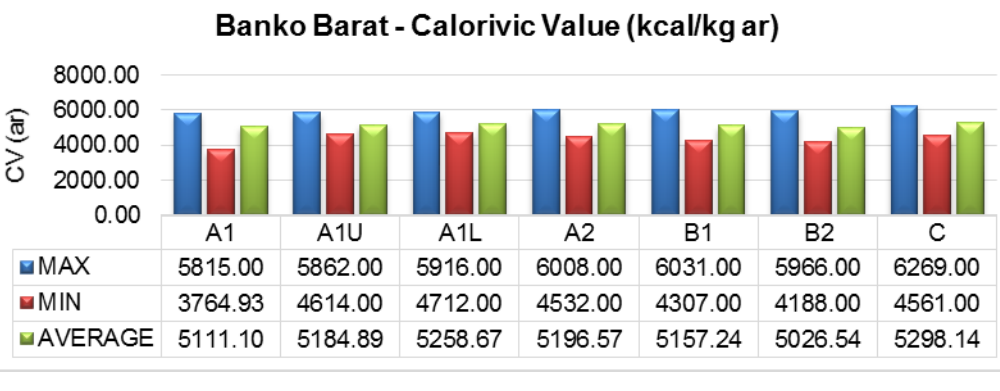
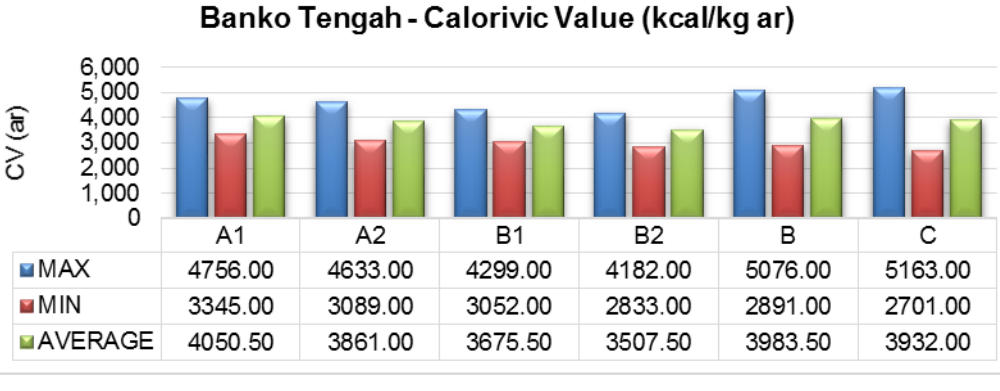
Appendix 1. Coal quality parameters for Calorivic Value



	A1	A2	B	C
MAX	8293.00	8206.00	8222.00	8500.00
MIN	5900.00	6051.00	4472.00	4800.00
AVERAGE	7096.50	7128.50	6347.00	6650.00

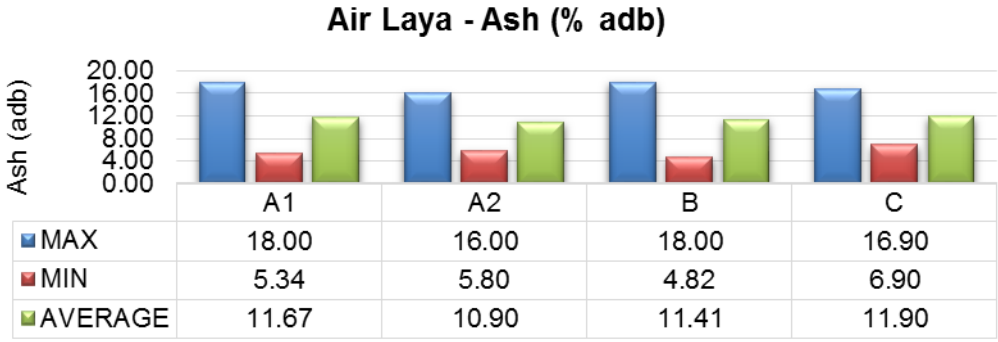


	A1	A1U	A1L	A2	B1	B2	C
MAX	5815.00	5862.00	5916.00	6008.00	6031.00	5966.00	6269.00
MIN	3764.93	4614.00	4712.00	4532.00	4307.00	4188.00	4561.00
AVERAGE	5111.10	5184.89	5258.67	5196.57	5157.24	5026.54	5298.14

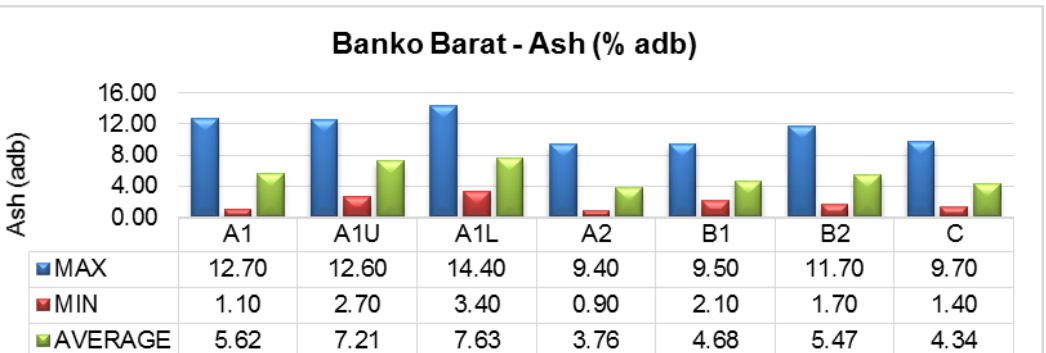


	A1	A2	B1	B2	B	C
MAX	4756.00	4633.00	4299.00	4182.00	5076.00	5163.00
MIN	3345.00	3089.00	3052.00	2833.00	2891.00	2701.00
AVERAGE	4050.50	3861.00	3675.50	3507.50	3983.50	3932.00

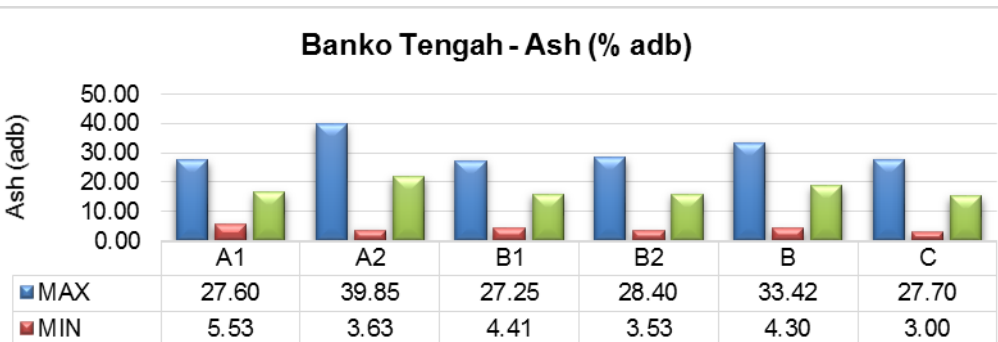
Appendix 2. Coal quality parameters for Ash content



	A1	A2	B	C
MAX	18.00	16.00	18.00	16.90
MIN	5.34	5.80	4.82	6.90
AVERAGE	11.67	10.90	11.41	11.90

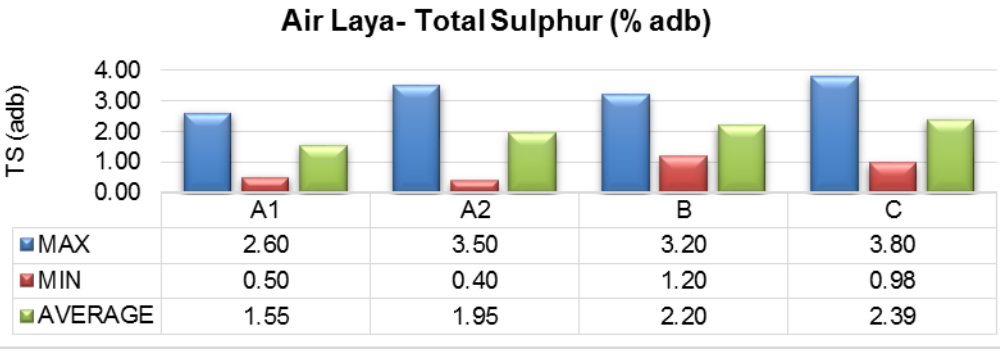


	A1	A1U	A1L	A2	B1	B2	C
MAX	12.70	12.60	14.40	9.40	9.50	11.70	9.70
MIN	1.10	2.70	3.40	0.90	2.10	1.70	1.40
AVERAGE	5.62	7.21	7.63	3.76	4.68	5.47	4.34

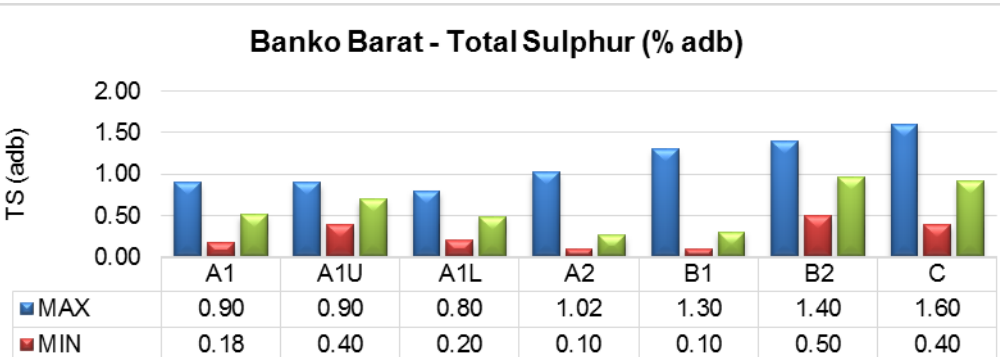


	A1	A2	B1	B2	B	C
MAX	27.60	39.85	27.25	28.40	33.42	27.70
MIN	5.53	3.63	4.41	3.53	4.30	3.00
AVERAGE	16.57	21.74	15.83	15.97	18.86	15.35

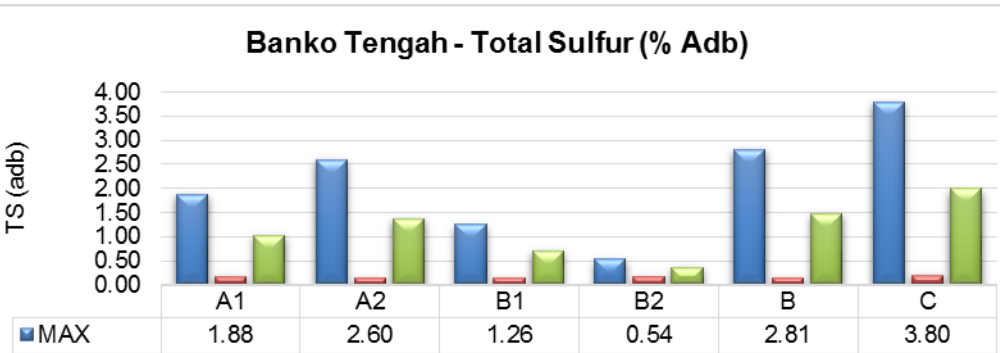
Appendix 3. Coal quality parameters for Total Sulphur



	A1	A2	B	C
MAX	2.60	3.50	3.20	3.80
MIN	0.50	0.40	1.20	0.98
AVERAGE	1.55	1.95	2.20	2.39



	A1	A1U	A1L	A2	B1	B2	C
MAX	0.90	0.90	0.80	1.02	1.30	1.40	1.60
MIN	0.18	0.40	0.20	0.10	0.10	0.50	0.40
AVERAGE	0.51	0.70	0.49	0.26	0.30	0.97	0.91



	A1	A2	B1	B2	B	C
MAX	1.88	2.60	1.26	0.54	2.81	3.80
MIN	0.17	0.15	0.15	0.18	0.15	0.20
AVERAGE	1.03	1.38	0.71	0.36	1.48	2.00

Appendix 4. SWOT Strategy for developing Coal Gasification Technology Energy

	STRENGTHS	WEAKNESS
	➢ Abundance Coal Resources ➢ Internal research availability of coal gasification technology energy ➢ Palm plantation as a mix component for biomass production ➢ Subsidiary company for electricity marketing product ➢ Environmental friendly technology energy ➢ Internal support obligation ➢ Availability of marketing opportunity research	➢ Lack of professional human capital resources of coal gasification technology energy ➢ Deficit of research and commercial project development ➢ Dependancy on eksternal parties to develop technology energy ➢ Lack of infrastructure and transportation system to develop coal gasification ➢ Unidentified future market prospect development
OPPORTUNITY	**SO Strategy**	**WO Strategy**
➢ Prospect development of technology coal gasification ➢ Prospect development mix with coal biomassa ➢ Availability of industry area as a market target	✓ Coal gasification can be develop in Banko Tengah and Underground Coal Gasification in Air Laya ✓ Installment of coal gasification plant fasilitiies combined with palm as a mixture for biomassa system ✓ Build network with industrial parties as a product consumers Build power plant in Banko Tengah with modifying system that can optimimize the use of coal gasification and palm as biomassa	✓ Prepare human capital resources from Coal Research dan Development as well as from Biomassa Research and Development ✓ Build network with third parties to build coal gasification facilities ✓ Build infrastructure and transportation system to the potential industrial area
THREATS	**ST Strategy**	**WT Strategy**
➢ Competitor company that has already develop coal gasification ➢ Fluctuative coal prices ➢ Environment issues ➢ Dependancy on export market	✓ Evaluating coal gasification development product from competitors ✓ Build network with local industry to widen potential market ✓ Build and develop coal gasification with friendly environment concept ✓ Making risk analysis to select most economic coal gasification plant	✓ Prepare human capital resources from Coal Research dan Development as well as from Biomassa Research ✓ Build a cooperative coal gasification with another company

Appendix 5. SWOT Strategy for developing Coal LiquefactionTechnology Energy

	STRENGTHS	**WEAKNESS**
	➢ Abundance Coal Resources ➢ Internal research availability of coal liquefaction technology energy ➢ Waste product can be reuse for wood industry ➢ Environmental friendly technology energy ➢ Availability of marketing opportunity research	➢ Lack of professional human capital resources of coal liquefaction technology energy ➢ Deficit of research and commercial project development ➢ Dependancy on eksternal parties to develop coal liquefaction technology energy ➢ Lack of infrastructure and transportation system to develop coal liquefaction
OPPORTUNITY	**SO Strategy**	**WO Strategy**
➢ Another product that can be sell is Hidrogen gas ➢ Government regulation is clearly stated for coal liquefaction ➢ Highly development technology already wide spread around the world ➢ Availability of industry area as a market target	✓ Coal liquefaction can be develop in Banko Tengah ✓ Build network with industrial parties as a product consumers	✓ Prepare human capital resources from Coal Research and Development Department ✓ Build network with third parties to build coal liquefaction facilities ✓ Build infrastructure and transportation system to the potential industrial area
THREATS	**ST Strategy**	**WT Strategy**
➢ High cost investation ➢ Competitor company that has already develop coal liquefaction ➢ Limitation of coal market	✓ Evaluating coal liquefaction development product from competitors ✓ Build network with local industry to widen potential market	✓ Prepare human capital resources from Coal Research dan Development Department ✓ Build a colaboration coal liquefaction with another company

Appendix 6. SWOT Strategy for developing Coal Bed Methane Technology Energy

	STRENGTHS	**WEAKNESS**
	➢ Abundance Coal Resources ➢ Internal research availability of coal bed methane technology energy ➢ Availability of subsidiary company for coal bed methane ➢ Optimizing gas methane usage that has not been use recently by the conventional mining method ➢ Availability of marketing opportunity research	➢ Lack of professional human capital resources of coal bed methane technology energy ➢ Limited market target ➢ Dependancy on eksternal parties to develop coal bed methane technology energy ➢ Lack of infrastructure and transportation system to develop coal bed methane technology energy ➢ Landuse issue and limitations due to the CBM Well configuration and overlapping area with plantation and other surface facilities
OPPORTUNITY	**SO Strategy**	**WO Strategy**
➢ Prospect development of technology coal bed methane ➢ Optimizing gas contain in coal pore ➢ Government regulation has bright prospect to be developed ➢ Availability of industry area as a market target	✓ More active in explore sweet spot of CBM Development ✓ Build CBM Production facilities in Banko Tengah ✓ Build research development of mine mouth power plant that can be integrated with CBM and Coal Gasification	✓ Prepare human capital resources from Coal Research and Development Department ✓ Build infrastructure and transportation system to the potential industrial area ✓ Optimizing design and layout of CBM Well configuration
THREATS	**Strategi ST**	**Strategi WT**
➢ Competitor company that has already develop coal bed methane ➢ Unprepared industry area ➢ Government regulation still not clear stated in selling price of gas product and insentif obligation	✓ Evaluating coal bed methane development product from competitors ✓ Build network with local industry to widen potential market	✓ Capital resources from Coal Research and Development Department ✓ Build a colaboration with another company