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The impact of Low Rank Coal (LRC) utilization on the Indonesian Economy 2025 : An Input-Output Analysis

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Abstract
The main objective of this paper is to quantify the economic impact of LRC utilization on the Indonesian economy in 2025 using Input-Output (IO) analysis. Combined with mathematical models, IO tables can be used to analyze economic impact, simulate the impact of policies and make estimates. In this study, the analysis is based on the 2005 IO Table 175 x 175 sectors with domestic transaction based on producer prices. The table was then adjusted to the conditions of 2013 and projected to 2025 with scenarios of economic growth at 5.5%. These growth scenarios are also used in forecasting energy demand. The type and amount of LRC utilization calculation results are based on economic and forecasting of energy demand, these then entered in the IO table as a new economic sector. After the IO tables are projected to 2025, multiplier, linkage and economic impact analyses are then carried out.
Keywords: low rank coal, input-output analysis, multiplier, linkage, economic impact analysis

1. Introduction

Developing natural resources (mining) is one of the undisputed means of improving welfare [1], where can be equated with economic growth and increasing GDP. Natural resources have an important role to play as main sources of income in some countries, especially where mining is the main contributor to the GDP [2]. Indonesia has coal resources of about 120,350 Million tons (Mt) and reserves of 28,020 Mt (around 10,020 Mt of LRC) [3]. Even as the world's largest coal exporter, LRC has not been used. Both the high moisture content and reactivity of LRC require its utilization close to the mine [4]. These characteristics can be technically improved to generate value added products which meet consumer demand in wider areas. This has inspired the government of Indonesia to consider LRC as a new source of domestic energy. In recognition of this, the government issued a guideline on the management of domestic energy within a sustainable development framework by means of Presidential Regulation, No. 5/2006 on National Energy Policy. By 2025, coal consumption is planned to have a share of 33% of total energy consumption. Gas will have a share of 30%, the share of oil will drop to 20%, with currently share up to 49% [5] while the percentage of new and renewable energies should increase to 17%. This opens up opportunities for the use of LRC which can play a role in providing energy in Indonesia.

Energy is fundamental to the modern industrial economy and is an important element in almost all human activities, whether: providing domestic services such as cooking and heating / water supply, lighting, health, food production and storage, or education, or industrial production, mineral extraction and transportation [6]. With an average economic growth of 5.5% (2000-2014), predicted energy needs will continue to significantly increase. This increase is also due to current low energy consumption in Indonesia, which only 850 kg of oil equivalent per capita, compared to other countries like North America (6,944), Japan (3,570), Europe (3,212), China (2,226), or even Brazil (1,438) ([7].

As a developing country, energy is one of the main economic drivers of Indonesia. However, the current composition of energy shares must be adapted to suit energy needs which continue to increase and are still dominated by fuel oil [5]. Improving and increasing the potential of using LRC utilization can help to change this composition and, in particular, reduce oil consumption in the industrial sectors. The utilization of LRC in Indonesia is intended to support the government in meeting domestic energy needs. LRC can be pressed into briquettes which help to reduce firewood consumption (biomass) by at least 10% and kerosene consumption by half in households and small industries. LRC can also be used in power plants for the generation of electricity. This may help to adjust the plan of increasing generating capacity of the State Electricity Company (PLN).

LRC not only can be used for generating electricity, as in other countries, it can also be used as a coal water mixture / fluid (CWM/CWF) in boilers – replacing oil -- for industrial purposes. When upgraded to a higher quality, by upgrading brown coal (UBC), LRC can become very attractive to industries currently using hard coal. Likewise, brown coal liquefaction (BCL), has a future in the transportation sector. In this context, it should be noted, that, in Indonesia, LRC is of better quality compared to many other countries, with moisture and ash contents of 35-45% and <6% respectively, and caloric values of 3,225 to 4,660 cal/g [4].

As a result, it becomes obvious that the government of Indonesia has issued a regulation stating that, in 2025, a share of 2 % of total energy needs must be covered by coal liquefaction.

Utilizing LRC as a source of energy is expected to have an economic impact on Indonesia in general, increasing GDP and other economic impacts. It is the intention of this paper to present an overview of this impact. The remainder of this paper is organized as follows: Section 2 contains a description of the methodology used for the energy forecast and the use of the input-output table. Section 3 contains the results for the two tasks which were set and section 4 conclusions.

2. Methodology

The main objective of the paper is to examine the possible economic advantages of LRC utilization in the economy of Indonesia in 2025. To determine the impact, the methodology of the Input Output (IO) model is used. For Indonesia, the latest Indonesia IO Table dates from 2005 and it has a 175 sectors (hence, the IO table consists of 175 sectoral inputs and 175 sector outputs) with domestic transactions on the basis of producer prices [8].

In order to use the IO model for an analysis of the economic impact of LRC for the year 2025 in Indonesia, it is necessary to develop a forecasting of LRC demand by that time. Hence, the methodology consists of two steps. In a first step, this forecasting has to be made and in a second step, the IO model has to be applied to quantify the economic impact of the LRC utilization.

2.1. Projection of energy demand and LRC demand

Forecasting energy demand in 2025 is needed to determine the appropriate type of LRC utilization. Engineers and economists have developed an interesting debate so as to enrich the methodology in analyzing and forecasting energy demand [9]. Energy demand forecasting is an essential component of energy planning, formulating strategies and recommending energy policies [10].

On energy policy report in India and China, a simple step calculation method using the elasticity of GDP and energy intensity was proposed to forecast energy demand for the time period of 10 years or longer. Other studies confirmed that such a simple model is suitable under certain conditions to reveal the accuracy of forecasting outcomes much like these results from the use of more complex models [11] [12].

Hence, within this simple approach, two key parameters need to be defined.

Energy intensity (EI) is defined as follows :

$EI = E/Q$ .... (1)

where

E = energy demand (consumption)

Q = output (GDP)

Formula (1) can be rearranged to forecast energy demand, using estimates for future Q and for EI [10]:

$E = EI \times Q$ .... (2)

For the purpose of this paper, data on GDP were taken from 2000 to 2013 and extrapolated to the year 2025 on the basis of an annual increase of 5.5 % under the assumption that this current annual increase rate will remain valid in the future. Equally, EI for 2025 was estimated on the basis of data for E/Q for 2013 under the assumption that this energy intensity is constant until the forecasting year of 2025.

2.2. Economic Analysis

Based on energy demand and the government regulation, the economic feasibility of each technology for LRC utilization (briquetting, upgrading, liquefaction, CWM/CWF and LRC power plants) is estimated. This implies assumptions on the price of LRC and the weighted average cost of capital (WACC). In essence, in a standard DCF method, the outcomes are estimates for the Cash Flow, the Net Present Value (NPV), the Internal Rate of Return (IRR) and the Payback Period (PB). Hence, the cash flows are like payments for a loan and the IRR is like a borrowing rate. However, the IRR can change over times since costs and prices may be beyond an ability to predict [13].

2.3. Analysis of input-output model

The estimation of the economic impact of LRC is based upon the use of an IO table constructed for the forecasting year of 2025. The IO analysis framework was developed by Professor Wassily Leontief in the late 1930s, who received the Nobel Prize in economics in 1973 [14].

The IO model is particularly useful to measure the inter-industry linkages in the economy, both nationally and regionally [14] [15]. This model is an adaptation of the theory of equilibrium among all economic activities in a region in the sense of flows of goods and services. The basic structure of a IO table consists of rows showing “which sectors delivery which quantities to which other sectors” and of columns showing “which sectors receive which quantities from which other sectors” in an economy [15] [16]. Hence, an IO table is basically a statistical description in the form of a matrix that presents information about all transactions of goods and services as well as all interconnections between units of economic activity (called sectors) in a region at a specific time period [8]. An IO table reflects an equilibrium model in the sense that there is no surplus production and consumption [8] [17]. Currently, the IO methodology is well developed and it is one of the analytical tools most widely used in economic analysis [18].

In this paper, the IO methodology is used more specifically to estimate the economic impacts of LRC utilization in the relevant sectors.

In Indonesia, the IO table was introduced in 1969 as a non-survey method. In 1971, the Statistics Agency (BPS), the Central Bank of Indonesia and the Institute of Developing Economics (IDE) conducted a survey method for the preparation of an IO table. Since then, the IO table has been updated regularly in 1980, 1985, 1990, 1995, 2000 and lastly in 2005 [19].

The key features of an IO table are as follows:

- Technical coefficients a_{ij} and the matrix A
- The Leontief inverse matrix M and the output multiplier Oj
- Income technical coefficients and the income multiplier H_j

Each row of an IO table is written as follows:

$x_{11} + x_{12} + \ldots + \ldots + x_{1n} + Y_1 = X_1$
$x_{21} + x_{22} + \ldots + \ldots + x_{2n} + Y_2 = X_2$
$x_{n1} + x_{n2} + \ldots + \ldots + x_{nn} + Y_n = X_n$ .... (3)

or in general:

$\Sigma_j\, x_{ij} + Y_i = X_i \quad (_i = 1,2,\ldots n)$………………………………………………………………….(4)

where x_{ij} = sales from sector i (rows) to sector j (column)
Y_i = sales from sector i to final demand,
X_i = total output of sector i

The technical coefficient in Table I-O is the ratio between the outputs of sector i used in sector j (x_{ij}) with a total input sector j (X_j). These input coefficients can be defined by the equation:

$a_{ij} = x_{ij} / X_j$, or $x_{ij} = a_{ij}$ x X_j ………………………………………………………………….....(5)

where X_j = total input of sector j

Then, we can write:

$a_{11}X_1 + a_{12}X_2 + \ldots. + \ldots. + a_{1n}X_n + Y_1 = X_1$
$a_{21}X_1 + a_{22}X_2 + \ldots. + \ldots. + a_{2n}X_n + Y_2 = X_2$
$a_{n1}X_1 + a_{n2}X_2 + \ldots. + \ldots. + a_{nn}X_n + Y_n = X_n$……………………………………………………….....(6)

Equation (6) can be rewritten in matrix form:

$$\begin{bmatrix} a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n + Y_1 = X_1 \\ a_{21}X_1 + a_{22}X_2 + \ldots + a_{2n}X_n + Y_2 = X_2 \\ \ldots\ldots\ldots \\ a_{n1}X_1 + a_{n2}X_2 + \ldots + a_{nn}X_n + Y_n = X_n \end{bmatrix}$$

$$\begin{bmatrix} X_1 - a_{11}X_1 - a_{12}X_2 - \ldots - a_{1n}X_n = Y_1 \\ X_2 - a_{21}X_1 - a_{22}X_2 - \ldots - a_{2n}X_n = Y_2 \\ \ldots\ldots\ldots \\ X_n - a_{n1}X_2 - a_{n2}X_2 \ldots - \cdots a_{nn}X_n = X_n \end{bmatrix}$$

$$\begin{bmatrix} (1 - a_{11}) - a_{12} - \ldots - a_{1n} \\ -a_{21} + (1 - a_{22}) - \ldots - a_{2n} \\ \ldots \\ -a_{n1} - a_{n2} - \ldots + (1 - a_{nn}) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \ldots \\ X_n \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ \ldots \\ Y_n \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & \ldots & 0 \\ 0 & 1 & \ldots & 0 \\ \vdots & \ldots & \ldots & \vdots \\ 0 & \cdots & \ldots & 1 \end{bmatrix} - \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \ldots & \ldots & \vdots \\ a_{n1} & \cdots & \ldots & a_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \ldots \\ X_n \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ \ldots \\ Y_n \end{bmatrix} \ldots\ldots\ldots\ldots(7)$$

Alternatively:

$(I – A)\, X = Y$ ………………………………………………………………………………(8)
$X = (I – A)^{-1}\, Y$……………………………………………………….……………………..(9)

where : I = Identity matrix
(I-A) = Leontief matrix
$(I – A)^{-1}$ = Leontief inverse matrix (M)

IO tables are then adjusted by the GDP data for 2013, thereafter compiled into the Indonesia IO Table 2013 and projected according to the demand forecast (as explained above) to obtain the IO table 2025. An economic growth rate of 5.5 % has been assumed. Actually, two IO tables were constructed. One of these, with

13 x 13 sectors, does not account for LRC utilization, while the other table has 13 x 13 sectors and an additional sector for LRC utilization. This was based on the calculation of the energy needs and the economic feasibility.

The next step consists of a multiplier analysis making use of the outputs, income, and employment multipliers. The analysis is made through a forward and a backward linkage. The impact multiplier can be interpreted as an indicator of a direct or indirect change in economic activity resulting from changes in the exogenous variables (i.e. demand) [14]. With the Leontief inverse matrix, this multiplier can be easily calculated [20] [21].

The multiplier output Oj indicates the overall increase in total output in the economy as a result of an increase of output in sector j. Calculations can be done by summing the Leontief inverse matrix column.

$O_j = \sum_i^n M$ ………………………………………………………………………………..(10)

where M is an element of the Leontief inverse matrix.

The income multiplier or income effect Hj shows the total amount of income that is created by the addition of one unit of final demand in sector j.

If $v_j = Vj / Xj$.. ……………………………………………………………………..…(11)

then $Hj = \Sigma$ vj. M ……………………………………………………………………………(12)

where, v_j = income coefficient sector j
Vj = value added of income sector j
Xj = total input/output sector j

Similarly, the employment multiplier or employment effect Ij indicates the total effect of a changes in employment in the economy resulting for a change final demand in sector j. An analysis of this employment multiplier gives an indication of the importance of a particular sector.

If wj = Lj / Xj……………………………………………………………...............................(13)

then, :

Ij = wj x M ……………………………………………...…………..……………..(14)

where wj = employment coefficient (man/output) sector j
Lj = total employment of sector j

A backward linkage with sectors of the economy can be described as follows:

$$\alpha j = \frac{\sum_i bij}{(\frac{1}{n})\sum_i \sum_j bij} \quad (15)$$

And a forward linkage can be calculated as follows :

$$\beta i = \frac{\sum_j bij}{(\frac{1}{n})\sum_i \sum_j bij} \quad (16)$$

In order to estimate the importance of LRC utilization in Indonesia in 2025, both IO tables (with and without LRC utilization) are compared in terms total output, the direct impact on GDP and the effect on employment.

3. Results and Discussion

3.1. Energy demand, economic analysis and production capacity

The forecast of energy demand is based on the energy intensity of 2013 (kept constant until 2025) and a GDP growth rate of 5.5%. From Table 1 it can be seen that, in 2025, GDP will amount to US $ 1,731 billion and energy demand will stand at 2,200 million barrels oil equivalent (boe). This energy demand is forecasted to be met by fuel oil (37.58 %), followed by biomass (22.76 %), coal (25.46 %), gas (14.62 %) and electricity (9.56 %).

Table 1. Energy needs of each sector 2013-2025 (million boe)

Year/Branches	Industry	Household	Transport	Commercial	Total
2013	487.8	338.9	323.6	37.3	1,187.7
2014	514.6	368.4	341.4	39.4	1,263.8
2015	543	384	360.2	41.6	1,328.7
2016	572.8	400.4	380	43.8	1,397.0
2017	604.3	417.5	400.9	46.2	1,469.0
2018	637.6	435.4	422.9	48.8	1,544.7
2019	672.6	454.2	446.2	51.5	1,624.5
2020	709.6	473.8	470.7	54.3	1,708.5
2021	748.6	494.3	496.6	57.3	1,796.9
2022	789.8	515.8	524	60.4	1,890.0
2023	833.3	538.3	552.8	63.8	1,988.1
2024	879.1	561.8	583.2	67.3	2,091.3
2025	927.4	586.4	615.2	71	2,200.1

For the economic analysis, it was assumed that LRC has a price of US $ 24.7/ton and that the WACC is set at 8% (based on a debt/equity ratio of 80/20). Other assumptions are shown in Table 2.

Table 2. LRC Utilization assumption [23] [24] [25] [26] [27], modified*)

Utilization	Production Cap, 000ton/y	Construction Cost, Million US $	Life of plants years	Production Cost, US $/ton	Price of product US $/ton
UBC	1,500	121	15	10.71	60
Briquetting	45	3.6	10	64.4	150
CWM/CWF	1,000	250	15	50	135
Power plants	1,000 MW	1,752	25	99.7 million	0.108/kWh
BCL	26,905 bod	2,345	25	28.65 million/y	70/barrel

*) modified in price of product

The government's target in the energy mix by 2025 is coal for 33% of total domestic energy demand. When LRC is used proportionately, LRC utilization will reach 261 million boe (with growth of 5.5%), not including liquefied LRC. The greatest energy demand will be located in Java (more than 60%). LRC is feasible for use as briquettes, CWM/CWF, power plant and coal liquefaction (BCL) [22].

Assuming that 10 % of firewood and 50 % of kerosene in households and small industries can be replaced by briquettes, LRC utilization as briquettes will reach 55 million boe. Since CWM/CWF is expected to reduce the dependence on oil in boilers in the industrial sector and assuming a reduction of 25% in the food industry sector alone, LRC utilization as CWM / CWF will reach 12.6 million boe. Assuming that LRC for power plants only takes place on Sumatra Island, LRC utilization in this segment will be 13.8 million boe (equivalent to 22.47 TWh). Similarly, LRC utilization as BCL will be 44 million boe.

Table 3. Economic Analysis of LRC added value, modified*)

Type	NPV	IRR	PB	Feasibility
UBC	-6,644,189	7.17%	> 15 year	Not feasible
Briquetting	4,607,547	39.06%	3 years 8 months	Feasible
CWM/CWF	49,509,458	11.07%	13 years 10 months	Feasible
Power plants	2,003,471,503	19.38%	7 years 1 months	Feasible
BCL	177,948,242	8.81%	21 years 11 months	Feasible

*) modified in in WACC, price of LRC and the price of the product

3.2. Input-output analysis

Table 4 shows the outcomes of the IO table calculations. It can be seen that LRC utilization as briquetting yields an output multiplier of 2.222, whereas the output multipliers for BCL, CWM/CWF and LRC power plants stand at 2.057, 1.549 and 1.824 respectively.

In comparison with other multipliers shown in Table 4, these values are rather high. Hence, if final demand (ΔY) increases by US $ 1,000, increases of output (ΔX) of US $ 2,222 result from briquetting, of US $ 2,057 from BCL, of US$ 1,549 from CWM/CWF and of 1,823 from LRC power plants. Similarly, Table 4 shows the income multipliers ranking from 0.268 (briquetting) followed by 0.223 (BCL), 0.175 (LRC power plants) and 0.142 (CWM/CWF). The higher multiplier value, the higher impact on income.

In respect of the employment multipliers Table 4 shows that the agricultural sector has the highest number of 0.225, implying that an increase in final demand of US $ 1 million will create 225 new jobs. The employment effects of LRC utilization vary for the different sectors, between 0.07427 (seventh rank) for coal briquetting, 0.06391 (eighth rank) for BCL, 0.05161 (ninth rank) for LRC power plants and 0.0296 (twelfth rank) for CWM/CWF.

Table 4 also reveals that LRC utilization yields large backward linkages (α_j>1) – with the exception of CWM/CWF (0.961), indicating that it highly depends on the growth of other sectors as input. Coal briquettes have the largest value of all sectors, followed by BCL (second rank), LRC power plants (sixth rank) and CWM / CWF (tenth rank). This is not surprising since LRC utilization result in the supply of energy. Hence, similarly, in respect of forward linkage, LRC utilization sector yields small values of 0.664 for BCL, 0.636 for LRC power plants, 0.632 for briquetting and 0.624 for CWM/CWF.

Table 4. Multiplier and linkage analysis

Sector	Output	Income	Employmt	Linkage	
				Backwd	Forwd
Agriculture, Livestock, Forestry, and Fisheries	1.37421	0.22832	0.22506	0.85338	1.02365
Coal Mining	1.27205	0.20282	0.02016	0.78994	1.24599
Oil, Gas and Geothermal Mining	1.06525	0.08473	0.00491	0.66152	1.27617
Metal Ore & Others Mining	1.40317	0.21010	0.03843	0.87137	0.76066
Industry	1.70158	0.21918	0.10534	1.05668	1.78178
Oil Refinery	1.00877	0.24236	0.00104	0.62644	1.13493
Liquefied Natural Gas (LNG)	1.29697	0.05114	0.00437	0.80542	0.65074
Brown Coal Liquefaction (BCL)	2.05694	0.22287	0.06391	1.27736	0.66464
Coal Water Mixture/Fluid (CWM/CWF)	1.54906	0.14213	0.02960	0.96197	0.62445
Coal Briquetting	2.22226	0.26809	0.07427	1.38002	0.63243
Electricity	1.95524	0.18919	0.03304	1.21421	0.80661
LRC power plant	1.82396	0.17527	0.05161	1.13268	0.63585
Gas and Water	2.00088	0.22914	0.02838	1.24255	0.69246
Construction	1.82680	0.26230	0.11491	1.13444	0.75760
Trade, Hotel and Restaurant	1.59433	0.28229	0.17438	0.99007	1.06499
Transportation	1.70355	0.29826	0.09701	1.05790	0.99062
Services, Finance, Government, and Other Activities	1.52022	0.35556	0.11638	0.94405	2.25642

3.3. The role of LRC utilization on Indonesia's economy in 2025

The last part of the calculations gives estimates about the role of LRC utilization in Indonesia in 2025. This result from a comparison of the IO tables with and without LRC utilization under the same economic growth conditions. As explained above, LRC utilization as briquetting, CWM/CWF and BCL reduces the importance of oil refineries (even oil importer) and LRC utilization in power plants will reduce the importance of the conventional electricity sector.

1). Based on the IO projection table for 2025, Indonesia's economy will be supported by the industrial sector with an input contribution of 20.75% of total GDP and an output of 23.31%. Other important sectors are the Services, Finance, Government and Other Activities sector with shares of 18.53% (GDP) and 19.14% (output), followed by the Agriculture, Livestock, Forestry and Fisheries with shares of 14.4% (GDP) and 14.45% (output) and the Trade, Hotel and Restaurant sector with shares of 14.32 % (GDP) and 14.31%. (output).

2). The results of the comparison of the two IO tables (with & without LRC utilization) is shown in Table 5.

a. LRC utilization will amount to 63.7 million tons, consisting of BCL (28.8 million tons), CWM/CWF (4 million tons), briquettes (18.13 million tons) and power plants (12.81 million tons).

b. In case LRC utilization takes place, total output will amount to $ 2,687,517 million, compared to US $ 2,676,701 million (no LRC utilization). This implies an increase of US $ 10,815.9 million (0.4% of total output).

c. LRC utilization will have direct impact on the creation of GDP amounting to US $ 2,469 million calculated as the sum of 964,188 + 185,950 + 615,139 + 703.809, equivalent to 0.14% of GDP and an output of US $ 8.341 million calculated as the sum of 3,513,988 + 594,000 + 1,965,000 + 2,268,377, equivalent to 0.31% of GDP.

d. LRC utilization will increase output in the coal mining sector by US $ 52,836.9 million compared to $ 54,371.4 million with a difference of US $ 1,534.5 million for the case in which LRC is not mined.

e. Similarly, LRC utilization will lead to 267,280 new jobs (difference between 210,953,771 and 210,661,473). Of these jobs, 25,018 are direct jobs.

Table 5. The effects of LRC utilization on the economics of Indonesia 2025

No	Description	5.5% growth (000 US $) without LRC	with LRC
1	GDP	1,731,008,980	1,731,008,980
	BCL		964,188
	CWM/CWF		185,950
	Briquetting		615,139
	LRC Power plant		703,809
2	Output	2,676,701,050	2,687,517,022
	BCL		3,513,988
	CWM/CWF		594,000
	Briquetting		1,965,000
	LRC Power plant		2,268,377
3	Oil Refinery Output	88,091,165	86,224,554
	Import	30,453,877	29,803,453
	Subsidy	(34,215,771)	(33,485,003)
4	Coal Mining Output	52,836,885	54,371,400
	LRC Mining		1,573,642
5	Electricity Output	28,561,418	27,781,484
	LRC Electricity		2,268,377
6	Export comodity	208,239,315	208,239,315
7	Employment	210,661,473	210,953,771

4. Conclusion

The utilization of natural resources supports the welfare of a country or a region. Low Rank Coal (LRC) is one of the natural resources which have not been optimally used in Indonesia. This paper has shown that LRC utilization has an effect on Indonesia's welfare as measured through higher income and employment. The methodology used to estimate these effects is known as the Input Output Analysis in combination with a forecasting model and an economic analysis. The outcomes show not only an increase in income (measured as GDP increase) and employment resulting for LRC utilization itself, but also in other sectors through forward and backward linkages. Moreover, the paper has shown the effects of LRC utilization through a comparison of two IO tables, one of them accounting for LRC utilization and the other table leaving LRC out as an additional energy option. This comparison clearly shows the contribution of LRC utilization which may be expected.

Obviously, the use of the IO method and of the forecasting model implies a number of assumptions which are required for the calculations. It can be argued that the assumptions made in this paper are realistic and, hence, provide estimates which can be used for future energy policy decision-making in Indonesia, especially with regard to LRC utilization and a a modification of the energy mix in the future.

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