Analysis Of Factors Affecting the Electricity Supply in Indonesia

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ANALYSIS OF FACTORS AFFECTING THE ELECTRICITY SUPPLY IN INDONESIA*)

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Abstract

In Indonesia, the activities of supplying of electricity energy or generating of electricity power is still dominated by PT PLN (Persero). The supply of electricity has not been able to meet the demand of electricity by PT PLN. The electricity supply can be affected by amount of generation units, installed capacity, power capacity, investment, energy produced, fuel consumption, unit price of fuel, energy losses, the length of transmission and distribution network, interruption of distribution network, and captive power.

The aim of this study is to analyze the factors affecting on the supply of electricity in Indonesia. Based on the characteristics of the data available on each units of PT PLN or provinces, the data used in this study is panel data in period of year 2009 - 2014. Based on the results of Chow Test and Hausman Test, to analyze the pooled data it is better by using Fixed Effect Model. The result of estimation shows that the factors affecting the supply of electricity in Indonesia are the price (tariff) of electricity, the price of fuel, the length of transmission lines, the energy losses. The the price (tariff) of electricity affects positively and significantly ($\alpha = 0.01$) and elastic on the supply of electriciy. The price of fuel, the length of transmission lines and the energy losses affect negatively and significantly ($\alpha = 0.01$) and inelastic on the supply of electriciy. While the number of distribution interruption has no significant effect on the supply of electriciy. Statistically, all dummy variables of individuals (PLN operational unit/province) and time (year 2009 – 2014) affect significantly ($\alpha = 0.01$) on the supply of electriciy. It means that the patterns of electricity supply of PLN operational units and time patterns of electricity supply are different from the benchmarks.

It is hoped that PT PLN focusing attention on tariff policy, to diversify the input of power generating units, to optimize the length of transmission lines, and also to minimize the electricity energy losses.

Keywords: electricity, energy losses, pooled data, price (tariff), transmission and distribution.

I. INTRODUCTION

In Indonesia, the demand for electricity continues to develop in line with increasing of daily needs of the community and the rapid development in the field of technology, industry, service and information. However, until now the electricity production conducted by PT PLN (Persero), as an official company designated by the government to manage the electricity can not meet the electricity needs of the community as a whole.The growth of electricity demand in line with the economic growth is indicated by increasing of economic activity and population growth.

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Currently, the electricity problems arising from the demand of electricity which increase more rapidly than the ability of PT. PLN (Persero) to meet the power supply. As a consequence, the rotating blackout occurs and even some areas have not been energized by electricity.

On the supply side, PT PLN emphasis on the power generation that includes several factors: number of generating units, installed capacity, rated capacity, investment, energy production, consumption of fuel, selling prices of electricity, unit price of fuel, energy production by type of fuel, energy losses and captive power. The selling price of electricity is a main factor influencing the supply of electricity. Besides, to produce electricity, the role of fuel is also important, due to most of generating units of PT PLN use the fuel as energy source. The role of technology also affects the supply of electricity. Furthermore, in distributing the electricity produced, of course, energy losses occur in transmission lines. These losses vary from year to year as a result of the increase of generating units and the condition of old machines as well as the theft of electicity in distribution networks.

The phenomenas or issues which indicate that the supply of electricity by PT PLN has not been able to meet the demand for electricity to be very important and interesting to study. Therefore, this study tries to analyze the factors that can affect the supply of electricity in Indonesia.

II. LITERATURE REVIEW

Supply is the ability of a manufacturer to produce and offer certain products at certain price levels and in certain period. Sugiarto, et al (2005) stated that the supply of a product is determined by various factors, namely: the price of the product itself, the price of other products, the production costs, the objectives of producer/company, the technological level, the season, etc. According to Rahardja and Manurung (2004) the relationship between the supply and those factors can be expressed mathematically in the form of the supply function. The example of supply function with theoritical expected sign of independent variables is shown below :

$$S_X = f(\overset{+}{P_X}, \overset{+/-}{P_Y}, \overset{-}{C}, \overset{+}{T}, \overset{+}{N}, \overset{+/-}{G}, \overset{+}{R}) \qquad (1)$$

where: S_X = supply of goods X, P_X = price X, P_Y = price of Y (substitutes or complementary), C = cost of production, T = production technology, N = number of merchant sellers/producers, G = goals of company, R = government regulation.

In line with equation (1), for energy supply Dahl (1993) offered the supply function of gasoline as follows:

$$Q_S = (P^+, P_i^-, P_c^+, P_s^-, P_l^-, P_k^-, P_n^-, T^+, E_r^-, \#S^+) \qquad (2)$$

where P = price of gasoline, P_i = price of input, P_c = price of complementary produc, P_s = price of substitute product, P_l = price of labor, P_k = price of capital, P_n = price of land or natural resource, T = change in technology, E_r = regulation and government policies on the environment, and #S = number of suppliers (manufacturers).

To measure the changes of those factors on the supply, it is necessary to compute the supply elasticity. Supply elasticity is a coefficient that indicates the magnitude of change in the number of products supplied as a result of changes in the price of the product and other factors. Supply elasticity can be expressed by the following formula:

$$\varepsilon_S = \frac{\%\ changes\ of\ product\ supplied}{\%\ changes\ of\ factors\ influence\ the\ supply} \qquad (3)$$

For example, the elasticity of supply on price can be formulated with :

$$\varepsilon_S = \frac{\%\Delta Qs}{\%\Delta P} = \frac{\Delta Qs/Qs}{\Delta P/P} \qquad (4)$$

As well as with the supply of electricity energy, it can be influenced by several factors: number of generation units, installed capacity, power capacity, investment, energy produced, fuel consumption, the unit price of fuel, the energy produced per type of fuel, shrinkage energy and captive power (Statistics PLN, 2014). In addition to these factors, the supply of electricity is also affected by the selling price of electricity itself, fuel price, the level of technology used to produce electricity, and others depending on the characteristics of generating units. However, Eberhard (2000) expressed that the generated electricity and distributed to consumers can be lost technically and non-technically. Technical losses include the use in power stations, losses in transformers, losses in transmission and losses in distribution, while non-technical losses occur which caused by electricity theft. Further, several factors driving the supply of electricity consist of : fuel price, subsidies and renewable energy policies, technological development and structure of generating units, market design and market structure, market connectivity, availability of resources and security of supply (Ruoss, 2009 ; OME 2007).

The study conducted by Sihombing (2010) in North Sumatra Indonesia showed that the index of electricity price has a positive and significant effect on the supply of electricity energy. Electricity loss has a negative and significant effect on the supply of electricity energy. As well as with the price of fuel has a negative and significant effect on the supply of electricity energy. Then, in their study in Nigeria, Ubi et al (2012*)* found that the most important determinants affecting the supply of electricity are electricity losses, government investment, and level of technology. While electricity price and rainfall are not significant on the supply of electricity energy.

In case of operation, the supply of electricity will be influenced by the characteristics of generating units, transmission and distribution, electricity price, investment, and use of technology. In generating the electricity energy, the important variable is the input of energy, such as fuel, coal and rainfall. For transmission and distribution activities will occur electricity losses and disruption. Thus, it is important to reduce them by using the advantage technology and maintenance. Then, to operate activities of generating, transmitting and distributing electricity, the investment is needed to support the operational costs. But due to the available data are incomplete, it is not all the variables included as factors that affect the supply of electricity. Therefore, in this study the factors included in estimating the model of electricity supply are selling price of electricity, input price, electricity losses, transmission networks, and distribution interruption.

III. DATA AND SPECIFICATION OF MODEL

This study used the panel data, the combination of cross section data and time-series. The time series data consisted of the period of year 2009 - 2014, and the cross section data consisted of data of electricity system in Indonesia which have 21 units of PLN operational region as shown in Table 1 below :

Table 1. PLN Operational Units in Indonesia

Region	Code	Region	Code
Nanggroe Aceh Darussalam	W1	Sulsel Sultra dan Sulbar	W12
Sumatera Utara	W2	Maluku dan Maluku Utara	W13
Sumatera Barat	W3	Papua	W14
Riau	W4	Bali	W15
Sumsel, Jambi, dan Bengkulu	W5	Nusa Tenggara Barat	W16
Bangka Belitung	W6	Nusa Tenggara Timur	W17
Lampung	W7	Jawa Timur	W18
Kalimantan Barat	W8	Jawa Tengah dan Yogyakarta	W19
Kalsel dan Kalteng	W9	Jawa Barat dan Banten	W20
Kalimantan Timur	W10	Jakarta Raya dan Tangerang	W21
Sulut, Sulteng dan Gorontalo	W11		

Source : PLN Statistic 2014 (data processed by author)

The data collected include electricity production, selling price of electricity, price of fuel (input), length of transmission networks, energy losses, and distribution interruption. The data sourced from: PLN Statistics, Handbook and Energy Statistics of Indonesia, Indonesia's Energy Outlook, Energy Statistics Indonesia in period of year 2009 – 2014. Descriptive analysis is used to describe the matters related to supply of electricity energy. To estimate the factors affecting the supply of electricity by using the panel data, the model can be specified in Common Effect Model, Random Effect Model and Fixed Effect Model. To determine the best model, Chow Test (F Test) and Hausman Test can be used (Hakim 2014, Ariefianto, 2012 ; Pratomo & Hidayat, 2007 ; Nachrowi & Usman, 2006).

The data panel of electricity supply has been estimated into the three models, and after doing the selection of best model by using Chow Test (F Test) and Hausman Test, found that the best model is the Fixed Effect Model where the intercept is not constant. It means that intercept can be changed for each individual cross section and time series. Mathematically, the Fixed Effect Model is specified as follows:

$$Y_{it} = \alpha + \beta X_{it} + \gamma W_{it} + \delta Z_{it} + \ {}_{it} \quad (5)$$

where: Y_{it} = the dependent variable for individual *i* and time *t*,
X_{it} = independent variables for individual *i* and time *t*,
W_{it} and Z_{it} are dummy variables, defined as categorial variables
W_{it} = 1 ; for individual cross section *i*,
= 0 ; others
Z_{it} = 1 ; for time series *t*,
= 0 ; others.

i = 1, 2, 3…N,
t = 1, 2, 3…T,
α = intercept
γ, δ = coefficient of dummy variable
= error term

Based on equation model (5), the regression of Fixed Effect Model for electricity supply in Indonesia is specified as below :

$$PEL_{it} = \alpha_0 + \beta_1 HEL_{it} + \beta_2 HIEL_{it} + \beta_3 JAT_{it} + \beta_4 SUEL_{it} + \beta_5 GAD_{it} + \alpha_1 dW_1 + \alpha_2 dW_2 + \alpha_3 dW_3 + \alpha_4 dW_4 + \alpha_5 dW_5 + \alpha_6 dW_6 + \alpha_7 dW_7 + \alpha_8 dW_8 + \alpha_9 dW_9 + \alpha_{10} dW_{10} + \alpha_{11} dW_{11} + \alpha_{12} dW_{12} + \alpha_{13} dW_{13} + \alpha_{14} dW_{14} + \alpha_{15} dW_{16} + \alpha_{17} dW_{17} + \alpha_{18} dW_{18} + \alpha_{19} dW_{19} + \alpha_{20} dW_{20} + \alpha_{12} dW_{12} + \lambda_1 d2009 + \lambda_2 d2010 + \lambda_3 d2011 + \lambda_4 d2012 + \lambda_5 d2013 + u_{it} \quad (6)$$

where : PEL = Supply of Electricity Energy or Total of Electricity Production (GWh)
HEL = Selling Price of Electricity (Rp/KWh)
HIEL = Fuel Price (Input Price) (Rp/Liter)
JAT = Length of Transmission Network (Kms)
SUL = Electrical Energy Losses (%)
GAD = Distribution Interruption (times/100 kmc)
α_0 = intercept,
u_{it} = error terms
i = 1, 2, 3, ... 126 ; t = 2009, 2010, ... 2014
$\beta_1 \ldots \beta_5$ = coefficient of independent variables ($\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 < 0$, $\beta_4 < 0$, $\beta_5 < 0$).
dW_1 ... dW_{20} = dummy of PLN Operational Unit, if $dW_1 = 1$, others = 0,
if $dW_2 = 1$, others = 0, ... etc., W_{21} = excluded dummy (benchmark)
α1 .... α20 = dummy coefficient of dW_i
d2009 ... d2013 = dummy of time series, if d2009 = 1, others = 0, d2010 = 1,
others = 0, ... etc., 2014 = excluded dummy (benchmark)
λ1 ... λ5 = dummy coefficient of time series *i*.

Furthermore, the analysis of electricity supply elasticity for HEL and HIEL is formulated as follows:

$$e_{HEL} = \frac{\%\Delta PEL}{\%\Delta HEL} = \frac{\Delta PEL/PEL}{\Delta HEL/HEL} \quad \text{, elastic if } e_{PEL} > 1 \quad (7)$$

$$e_{HIEL} = \frac{\%\Delta PEL}{\%\Delta HIEL} = \frac{\Delta PEL/PEL}{\Delta HIEL/HEL} \quad \text{, inelastic if } e_{PEL} < 1. \quad (8)$$

IV. RESULTS AND DISCUSSION

4. 1 The Profile of Supply of Electricity Energy in Indonesia

At the end of December 2014 PT PLN (Persero) and Subsidiary Companies owned and operated about 5,007 generating units with total installed capacity of 39,257.53 MW, of which

31,062.19 MW (79.12%) was installed in Java. The total installed capacity was up 14.77% from December 2013. The total generating plant capacity broken down by type of power plant as follows : Steam Turbine 20,451.67 MW (52.10%), Combined Cycle 8,814.11 MW (22.64%), Diesel 2,798.55 MW (7.13%), Hydro 3,526.89 MW (8.98%), Gas Turbine 3,012.10 MW (7.67%), Geothermal 573 MW (1.46%), Solar and Wind 9.20 MW (0.02%). Total of national installed capacity included rented and IPP were 51,620.58 MW. The system peak load for the year of 2014 was 33,321.15 MW, increased 8.06% over the previous year. The peak load for the Java Bali interconnection system was 23,900 MW. This was up 5.90%, over the previous year.

During the period of years 2006 - 2014 generatiing capacity had a negative growth on average - 0.41% per year. The installed capacity grew an average of 6.49% per year, rated capacity grew an average of 5.58% per year. While connected capacity to consumers grew an average of 7.87% per year. This indicated that the procurement of generating machines had no changes, so PT PLN is not able to compensate the growth rate of installed capacity, rated capacity and connected capacity.

The own energy production (included rented) throughout the year of 2014 was 175,296.98 GWh, up 6.91% over the previous year. Of the energy production, 59.12% was produced by PT PLN (Persero) Holding, and 40.88% came from subsidiary companies, i.e. PT Indonesia Power, PT PJB, PT PLN Batam and PT PLN Tarakan. Of this energy production 49,312.48 GWh (28.13%) was produced by natural gas, 84,076.12 GWh (47.96%) was produced by coal fired, 26,422.18 GWh (15.08%) was produced by oil, 11,163.62 GWh (6.37%) was produced by hydro and 4,285.37 GWh (2.44%) came from geothermal. The share of oil increased over the previous year while natural gas, coal, hydro and geothermal used for electricity production were decreased.

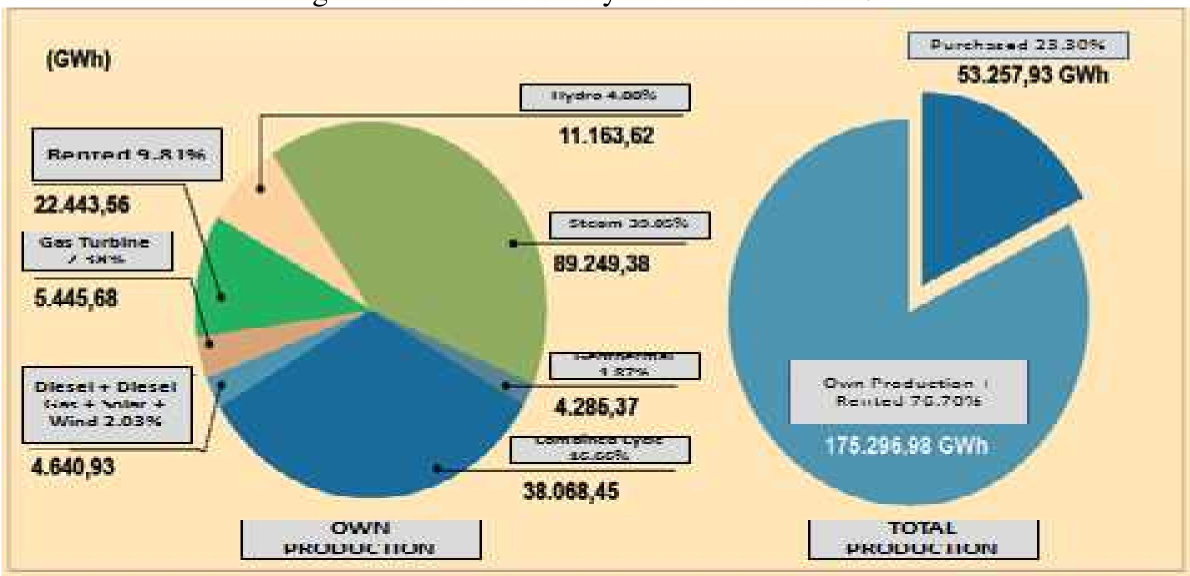
The total production (including purchase from utilities outside PLN) during the year of 2014 was 228,554.91 GWh, an increase of 12,366.36 GWh or 5.72% over the previous year. Of this energy production, the energy purchased from other utilities outside PLN amounted 53,257.93 GWh (23.30%). This was increased by 1,035.14 GWh or 1.98% over the previous year. From the total energy purchased, the greater part were 8,434 GWh (21.31%) from PT PT Jawa Power, and 7,435 GWh (18.79%) from PT Paiton Energy Company. Figure 1 summarizes the total production.

At the end of year 2014, the total of transmission lines was 39,909.80 kmc of which about 5,053 kmc was 500 kV, 1,374 kmc was 275 kV, 29,352.85 kmc was 150 kV, 4,125.49 kmc was 70 kV and 4.16 kmc was 25 and 30 kV transmission levels. The total length of distribution lines amounted to 925,311.61 kmc of which about 339,558.24 kmc was medium voltages lines (20 kV, 12 kV, 6-7 kV distribution networks) and 585,753.37 kmc was low voltage lines (220/380 V).

Total capacity of substation transformers operated was 86,472 MVA, increased by 6.30% over the previous year. The total substation transformers was 1,429 unit. This consisted of 52 substation transformers with 500 kV system, 5 substation transformers with 275 kV system, 1,179 substation transformers with 150 kV system, 192 substation transformers with 70 kV system and 1 substation transformers with < 30 kV system. Total capacity of distribution substation transformers increased by 8.32% to be 46,779 MVA and the total substation transformers increased by 7.32% to be 389,302 unit.

During the year of 2014, energy losses were 9.71%, consisting of 2.33% transmission losses and 7.52% distribution losses. This was better than the year of 9.91%. With the growth of total number of residential customers from 53,996,208 at the end of year of 2013 to 57,493,234 at the end of 2014, the electrification ratio reached around 81.70%.

Figure 1. Total Electricity Production Year 2014



4. 2 Regression Model of Electricity Supply With Panel Data

Based on regression model in equation (6) the result of estimation of electricity supply with panel data by using Fixed Effect Model shown below :

Table 2. Regression of Panel Data of Electricity Supply (PEL)

Variable	Coefficient	t	Variable	Coefficient	t
Constant	30343.883	8.167***	dW16	-34030.611	-14.900***
dW1	-31839.169	-13.812***	dW17	-35323.492	-15.021***
dW2	-25196.229	-11.428***	dW18	-5070.343	-2.413**
dW3	-31864.176	-13.845***	dW19	-20377.489	-16.637***
dW4	-32268.267	-14.294***	dW20	17487.486	8.475***
dW5	-28781.992	-12.966***	d2009	-5832.270	-4.580***
dW6	-33954.055	-14.636***	d2010	-5140.668	-4.641***
dW7	-31184.164	-13.977***	d2011	-3007.936	-4.454***
dW8	-33373.257	-15.224***	d2012	-1139.441	-1.979*
dW9	-31805.083	-14.322***	d2013	-2073.275	-4.783***
dW10	-33810.645	-15.325***	HEL	23.589	6.552***
dW11	-32753.629	-14.300***	HIEL	-1.032	-4.267***
dW12	-30847.704	-14.310***	JAT	-.029	-2.707***
dW13	-35176.105	-14.933***	SUL	-1.566	-2.951***
dW14	-36265.369	-15.421***	GAD	.017	0.353
dW15	-34048.733	-13.975***			
R^2	0.993	***	Significant at 1 %		
R^2 adjusted	0.991	**	Significant at 5 %		
F-Statistic	476.256***	*	Significant at 10 %		
D-W Test	1.570				

Table 2 shows that the value of R2 0.993, value of Durbin-Watson Test 1,570, and the value of F stattistic 476.26 indicate that the regression model has a fit model. The coefficients of variable HEL, HIEL, JAT, and SUEL have fulfilled the expected sign, but the coeffcient of GAD is positive, unexpected sign. The coefficient of variable HEL is positive and has a significant effect ($\alpha = 0.01$) on the PEL (supply of electricity). The coefficients of variable HIEL, JAT, and SUL are negative and have a significant effect ($\alpha = 0.01$) on the PEL (supply of electricity). The dummy variables for all individuals (dW1, dW2, ... dW20) and all the time (d2009 ... d2013) are significant. Generally, this indicates that the characteristics of all PLN operarational units and time are different from its benchmark dummy.

Then, based on the equation (7) and (8), Elasticity coefficient of HEL is 1.96 (elastic). It means that the increase of 1% in electricity price will increase the supply of electricity by 1.96%. While the elasticity coefficient of HIEL equals to - 0.89 (inelastic), means the increase of 1% in fuel (input) price will decrease the supply of electricity of supply by 0.89%.

4. 3 Interpretation of Regression Model

(1) Selling Price of Electricity Supply (HEL)

The regression model indicates that the coefficient of HEL is 23.59, means that an increase of Rp 100 / kWh in selling price of electrcity will increase the electricity supply as 2,359 GWh. The variable of HEL has positive and significant effect ($\alpha = 0.01$) on the electricity supply (PEL). This finding supports the study of Ubi *et al* (2012) and Sihombing (2010). The variable of HEL is elastic on supply of electricity. During the period of year 2009 - 2014 the growth of selling price of electricity is always positive with an average increase of 0.63% per year. Likewise, the growth in the electricity supply remains positive with an average increase of 6.72% per year. This suggests that the increase in electricity price has pushed to increase the supply of electricity.

According to Mulyati (2008) there has been some reasons to raise the selling price of electricity, namely: (1) the solidarity of PLN customers to pay the price (tariff) in accordance its economic price, (2) seeking price (tariff) reflect costs, (3) the lack of government funding to support the industry of electricity production, (4) supporting the investment program, in order to maintain the continuity of supply in the future, (5) the price increase of fuel (input), (6) financing the subsidy policies for low-standar consumer groups. However, from those reasons the price increase of fuel is the most dominant to trigger an increase in electricity price. It is caused by that the majority of generating units are still driven by non-renewable energy such as fuel oil, gas, and coal.

In 2014 the number of generating units of PT PLN amounted to 5,007 units, and the majority (89.31%) or 4,472 units were Diesel Power Plant driven by fuel oil. Therefore, the increase of fuel (input) price will push PT PLN to raise electricity price. Furthermore, PT PLN always seek that the electricity price should be adjusted with its economical price, that is higher than basic cost of supply (production). In 2013 the basic cost of supply (production) of electricity energy was Rp 1,128 / kWh, while the electricity price was Rp 818.41/KWh. It means that on average, the electricity price paid by consumers was only 72.55% of the basic cost of supply (production). This is one of the causes why the PT PLN tends to raise the electricity price. However, starting in 2015 the government has done an adjustment to the price electricity (tariff adjustment) for every month if there is a change, either an increase or decrease in one or several factors that can influence the cost of electricity supply, namely: (1) the currency exchange rate of US dollar against rupiah, (2) Indonesian Crude Price (ICP), and or (3) inflation.

(2). Input price Electrical Energy (HIEL)

The coefficient of HIEL is - 1.03, means that an increase of Rp 100/liter in fuel (input) price for generating of electricity energy will decrease the electricity supply as 103.2 GWh. The variable of HIEL is inelastic on the electricity supply. During the period of year 2006 - 2014 input prices of fuel oil, coal, natural gas, and geothermal each grew an average increase of 1.16%, 1.75%, 2.36% and 1.10% per year. The consequences of the price increase in fuel tends to raise the operational budget of PT PLN. In fact, the budget increase of operating costs will cause the reduction of generating in electricity supply, and doing saving such as the rolling blackouts at the time (hours) outside of peak load. Of course, this action will reduce the production of electricity. However, the variable of HIEL is relatively inelastic on the electricity supply, means that the increase of input price is not too responsive to the production of electricity because the electricity produced by PT PLN is a public good. The increase of input price does not delay the PT PLN to operate. Or the increase of input price will not necessarily reduce the amount of electricity production in order to meet the needs of customers as well as to maintain the peak load.

The proportion of fuel cost is the largest component in the cost of electricity generation. According to Isaac (2013), in practice, the fuel accounted for 56% of total costs in PT PLN operation, followed by the cost of purchasing power and business costs were respectively 28 % and 16%. The amount of fuel costs caused by the dependency on the use of fuel that PLN purchased with international prices. The energy mix used by PT PLN is dominated by coal (43 %), followed by fuel oil (23%) and natural gas (24%). Nevertheless, in terms of cost, the purchase of fuel oil contributes 59% to the total cost of energy.

Therefore, to reduce the burden of input price of electricity, the government and PT PLN (Persero) are seeking to lower the the basic cost of supply (production) of electricity energy, including through: (1) diversification program of generating by fuel oil to non-fuel oil, (2) reduction program of electricity network losses , (3) to optimize the use of gas and coal in power plants, (4) to increase the role of renewable energy in power generation (Pusdatin ESDM, 2012).

(3) Transmission Network (JAT)

The coefficient of JAT is - 0.029, means that the increase of the number of transmission and distribution network as 1 kmc (kilometer circuit) will reduce the electricity supply as 0.029 GWh. The decrease of electricity supply caused by the addition of electricity transmission and distribution network can be viewed from the quality of the electricity distributed. The electricity generated from the power plant is distributed by using wires or transmission lines leading to the load centers. Transmission line serves to channel the electricity from generating unit which are generally located far from the load center. The longer transmission line, the farther the distance of load centers from the distribution center, then the less the quality of electricity supply.

The drop voltage on the system will result in reducing light intensity (dimmer) of lighting equipment ; vibrating and an error occurs in the operation of the control equipment such as automatic valves, magnetic switches and auxiliary relays ; decreasing in torque at start (starting torque) on the electric motors. The drop voltage is usually caused by a lack of excitation in an electric generator (drop excitation). This voltage disturbances can cause equipment that uses electricity to operate abnormally and even able to destruct or burning the equipments. Therefore, it is expected that PT PLN can optimize the use of transmission network.

(4) Losses of Electricity Energy (SUL)

The coefficient of SUL is - 1.57, means that the increase of energy losses as 1 GWh can decrease the electricity supply as 1.57 GWh. The less the percentage of energy losses, the better quality and the more electricity supplied to consumers. It was also stated by Sihombing (2010) and Ubi *et al* (2012).

According to Surasa (2007) factors suspected as the cause of losses are the damage of the distribution network and the theft of electricity. Electricity energy transmitted from the substation will not get to the customers if the distribution damage occurs, so the power will be turned into heat energy. In addition to the losses of electricity energy, the damage of distribution network can also cause the blackout.

(5) Dummies of Region and Time

The regression model in Table 2 shows that all dummy variables of regions are statistically significant. This indicates that the patterns of electricity supply of PLN operational units in Indonesia are different from the benchmark region (Region of PLN Jakarta and Tangerang). Dummy coefficients (W_1 to W_{19}) in the equation are negative, means that the levels of electricity supply are lower than the benchmark, but for W_{20} (Region of PLN West Java and Banten) the coefficient is positive, means the level of electricity supply is higher than the benchmark.

Likewise with the dummy variables of time, all show statistically significant, means that the time patterns of electricity supply (previous years: 2009, 2010, 2011, 2012, 2013) are different from the benchmark year of 2014. While, the dummy coefficients of time are negative, means that levels of electricity supply are lower than than benchmark year of 2014.

V. CONCLUSION AND RECOMMENDATION

The results of Fixed Effect Model estimation indicates that the variable of electricity price (HEL), the fuel (input) price of electricity (HIEL), the losses of electricity energy (SUL), transmission networks (JAT), dummies of individual have the significant effect (each with $\alpha = 0.01$) on the electricity supply (PEL), whereas the variable of distribution interruption (GAD) has no effect significantly. The most dominant variables affecting on electricity supply (PEL) are variable of electricity price (HEL) and the fuel (input) price of electricity (HIEL). The variable of HEL is elastic on the electricity supply (PEL) and the variable of HIEL is inelastic on the electricity supply (PEL).

In order the electricity price is able to offset the economical price, PT PLN is expected to continue to pursue the diversification program of energy of generating units from fuel to non-fuel. And also to increase the role of renewable energy in power generation. PT PLN is expected to continue to optimize the transmission and distribution network to minimize the losses in order to maintain the quality of electricity remains guaranteed.

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