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Economy Growth and Oil Import Requirement in Indonesia

Dwi Atty Mardiana[1*] Zulkifli Husin[1] Muhammad Zilal Hamzah[2] RS. Trijana Kartoatmodjo[3]

1. Economic Faculty, Trisakti University, Kyai Tapa No.1 Grogol Jakarta 11440, Indonesia
2. Indonesian Business School (STIEBI), Kebayoran Lama No.46, Jakarta 11560, Indonesia
3. Energy and Earth Science Faculty, Trisakti University, Kyai Tapa No.1 Grogol Jakarta 11440, Indonesia

*Email address of corresponding author: dwi_atty@yahoo.com

Abstract

Indonesian oil consumption increase twice as fast as in the world, while domestic productions are declining. The impact is a steady growing dependence on imported oil, balance of payment of deficit economic and negative toward national energy security. An econometric model of Indonesia's energy is constructed based on its energy balance model into 2030; makes projection of future energy needs; and simulates various alternative strategies to deal with energy dependency. The analysts use an energy balance model which estimated by two-stage least squares (2SLS) framework. This paper suggests that Indonesia oil import will be more affected by transportation fuel consumption rather than economic growth and it is estimated that Indonesia will become net importer energy in 2015. This simulation suggests that there are some potential factors to reduce the import dependence by reduce gasoline subsidize; increase oil production; and diversification from gasoline to Natural Gas Vehicle (NGV) or Liquefied Gas Vehicle (LGV) in transportation sector.

Keywords: 2SLS, energy diversification, energy projection, gasoline subsidize, oil import, balance of payment, energy balance model, national energy security

1. Introduction

The growth in various economic sectors, developments in socio-economic activities, population growth and standard living improvement in Indonesia, will contribute to rapid increase in energy demand. Over the past 21 years, energy consumption grew at 4.8 percent on average; slightly the same with the GDP which grew at annual rate of 4.9 percent.

In 1990, final energy consumption was dominated by oil (over 50 percent). Now, in 2011, oil still account for 39% of total energy consumption, 14% in natural gas and 24% on coal. Renewable energy, particularly hydro and geothermal have a share of 3% and 20% in traditional use of biomass as energy. The decline of oil use on the share of energy consumption has been offset by a rapid increase in the use of electricity, natural gas and coal because of the oil expense. However, the oil consumption still growth annually in a rate of 4 percent.

The focus on oil consumption was caused by the low price of oil in the past, due to own of oil source and prolonged price subsidies. Fuel and electrical subsidize led to inefficiency of fuel consumption and impede the development of alternative energy resources. Limited oil reserves as a non-renewable fossil energy and declining production rate then no longer support to fulfilled domestic oil demand. As a result, Indonesia has become a net oil importer since 2004 and left the OPEC membership in 2008 after joined in 1962. The oil and gas imports amounted to approximately US$ 42 billion in 2012, which is equivalent to 22% of total export. Furthermore, a deficit Indonesia trade balance in 2012 was due to oil and gas import rising higher than export.

In recent years, as a concern on Indonesia's energy need and economic growth, a number of studies have been conducted to make long term projection of Indonesia's energy demand. Most of these studies focused on Indonesia's aggregate supply and demand and suggest in the same general direction that Indonesia's energy consumptions are increase rapidly. Some of these studies use different model and variable to analyze. Sugiyono (1999) forecasted Indonesia energy demand and economic growth before and after crisis until 2025 using general equilibrium model. Sugiyono (2005) examine the outlook for oil consumption until 2025 related to biofuel utilization and price, using Model for Analysis of Energy Demand (MAED). Santosa and Yudiartono (2005), Ibrahim et al. (2010) predicted the outlook for energy demand until 2035 at a regional level using a linear model. Sugiyono and Suarna (2006) predicted Indonesia's electricity demand until 2030 using Market Allocation Model (MARKAL) and suggest to coal as main energy for power generation. Elinur (2012) employed World Energy Model (WEM) to examine the factors that affect energy supply and demand. The outcomes of these predictions are entirely dependent on the methodologies, time of research and underlying assumption.

This paper adds to the literature by examining the determinations of Indonesia's energy imports and use the finding to projecting Indonesia energy import requirement. Study on the relationship between energy import requirement and economic growth are conducted by among others: Goldar and Mukhopadhyay (1990); Adams et al. (2000); Zhao (2007); Shachmurove and Adams (2008); Ghosh (2009); Hotunluoglu and Karakaya (2011); etc.

Adams et al. (2000) forecasted the energy demand in Thailand until 2010 by using energy balance model and did the same study with Shachmurove (2008) for China's energy import requirement. Zhao (2007) forecasted China's oil import using cointegration and VECM techniques. Goldar and Mukhopadhyay (1990) and Ghosh (2009) estimate demand for imported crude oil in India using OLS methods and error correction models. Hotunluoglu and Karakaya (2009) estimated energy demand in Turkey using artificial neural network technique.

The objective of this paper is to develop an energy balance model for Indonesia, examine the factors that influence and determine oil import in Indonesia, makes projection of future energy needs in 2012 until 2030 and simulates various alternative strategies to deal with energy dependencies, especially in oil. Projection of the energy balance will show the need to import growing quantities of fuel, causing fear of significant burdens on balance of payments and national energy security. The simulation that run to see the effect of: (a) economic growth, (b) international and domestic oil price, (c) oil production incremental, (d) refinery efficiency and (e) energy diversification on the growth of energy and oil import requirement.

Identifying the factors that influencing oil import through oil demand and supply is important for policymakers. Through oil demand, oil import is responsive not only to world oil price but also economic growth, government distortion to domestic gasoline price and government policy to substitute oil use to other energy, while for supply side, oil import is responsive to crude oil production and refinery efficiency.

2. Method

An econometric approach was applied to energy balance model. Econometric is a standard quantitative approach for economic analysis that establishes a relationship between the dependent variable and certain chosen independent variables by statistical analysis of historical data. The relationship can then be used for forecasting by considering changes in the independent variables and determining their effect on the dependent variable.

The energy balance approach is traditionally used as an accounting system to analyze a country's energy supply and utilization. Based on World Energy Model (WEM), energy balance framework reconciles the flow of energy supply, transformation and final demand, by sector and by source of energy. The explanations of the model are:

1) The final energy demand module or secondary energy demands follows the disaggregated end-use approach by considering industry, transportation, household, commercial, electricity power plant, and other sector.

The microeconomic basis for consumer energy demand relies on consumer's utility maximization principles. In the case of industry, power plant and commercial sectors, energy is used as an input to produce an output. Producer will face certain constrain: maximization output level and minimization production cost. Linkage from economic activity to sectoral energy demand by fuel is used the following structure:

$$CE_i = f_i(Y, P_i, P_j, CF_j, CE_{i\text{-}1})$$

where Y represents sectoral activity, P_i is the price of fuel i, P_j is the price of other fuels, CF_j is the consumption of other fuels and $CE_{i\text{-}1}$ is a lagged fuel consumption of fuel i (Bohi, 1981; Bohi and Zimerman, 1984; Madlener, 1996; Adams, 2000; Elinur, 2012). The autocorrelation of lagged endogenous variable will test by Durbih-h statistic.

In transportation sector, fuel demand has been increasing rapidly in line with the rapid motorization and number of vehicle in Indonesia society. The consumption of gasoline in this sector are depends on GDP per capita, number of vehicle, and price of gasoline.

The energy demand is estimated by estimating each source of energy, and the overall demand is obtained using the identity. Total of energy demands by fuel represents the secondary energy requirement.

2) Secondary energy demands are then allocated to the transformation block to generate primary energy requirement. All electrical power is consumed by the electricity rate of 76 percent, which show no electricity imports. Crude oil input to refining is determined by available refinery capacity, refinery specification, domestic crude oil production and petroleum product demand that are obtained using the identity. Refinery efficiency is treated exogenously and used to calculate refinery output.

3) The requirements of primary energy (i.e.: oil, natural gas, coal, geothermal, hydropower, biomass) are confronted with estimates of domestic energy production, imports and exports. Indonesia is well endowed with

energy resource, although oil production has probably peaked and is now in decline. Domestic production is projected on supply resources, recent decline rate and exploitation potential. Crude oil exports is coming from government production share of crude production which out of domestic refinery specification.

Import requirements of crude petroleum and petroleum products, as a target of the analysis, are computed by the difference between domestic need (include exports), domestic production and stock. Indonesia has two alternative regarding oil imports: to import petroleum product directly and to import crude oil then refine it domestically. The lack of refinery capacity has made 40 percent petroleum product and 30 percent of crude oil are imported in 2011.

4) The economic activity, energy prices and other exogenous variables are considered as the main drivers of energy demand. Its linkages to industry, transportation, commercial, electricity power plant and other sector are determined by interest rate, exchange rate and trend.

The data are a state-level time series of yearly observation that span the period from 1990 to 2011 and include energy consumption, economic and social data from report issued by the Ministry of Energy and Mineral Resources, Central Bank of Indonesia and Statistical Bearou.

The energy balance model is composed of four blocks of behavioral equations and identities; consist of 26 behavioral equations and 22 identities. The empirical work begins with identifying the model to ensure that unique values of the structural parameters could be derived from the reduced form of the system. Estimations of the model were conducted by simultaneous equations using a two stage least square (2SLS) framework, because the ordinary least square (OLS) method can not be used to estimate an equation in a system of simultaneous equations (Koutsoyiannis, 1977).

To investigate the relationship between different macro variable (i.e., economic growth, world oil price, gasoline domestic price, crude oil production, refinery efficiency and energy diversification) and oil import (i.e., crude oil and petroleum product), correlation test between variables were applied in final energy consumption (oil, gas, coal, biomass, hydropower and geothermal) in all economic sectors.

Finally, the estimation results will be used to forecast energy consumption and oil import in Indonesia to 2030. Prior to forecast, these estimation results were validated by generating an ex-post forecast (Greene, 2008) to determine how well the models predict variable. The ex-post forecast evaluation is conducted by comparing projections for 2008 until 2011 endogenous variables to actual values for them. Forecasts are evaluated in two ways: in term of the accuracy and in the ability to predict turning the data. Root mean percent error (RMSPE) and Theil's U (measure of forecasting quality) are two statistics employed to assess accuracy. A higher RMSPE and a lower Theil's U indicate a better performance in predicting turning points in the data.

3. Results

The 2SLS estimation resulted from identified energy balance model for oil consumption in all economic sectors is shown at Table 1. From the estimations of demand side, economic theory predicts that price should have a negative effect on demand, whereas income should have a positive effect. Over period 1990 to 2011, GDP has a significantly positive in the regression of oil consumption in a sector which is dominated by oil, such as transportation and household. The domestic gasoline price has a significantly positive on oil consumption in all sector, while power generation sector have a positive effect on oil consumption due to diesel subsidize. World oil price appears negative significantly to oil consumption due to government price distortion and have been exclude from the final result.

From the estimation of supply side, oil production and refinery efficiency have a significant positive effect in the regression of oil import (crude oil and petroleum product). Expanding refinery capacity and efficiency will made substantial substitution occurs between imported petroleum product and crude oil imports. Energy diversification has a significantly positive in the regression of oil consumption in all sectors.

Table 1. 2SLS final estimation result for oil consumption in all sector

Endogen variable	Exogen variable	Coefficient	Std. Error	t-Statistic	Probability	R^2
Oil consumption comercial Sector, COMOLT	C	2394.3280	738.1121	3.2439	0.0013 *	0.8626
	Gasoline price	-0.0037	0.0013	-2.8197	0.0050 *	
	Interest rate	-57.9711	27.2404	-2.1281	0.0339 *	
	COMOLT(-1)	0.8703	0.0914	9.5174	0.0000 *	
Oil consumption power generation sector, EGOLT	C	-42848.9000	18431.0200	-2.3248	0.0206 *	0.9379
	Diesel price	0.0552	0.0111	4.9645	0.0000 *	
	Number household	1.8214	0.4455	4.0887	0.0001 *	
	Gas consumption	-0.5692	0.1329	-4.2839	0.0000 *	
Oil consumption industry sector IDOLT	C	-89514.9200	25199.6800	-3.5522	0.0004 *	0.9261
	Diesel price	-0.0420	0.0122	-3.4329	0.0007 *	
	IDOLT(-1)	0.2457	0.1430	1.7183	0.0864**	
	Ratio oil to gas	74993.5000	27995.3800	2.6788	0.0077*	
	Number household	2.1662	0.4845	4.4710	0.0000*	
Oil consumption other sector OCOLT	C	12760.3000	2949.4660	4.3263	0.0000*	0.7530
	Gasoline price	-0.0062	0.0019	-3.2169	0.0014*	
	OCOLT(-1)	0.7529	0.1100	6.8471	0.0000*	
	Interest rate	-303.6808	81.1652	-3.7415	0.0002*	
Oil consumption household sector, REOLT	C	-100888.9000	10402.1000	-9.6989	0.0000*	0.9798
	LPG price	-0.0187	0.0070	-2.6695	0.0079*	
	Number household	2.2105	0.2037	10.8535	0.0000*	
	GDP/capita	-2512.0840	1247.6980	-2.0134	0.0447*	
	Ratio oil to gas	67047.4600	5275.1220	12.7101	0.0000*	
Oil consumption transportation sector, TROLT	C	11724.7600	13454.3700	0.8714	0.3840	0.9952
	Gasoline price	-0.0894	0.0132	-6.7757	0.0000*	
	LGV price	0.1555	0.0368	4.2214	0.0000*	
	Number of vehicle	1.7559	0.2475	7.0951	0.0000*	
	GDP/capita	6505.4740	2637.0890	2.4669	0.0140*	
	TROLT(-1)	0.3095	0.1138	2.7209	0.0068*	

Description: Superscripts * and ** represent rejection of null hypothesis at 5% and 10% significance level, respectively.

Forecast and simulation exercise are influenced by the assumptions of the exogenous variable of the system. Price for international oil, natural gas and coal has been obtained from International Energy Outlook. Domestic oil price assume follow to the international oil price with the incremental per 4 years. Production assumption for crude oil, natural gas, coal, hydropower and geothermal has been obtained from Ministry of Energy and Mineral Resources.

The baseline forecast show that in 2030 Indonesia's energy consumption will increase at annual rates of 4.2 percent. It still remains slightly lower than the growth of GDP at 5 percent per year, through structural changes in an economy. Final energy supply and consumption for 2012 until 2030 are shown on Figure 1. Natural gas, coal and electricity consumption is projected to increase more rapidly than the consumption of oil, replace the usage of oil in all sector, except in transportation sector which still dominated by oil.

Industrial sector still use the most energy, followed by electricity power plant, households and transportation. The total number of vehicle is expected to grow 5 percent per year; as a result, consumer demand for oil product in transportation sector will increase in a rate of 5.5 percent per year. Growing electricity need in household will increase rapidly (over 9.6 percent per year) which link to economic growth, rise of living standard, and clean energy.

Coal estimated will supply 73 percent of Indonesia's total energy production in 2030, while natural gas and crude oil supplies only 19 percent and 3 percent respectively. Production of coal and natural gas still dominan for export purpose rather than domestic market in a share of 77 percent and 44 percent. Declining crude oil production (5 percent per year) and expected refining capacity expansion over 820 thousand barrels oil per day, create increasing crude oil import roughly by 5 times from 2011 to 2030 or about 84 percent of its 1.6 million barrels oil per day (bopd) refinery needed in 2030. Petroleum product import estimated increase 2 times in 2030 compare to 2011 or almost 57 percent of 2.5 million bopd domestic fuel consumptions in 2030.

The most important finding is the very large increase of oil import (crude oil and petroleum product) from 268 million barrel in 2011 to over 846 million barrel in 2030. In term of value, the oil imports, which amount to IDR 220 billion in 2011, will grow to IDR 941 billion in 2030. Comparing to real GDP, increasing 6.3 percent oil

import against 5 percent GDP annually, suggest that growing energy needs will impose a serious burden on Indonesia economy.

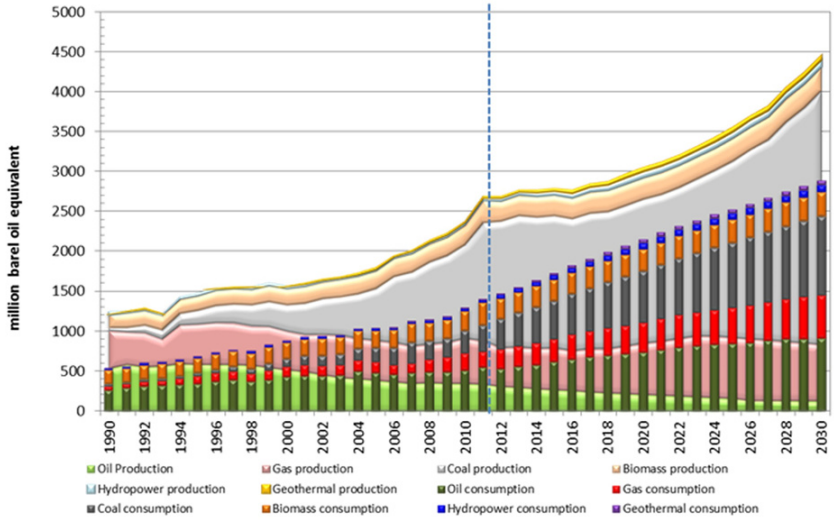

Figure 1. Energy supply and demand 1990-2030

Simulation to 2030 was carried out to establish how the result would be affected by changes in the assumption. The following cases were considered:

• Increase in GDP at annual rate of 1% above the baseline. The higher growth rate of GDP leads to higher energy consumption. The energy consumption is 5.4 percent higher from the baseline in 2030. Oil consumption estimated higher by 10.5 percent, mainly from transportation sector (increase 17.5% from the baseline). It caused gasoline import and it cost increase by 22 percent and 8.5 percent respectively compared to the baseline.

• Increase of 1% in world oil price. Although there have been no significantly effect of world oil price to oil consumption, but it will give an effect to the cost of oil import by the incremental of 12.8% in 2030 compare to baseline.

• Increase in domestic gasoline price. When gasoline price increase, all economic sectors will reduce their oil use and substitute with other energy. Oil consumption estimated lower by -7.4 percent in 2030 compare to baseline which caused oil import and it cost expected decreased significantly by 15.7 percent and 5.9 percent.

• Increase of 1 million barrel oil production per day in 2014. Development of oil and gas in Cepu Field and enhanced oil recovery project increases oil production. Increasing crude oil supply has no effect to oil consumption due to crude oil for refinery process still higher compare to production increase. However, increasing crude oil production will reduce an oil import and its cost by 6.7 percent and 4.1 percent respectively in 2030 compare to baseline.

• Increase of 1% refinery efficiency. In assumption that refinery efficiency increase to 95 percent in 2030, *cateris paribus*, it will give an effect to additional output of petroleum product by 21 percent and crude oil import by 22 percent resulting total oil import and its cost slightly higher by 4 percent and 5.8 percent respectively compare to baseline.

• Increase energy diversification in transportation sector, changing from using gasoline to NGV or LGV. Diversification success story in household sector by substitute kerosene and LPG at 2007-2012 will remain follow in transportation sector. In a beginning process, it will convert 2 percent of vehicle (especially for public transportation, i.e.: taxi, bus and truck) in 2014 and increase to 14 percent or 6 million vehicles in 2030, will reduce oil consumption from 4 million barrel oil in 2014 until 61 million barrel of oil in 2030 or decrease by 8.1 percent compare to baseline. Natural gas consumption estimated increase by 3.8 percent in 2030. Import of petroleum product will reduce significantly by 17.3 percent, and reduce cost of oil import by 6.5 percent in 2030.

Table 2. Summary table for simulation: percentage different from baseline in 2030

Variable name	Baseline Forecast	% Difference from Baseline Forecast					
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Oil consumption, MBOE	753,213	10.5%	0.0%	-7.4%	0.0%	0.0%	-8.1%
Gas consumption, MBOE	539,834	5.2%	0.0%	0.0%	0.0%	0.0%	3.8%
Coal consumption, MBOE	985,171	3.6%	0.0%	2.6%	0.0%	0.0%	0.0%
Electricity consumption, MBOE	332,438	9.7%	0.0%	0.0%	0.0%	0.0%	0.0%
Biomass consumption, MBOE	303,901	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Geothermal consumption, MBOE	60,000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hydropower consumption, MBOE	86,503	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total energy consumption, MBOE	3,235,667	5.4%	0.0%	-0.9%	0.0%	0.0%	-1.9%
Petroleum product refinery, MBOE	398,943	0.0%	0.0%	0.0%	0.0%	18.4%	0.0%
Crude oil production, MBOE	131,898	0.0%	0.0%	0.0%	28.2%	0.0%	0.0%
Crude oil import, MBOE	492,035	0.0%	0.0%	0.0%	-6.7%	22.0%	0.0%
Petroleum import, MBOE	354,271	22.4%	0.0%	-15.7%	0.0%	-20.8%	-17.3%
Total oil impor, MBOE	846,306	22.4%	0.0%	-15.7%	-6.7%	1.2%	-17.3%
GDP (constant price 2000), Trillion rupiah	6,133,411	22.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Total oil import in value, Trillion rupiah	940,897	8.5%	12.8%	-5.9%	-4.1%	5.8%	-6.5%

Description: Scenario (1) economic growth, scenario (2) world oil price, scenario (3) domestic oil price, scenario (4) oil production, scenario (5) refinery efficiency, scenario (6) transportation energy diversification from gasoline to LPG or NGV

4. Discussion

The investigation on relationship among economic growth, world oil price, domestic oil price, oil production, refinery efficiency, energy diversification and oil import requirement suggests that increasing world oil price will not affect oil import through consumption due to government price distortion for gasoline and diesel, while other variable will affect oil import. However, high world oil price will impose a strong brake on economic growth and deficit balance of trade due to uninterrupted domestic oil consumption.

The lower growth forecast in energy consumption from 2012 to 2030 relative to GDP reflects the fact that there will be further structural change in Indonesia economy. In 2030 final energy consumption will dominated by coal (34%), oil (31%), gas (19%), biomass (10%) and other renewable energy (5%), as a result of continuing conversion program from oil to other energy use (i.e., natural gas, coal and renewable energy). However, looking forward to 2030, continue of rapid motorization in transportation sector may cause Indonesia's oil import will dominantly be affected by transportation fuel rather than economic growth.

Because of high oil demand in transportation sector, removing price distortions and increasing energy diversification from simulation will give the highest impact in reducing total oil import. Some additional domestic crude oil production to fulfill refinery capacity will also alleviate the tendency of oil import and expand the economic growth.

Excessive oil consumption could be reduced by eliminating inappropriate government intervention in oil market, removing price distortions (subsidies), allowing market price to reflect the true cost of oil. Tax benefit and incentives should be designed to encourage the use of energy saving goods and services, develop technology that allow switching to other energy source, and support increased use of diversification energy (i.e.: natural gas and coal) and renewable energy.

Increasing export on natural gas and coal production could not significantly effect in reducing the deficit of energy trade due to a higher price disparity between imported and exported energy. Coal and natural gas are exported at a price of 5.6 and 1.5 times respectively, cheaper than the price of oil imports. Converting energy supply and demand in value of money, Indonesia expected to be a deficit energy country in 2015, while deficit of

oil and gas was occurred in 2012.

Sustainable energy security in Indonesia could be achieved by early focus on optimization various energy resources which already exist to support the energy consumption growth while oil production will be fully exhausted in the next decade, otherwise consumption will stop to grow or even to decline.

References

Adams, F.G., Ichino, Y. and Prasmowski, P.A. (2000). *Economic Growth and Energy Import Requirement: An Energy Balance Model of Thailand*. Journal of Policy Modeling 22(2): 219-254

Bohi, D. (1981). *Analyzing demand behaviour: A study of energy elasticities*. Baltimore. John Hopkins University Press.

Bohi, D. R. and M. B. Zimmerman. (1984). *An update on econometric studies of energy demand behavior*. Annual Rev of Energy. Vol. 9. pp. 105-54.

Battacharyya, S.C. and Timilsina, G.R. (2005). *Energy Demand Models for Policy Formulation: A Comparative Study of Energy Demand Models*. Policy Research Working Paper 4866. The World Bank Development Research Group Environment and Energy Team.

Elinur. (2012). *Analisis Konsumsi dan Penyediaan Energi dalam Perekonomian Indonesia* (Disertation). Sekolah Pascasarjana. Institute Pertanian Bogor

Gujarati, D. (2009). *Basic Econometrics*. McGraw-Hill International Edition. Fifth edition.

Ghosh, Sajal. (2009). *Import demand of crude oil and economic growth: Evidence from India.* Energy Policy. 37. 699-702

Greene, W.H. (2008). *Econometric Analysis*. Sixth Edition. Upper Saddle River. NJ: Prentice Hall.

Goldar, Bishwanath. and Mukhopadhyay, Hiranya. (1990). *India's Petroleum Imports: An Econometric Analysis*. Economic Political Weekly. 25 (42/43). 2373-2377.

Houthakker, H.S., and L.D. Taylor. (1970). *Consumer Demand in the United States* (2nd ed.). Cambridge, MA: Harvard University Press.

Hotunluoglu, H. and Karakaya E. (2011). *Forecasting Turkey's Energy Demand Using Artificial Neural Networks: Three Scenario Applications*. Ege Academic Review. ss 87-94.

Ibrahim, H.D., Thaib, N.M., and Abdul Wahid, L.M. (2010). *Indonesian Energy Scenario to 2050: Projection of Consumption, Supply Options and Primary Energy Mix Scenarios*. http://www.academia.edu/1429585/A_review_on_energy_scenario_and_sustainable_energy_in_Indonesia. Downloaded on February 2013.

International Energy Administration. (2012). *World Energy Model 2011*. www.worldenergyoutlook.org

Kementrian Energi dan Sumber Daya Mineral. (2010). *Indonesia Energy Outlook 2010*. Center for Data and Information on Energy and Mineral Resources. Ministry Energy and Mineral Resources. Jakarta.

Kementrian Energi dan Sumber Daya Mineral. (2013), *Handbook of Energy and Economic Statistic of Indonesia 2012*. Center for Data and Information on Energy and Mineral Resources. Ministry Energy and Mineral Resources, Jakarta.

Koutsoyiannis, A. (1977). *Theory of Econometrics: An Introductory Exposition of Econometric Methods*. Second Edition. The MacMillan Press Ltd., London.

Madlener, R. (1996). *Econometric analysis of residential energy demand: a survey.* Journal of Energy Literature 2(2). pp. 3-32

Pindyck, R.S. and D.L. Rubinfield. (1998). *Econometric Model and Economic Forecast*. Fourth Edition, McGraw-Hill International, New York.

Santosa, Joko. and Yudiartono. (2005). *Analisis Perkiraan Kebutuhan Energi Nasional Jangka Panjang di Indonesia*. http://www.oocities.org/markal_bppt/publish/pltkcl/pljoko.pdf. Downloaded on March 2013

Shachmurove, Y. and Adams, F.G. (2007). *Projections of Chinese Energy Demands in 2020*. PIER working paper 07-012

Stern, I.D., Cleveland, C. (2004). *Energy and Economic Growth, Rensselaer Working Papers in Economics*. Rensselaer Polytechnic Institute. USA.

Sugiyono, Agus. (1999). *Permintaan dan Penyediaan Energi Berdasarkan Kondisi Perekonomian di Indonesia dengan Menggunakan Model Nonlinear Programming*. Analisis Sistem No. 13 Tahun VI, pp: 16-23

Sugiyono, Agus. (2005), *Pemanfaatan Biofuel Dalam Penyediaan Energi Nasional dan Aplikasi Model MARKAL*, presented on Nasional Seminar of Mathematics and Statistic, Mathematics Department, University of Padjajaran, Bandung

Sugiyono, Agus and Suarna, Endang. (2006). *Optimasi Penyediaan Energi Nasional: Konsep dan Applikasi Model MARKAL*, presented on Nasional Seminar of Mathematics and Statistic, Mathematics Department, University of Padjajaran. Bandung. 22 April 2006

Zhao, X., Wu, Yanrui. (2007). *Determinants of China's Energy Imports: An Empirical Analysis*. University of Western Australia. Business School. Economics.