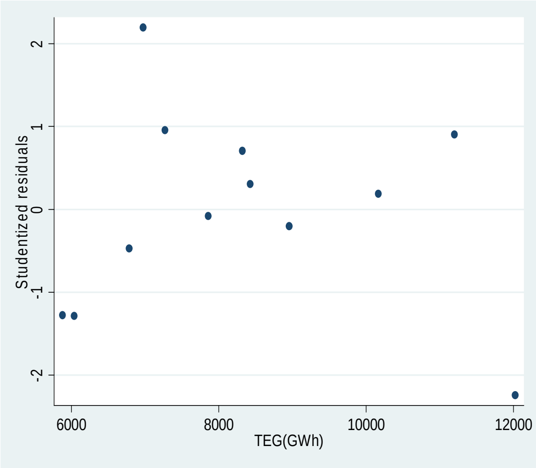

Figure 1a: Scatter plot of teg(gwh)

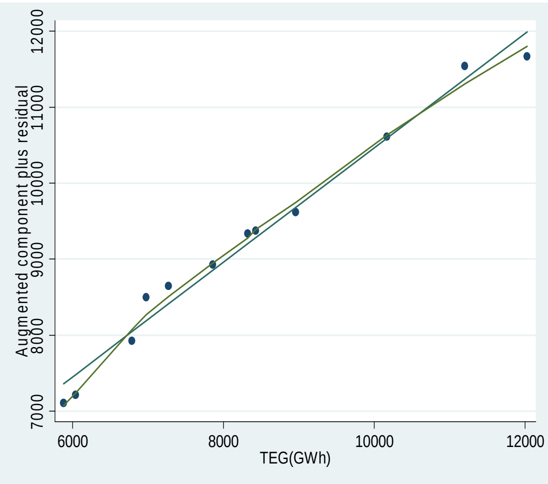

Figure 1b: Linearity plot of teg(gwh)

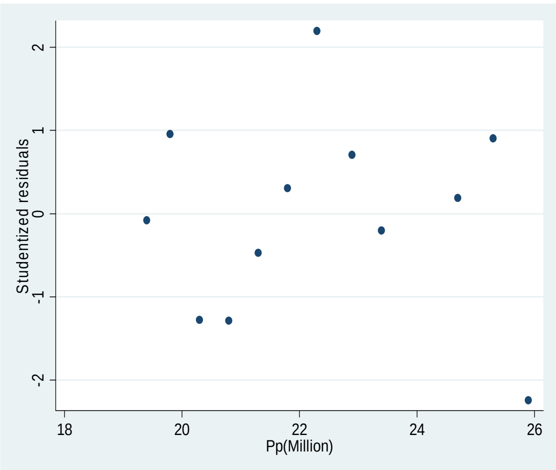

Figure 1c: Scatter plot of Pp(million)

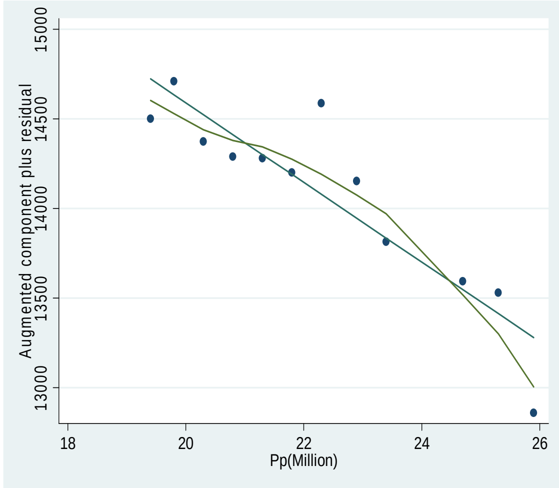

Figure 1d: Nonlinearity plot of Pp (million)

Whereas the residual versus predictor variable plots in Fig.1c and fig.1d show strong departure from linearity, Fig.1a and Fig.1b did not indicate any strong clear departure from linearity. The acprplot clearly displays both the nonlinearity and linearity of the predictor variables. Since Pp(million) is nonlinear there is the possibility that it is shift or skewed to a certain direction. We observed from the scatter plots the outliers of pp(million). These outliers are the very influential and worrisome in regression analysis and require proper attention. Fig. 2a and 2b continue to show linearity and nonlinearity using graph matrix.

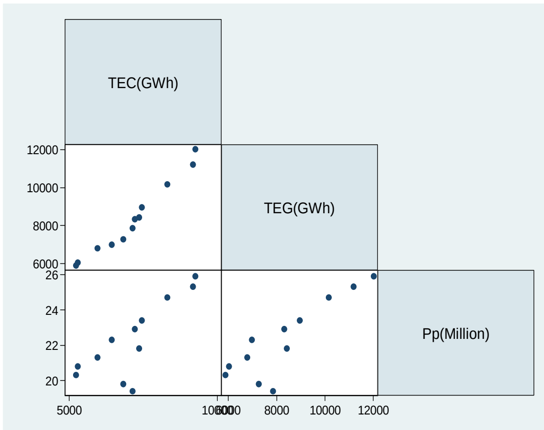

Figure 2a Half graph matrix

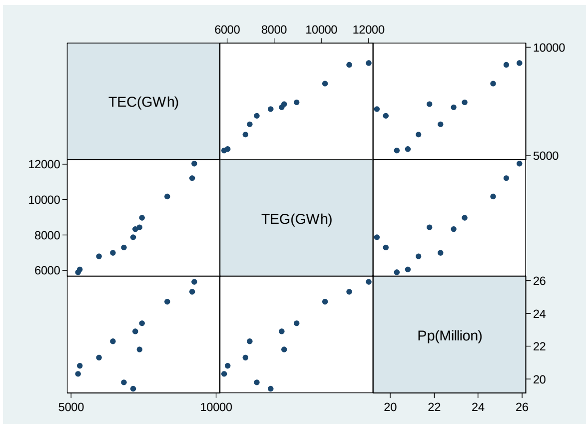

Figure 2b: Full graph matrix

The k density plot at Fig. 3a revealed that Pp(million) variable is skewed to the right. The normality of the residuals is clearly shown by the normal density plot which overlaid the initial plot as shown in Fig.3a. This situation suggests that Pp(million) variable must be transformed. One of such techniques is the log transformation of Pp(million) variable. Fig. 3b shows the graph of log Pp (million) which is the transformed Pp(million) variable.

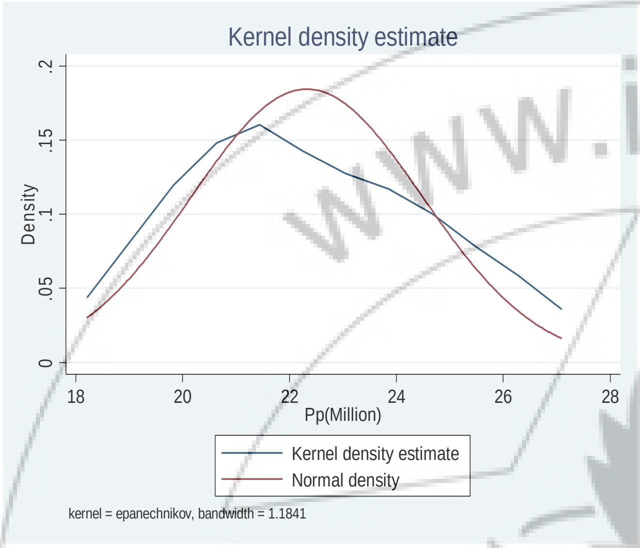

Figure 3a: Normality plot of Pp(million) 1

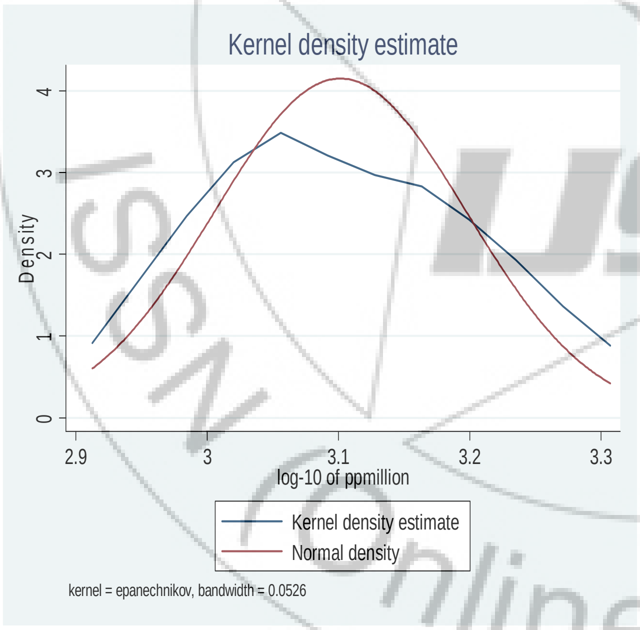

Figure 3b: Normality plot of logPp(million) 2

Fig.3b shows how the transformation has reduced skewness. The normalized graph has smaller standard deviation as compared to the initial graph of pp(million).Therefore tec(gwh) was regressed on teg(gwh) and lgPp(million) to check the significance of the model using ANOVA test as shown in Table 3

Table 3: Summary of ANOVA test of tec(gwh), teg(gwh) lgpp(million)

Source	SS	df	MS
Model	18708801.5	2	9354400.74
Residual	473969.18	9	52663.2422
Total	19182770.7	11	1743888.24

F(2, 9) = 183.92
Prob > F = 0.0000
R-squared = 0.9761
Adj R-squared = 0.9708
Root MSE = 225.62

tecgwh	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
teggwh	.7744124	.0686805	11.28	0.000	.6190463	.9297784
lgppmillion	-2715.887	1404.337	-1.93	0.085	-5892.718	460.9434
_cons	9118.132	3876.212	2.35	0.043	349.5299	17886.73

After the test, the problem of nonlinearity still persists as shown by the new acprplot in Fig. 4

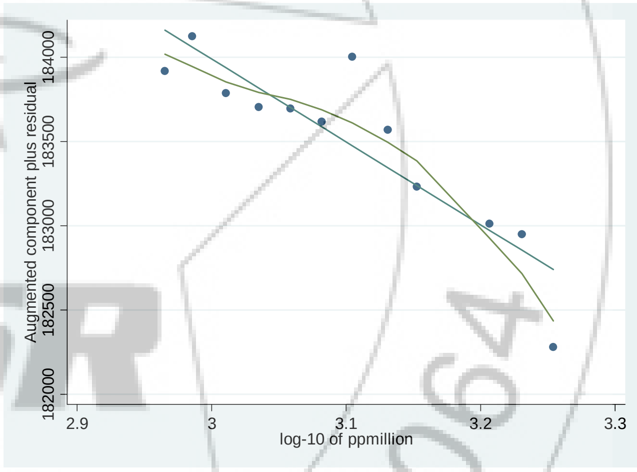

Figure 4: Nonlinearity plot of logPp (million)

The directions of the pp (million) and teg(gwh) variables with respect to tec(gwh) is further checked using regression line. Fig.4a shows the downward trend of the regression line and its corresponding outliers. The value of the slope of the plotted line is the same as the coefficient of Pp (million). The populations for the years 2002, 2004, 2007 and 2012 are the potential outliers. The plot shows how the outliers influence the coefficient.

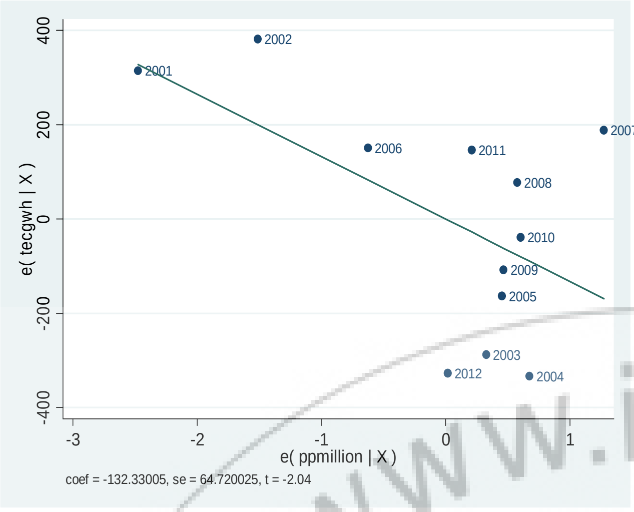

Figure 4a: graph of tec(gwh) versus Pp (million)

Fig.4b shows how the regression line moved upwards trying to fit through all the data points. No year appeared as an outlier. From avplots of tecgwh against pp(million) in Fig.4a 2002, 2007 2012 and 2004 are the potential outliers and are very influential points in the analysis. Therefore, tec(gwh) can be regressed on teg(gwh) and pp(million) taking away these outliers from population observations. First of all let us regress all the variables together with the outliers.

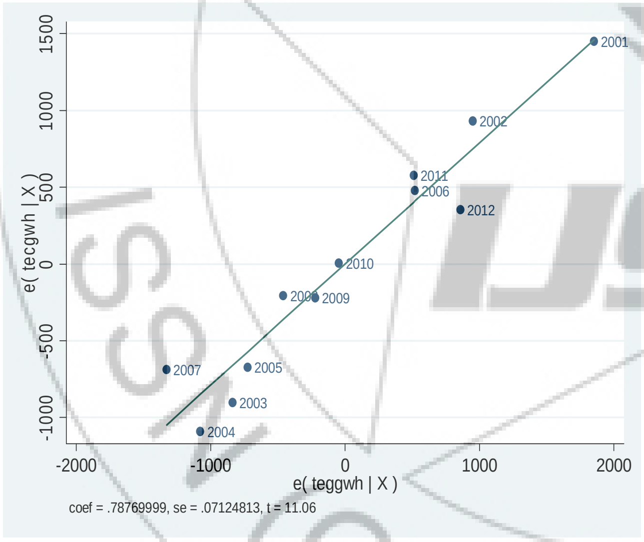

Figure 4b: graph tec(gwh) versus teg(gwh)

Fig.4b clearly shows that as electricity generation increases the electricity consumption also increases. The validity of the association between tec(gwh) and teg(gwh) is further checked by using the model specifications. The stata command was used to test the model and the stata output is shown in Table 4

Table 4: Summary of ANOVA test of tecgwh teggwh

Source	SS	df	MS
Model	18511836.8	1	18511836.8
Residual	670933.916	10	67093.3916
Total	19182770.7	11	1743888.24

Number of obs = 12
F(1, 10) = 275.91
Prob > F = 0.0000
R-squared = 0.9650
Adj R-squared = 0.9615
Root MSE = 259.02

tecgwh	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
teggwh	.6603869	.039757	16.61	0.000	.5718028	.748971
cons	1644.402	339.3894	4.85	0.001	888.195	2400.608

linktest

Source	SS	df	MS
Model	18813058.3	2	9406529.15
Residual	369712.371	9	41079.1523
Total	19182770.7	11	1743888.24

Number of obs = 12
F(2, 9) = 228.99
Prob > F = 0.0000
R-squared = 0.9807
Adj R-squared = 0.9764
Root MSE = 202.68

tecgwh	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
_hat	2.607123	.5953617	4.38	0.002	1.260321	3.953925
_hatsq	-.000107	.0000395	-2.71	0.024	-.0001965	-.0000176
_cons	-5853.222	2188.357	-2.67	0.025	-10803.63	-902.8145

. ovtest
Ramsey RESET test using powers of the fitted values of tecgwh

Ho: model has no omitted variables
F(3, 7) = 4.77
Prob > F = 0.0408

Table 5: Summary of ANOVA test of tec(gwh) and pp(million) regress tecgwh ppmillion

Source	SS	df	MS
Model	12502799.7	1	12502799.7
Residual	6679970.93	10	667997.093
Total	.9182770.7	11	1743888.24

Number of obs = 12
F(1, 10) = 18.72
Prob > F = 0.0015

R-squared = 0.6518
Adj R-squared = 0.6169
Root MSE = 817.31

tecgwh	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
ppmillion	492.9951	113.9531	4.33	0.001	239.0917	746.8984
_cons	-3862.781	2554.921	-1.51	0.161	-9555.499	1829.937

linktest

Source	SS	df	MS
Model	15034893.4	2	7517446.71
Residual	4147877.24	9	460875.249
Total	19182770.7	11	1743888.24

Number of obs = 12
F(2, 9) = 16.31
Prob > F = 0.0010
R-squared = 0.7838
Adj R-squared = 0.7357
Root MSE = 678.88

tecgwh |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
_hat	-6.311085	3.125034	-2.02	0.074	-13.3804	.7582339
_hatsq	.0005008	.0002136	2.34	0.044	.0000175	.0009841
_cons	26150.73	11242.39	2.33	0.045	718.6884	51582.77

. ovtest
Ramsey RESET test using powers of the fitted values of tecgwh
Ho: model has no omitted variables
F(3, 7) = 4.87
Prob > F = 0.0389

4. Results and Discussions

Statistical Analysis of the data gathered was used to determine whether the electricity generation and population of Ghana are really significant contributors to the electricity consumption in Ghana.

Table 2 indicated that electricity generation makes the best contribution to the electricity consumption in the study area. Though the model showed association between all the variables under consideration, thus, both the dependent and independent variables as justified by the F-test at p = 0.000, it was not clear about the actual independent variable that serves as the significant predictor of the dependent variable. The R-squared value of 0.9761 indicates that 97.61% of the variation of electricity consumed is catered for by the model. An indication that 97.61% of the variation of electricity consumed is provided for by the amount of electricity generated and the population at that year. But the p-value of 0.077 (p=0.077) for the coefficient of population pp(million) shows that population was not significant. This was further confirmed by the coefficient of pp(million), thus -132.2. Statistically, it shows that for each increase in population, the electricity consumption in Ghana decreases by 132.2units. Thus, high population is related to lower electrical consumption. The result is misleading and consequently, seems to suggest that the population of the country cannot be a major factor for predicting electricity consumption. Statistically, it has been shown that the population of the country cannot always have positive relation with the electricity consumption. It may however, depend on the level of industrialization of the country. The coefficient for teg(gwh) is 0.7877 and the p-value is significant (p=0.00). This figure demonstrates that for every unit rise in electricity generated electricity consumption in Ghana increases by approximately 0.79 units (79%). This result makes some sense and this is what the study wants to look at. That is the more electricity is generated, the more the electricity is consumed.

It cannot be confirmed with 100% certainty that the results above are the true reflection of the situation on the ground. Therefore, other tests need to be carried out to be sure of these initial results. Fig.1a, 1b, 1c and 1d were used to standardize the predictor variables in the regression model and pp(million) variable was found to have a many outliers which has little effects on the model thus, confirmed by p-value in Table 2. This seems to suggest that population of a country is not a good predictor variable for electricity consumption. Fig. 2a and 2b also confirmed that the relation between tec(gwh) and Pp(million) is nonlinear. Since pp(million) is nonlinear there is the possibility that its effects on electricity consumption may be tilted to one side. An indication that the population may be dense but the electricity consumption may or may not be high depending on how industrialized the country is.

Fig.3a and 3b transformed the pp(million) variable into normal. Thus, the effect of skewness was reduced. The association between the population and electrical consumption was done to check whether the new result indeed correlates well with the response variable. Unfortunately, it was realized from Table 3 that the transformed pp(million) variable was not significant as shown by P- value of 0.085 (p=0.085). Table 3 confirmed that teg(gwh) was significant and it could be used to predict electricity consumed.

Fig.4a and 4b showed the downward and upward trend of the regression line and its corresponding outliers respectively. It was realized from Fig.4a that pp(million) variable was not a good predictor as a result of more potential outliers which virtually may influence the analyses.

Table 5 also goes to confirm that pp(million) was not a better predictor for electricity consumption. The variable of squared prediction represented by hatsq was not significant. Thus, the linktest failed to reject the assumption that the model was specified correctly. The ovtest showed that the p-valve was significant; therefore we reject the null hypothesis that the model has no omitted variables. This is an indication that the model has some omitted variable distribution.

5. Conclusions and Recommendations

The statistical analyses finally provided the following conclusions. All the tables and diagrams proved that Population of Ghana was not a reliable predictor for electricity consumption. Among the two predictors used for the analyses, there seems to be close association between total electricity generated and total electricity consumed. The linktest and ovtest rejected the null hypothesis that the model has no omitted variables. The analyses showed that about 97.61% of the variation of electricity consumed can be explained by the model. The kdensity plot was used to transform the population variable to normal but the results could not have any meaningful effect on the electricity consumption. The model was significant. Thus, from the statistical analyses electricity generation has close association with electricity consumption. Based on the study there is the need to increase electricity generation in Ghana since for every electricity generated 79% of it are consumed.

Based on the conclusions it is recommended that the Government of Ghana reinforce the electricity generation infrastructures by constructing new generation and transmission facilities. It is important that companies, factories, industries and most consumers install self electricity generating facilities to complement the electricity supply from the national grid. The obsolete electricity equipment must be frequently checked and replaced. Management and other stake holders should sensitize the consumers to switch off their deep freezers during the peak times to conserve electricity. Finally, as a short time measure, the Government should ensure that there is prompt availability of fuel for electricity generation even at the higher cost.

6. Future Scope

This research will help policy makers and other stake holders to properly address the issue of electricity outages in Ghana. It will enable the Governments to have a fair idea that the consumption of electricity depends strongly on industrialization of the country and not on the population of the country. The study also revealed the needs of sufficient electricity supply to make it possible for the consumers to enjoy optimum electricity which is crucial with respect to the improvement of the standard of living. The frequent power outages as a result of low electricity generation lead to job losses and finally increase the rate of unemployment. Its further creates high standard of living in the country, which of course increases social vices in the country. It is therefore imperative for the Government and other stake holders to effectively tackle the issue of electricity generation in the country to avoid any future problems. Believably, electricity creates a lot of employment. Its promotes proper ventures for the people in the country to enjoy good living, therefore, there is the need for the policy makers and other agencies to work together to provide effective, efficient and long-term plans that will sustain and promote proper electricity generation. The issue of obsolete electricity equipment must be frequently monitored and replaced to avoid continuous electricity leakages. It is believed that the problems associated with electricity generation in Ghana can be improved, and to overcome these problems there is the need for proper coordination and collaboration, using holistic and integrated approach, across many sectors and disciplines. Thus the technocrats from other disciplines must be involved in effective monitoring and planning of electricity generation in the country. Indeed, if effective management is properly put in place, the issue of inadequate electricity generation, job losses and unemployment would gradually be reduced, and the people will enjoy quality life.

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