Journal of Polytechnic, 2016; 19 (4) : 415-420

Empirical Analysis of Causal Relationship between Electricity Production and Consumption Demand in Turkey Using Cobb-Douglas Model

Nihat PAMUK
Turkish Electricity Transmission Company, Sakarya, Turkey
(Received : 21.01.2016 ; Accepted : 05.02.2016)

ABSTRACT

Energy is one of the most crucial data of economical and social development in Turkey. Therefore, energy planners have to design different policies to direct justifiable energy consumption for which various modeling techniques need to be adopted. In this study, the main idea is the causality relationship between electricity production - consumption demand and economical growth in per capita and aggregate levels in the emerging economies during the period 2003 - 2014 by using Cobb Douglas Model and Granger causality tests. Electricity production and consumption demand in Turkey are studied through economical models for residential and industrial sectors. Industrial sector is the largest electricity consuming sector in Turkey. The economical model developed here focuses on the use of only significant variables that are not collinear. Hence, statistical tests have been used to recommend significant economical models. In Turkey, between 2003 and 2014, while real per capita Gross Domestic Product (GDP) growth averaged 16.3% per annum, annual electricity production and consumption growth averaged 11.67 %. In spite of the fact that real per capita GDP and electricity consumption demand are positively correlated, it is still not clear the direction of causality between real per capita GDP, electricity consumption. The positive impact of electricity production and consumption demand on the economical growth and the bidirectional causality between economical growth and electricity consumption are evaluated. The analysis shows that not all the socio - economic variables used in other studies can be useful for model representation for Turkey's electricity consumption. The chosen models provide a very small absolute difference with actual electricity consumption demand. Recently, government has been focusing in industrial development in non - hydrocarbon sectors. So, the study of electricity production and consumption in these two sectors is considered as significant. An understanding of relationship between electricity consumption and various socio - economic variables is expected to help the planners to make appropriate generation and transmission planning in the country.

Keywords : Energy policy, Empirical analysis, Cobb - Douglas model, Electricity production and consumption demand, Granger causality tests.

1. INTRODUCTION

Energy is a basic necessity for all human activities. Energy is also a basic driver that fuels socio - economic development of a country. Among the various energy sources, petroleum fuel is still considered as the major energy supplier in the world due to convenience in access and use. With oil supply and price shocks in 2008, the vulnerability of economic programs has been highlighted in different countries. Although oil shocks did happen in earlier times as well, but the global economic impact that was created in 2008 has lasted longer. This has required strategic thinking on energy source diversification, energy efficiency and alternatives to oil energy [1]. There were similar attempts made by the countries after the oil shocks in the past as well. There were attempts to initiate demand management, supply augmentation from alternative sources, retrofitting of energy using devices and reducing or replacing oil consumption. However, those efforts subsided once the oil supply resumed unabated. Recently, before the oil shock in 2008, many countries like Singapore had started avoiding electricity generation from oil for natural gas. In other countries, hydropower, wind and coal based technologies are being considered as well. The availability of better technologies, for example, cogeneration in gas industry and critical and supercritical clean coal technologies [2] is being considered to move away from oil dependence at least to some extent.

Diversification of energy resources and the need to use resources efficiently and effectively is not only the need of oil importing countries, but also of oil exporting countries. Oil exporting countries are also diversifying economy away from hydrocarbon. Therefore, the practice of planning for energy consumption is also on the rise in oil exporting countries. Most of the studies found that there was unidirectional causality between electricity consumption and economical growth, while some studies such as [3, 4, 5, 6, 7] found that there was bidirectional causality between electricity consumption and economical growth. The direction of unidirectional causality varies from countries to countries. Some studies such as [8, 9, 10, 11] have found that there was unidirectional causality from electricity consumption to economical growth, while some studies such as [12, 13, 14, 15, 16, 17, 18] have found that there was unidirectional causality from economical growth to electricity consumption.

In this study, in addition to other studies in the literature, "the modeling of income regions and number of

*Corresponding Author
e-posta: nihatpamuk@gmail.com
Digital Object Identifier (DOI) : 10.2339/2016.19.4 415-420

households which supply domestic employment" is included in residential sector modeling part. Also, the industrial sector modeling part consists of "the sum of Consumer Price Index (CPI) and Gross Domestic Product (GDP) based on production minus revenue of mining operations". The objective of this paper is to present economical model as a way to facilitate decision making for electricity generation to meet demand in residential and industrial sectors. Therefore, in the following section, major energy models are defined. Features of economical models follow the discussion. The paper concludes with discussion and conclusions.

2. ENERGY MODELS FOR PLANNING

Various energy models are used in practice for energy analysis and planning - focused on energy supply, energy demand and other factors. The models which consider energy supply focus mainly on extraction and distribution of energy sources. Market Allocation (MARKAL) model, developed by the Energy Technology Systems Analysis Program (ETSAP) of the International Energy Agency is used for obtaining low cost energy options and analyzing carbon restrictions [19]. This model accounts for energy cost but they are basically supply focused. The long range energy alternative model (LEAP) developed by Stockholm Environment Institute is another model, which can also be considered supply focused as it carries a very good inventory of available energy sources and the possible alternative when fully developed [20]. It does consider economics and environment as well for proposing energy policies. This is to note that some of these supply models can use optimization as their tools and others may use accounting or simulation as their basis for analysis.

The models which consider energy demand focus on demand management, that is, assessing demand and altering energy consumption pattern through the use of better technology, diversification of energy sources and adoption of voluntary and non-voluntary conservation measures. Demand management generally starts with the energy end-use analysis for a particular service, such as industrial water boiling or household cooking and then proceeds to analyze energy efficiency, energy utilization costs and options for changes in energy demand. One such model for energy end use analysis for cooking is called Energy Service Analysis Method (ESAM) proposed by Reister and Devine [21]. For a larger scale energy end use analysis, Model Evolution Demand Energy (MEDEE) can be used. In MEDEE, sectorial energy end-use, such as for energy consumption in transportation sector and residential sector, is analyzed and final energy demand is assessed [22].

The third type of models use hybrid methodology, by considering both supply distribution and demand management. They can also consider technology and goals more explicitly. Models such as input - output analysis and economical analysis can be considered as the hybrid models. Bildirici et al. have developed comprehensive economical models for national energy planning by including at both conventional and non-conventional energy sources [4]. A review of 15 energy models focused on engineering economics has been compared in Worrell et al [23]. The authors have reviewed models such as All Modular Industry Growth Assessment (AMIGA), Energy Efficiency Resource Assessment (EERA) and Energy Simulation Model (ENUSIM) in their work. The authors have reviewed models that are focused on actual characteristics of individual technologies or group of technologies and the goal of the model. The model used in this paper is focused on time series data and the aim is to find a matching model of electricity consumption demand with various socio - economic factors in order to provide overall view on the impact of socio - economic development on electricity consumption. Therefore, economical modelings approach in the analysis of time series data have been used.

Atif et al., Adom et al., and Akinwale et al., found that there was unidirectional causality from electricity consumption demand to economical growth [11, 15, 17]. Hu et al. and Ogundipe et al. found that there was bidirectional causality between electricity consumption and economical growth [5, 6]. Nazlioglu et al., found that there was a bidirectional between electricity consumption and economical growth with linear Granger causality test, while there was no causality between economical growth and electricity consumption with nonlinear Granger causality test [7]. Bildirici et al., found that there was bidirectional causality between electricity consumption and economical growth in Belarus, Czech Republic, Hungary, Poland, Romania and unidirectional causality from electricity consumption to economical growth in Albania and unidirectional causality from electricity consumption to economical growth for Bulgaria and Slovakia in the long term [4]. Gurgul et al., found that there was bidirectional causality between GDP and electricity consumption demand [3]. Aslan et al., found that electricity consumption had a positive impact on economical growth and there was bidirectional causality between electricity consumption and economical growth [14].

This study mainly employed causality test using Cobb-Douglas model and co-integration method to identify the causal association between electricity production and consumption demand for economical growth in Turkey. It has concluded that causality run from energy consumption to GDP. It estimates the electricity demand function by employing the structural time series technique. It finds that the nature of relationship is not linear and deterministic, but it is stochastic. This study shows that adjustment process of energy production and consumption demand toward equilibrium is highly persistence when an appropriately threshold is reached.

3. FEATURES OF INDUSTRIAL AND RESIDENTIAL SECTOR IN TURKEY

In this section the main features of industrial sector and the residential sector is discussed.

3.1. Industrial Sector

Turkey's industrial sector is dominated by petrochemical industry as the country has heavily invested in the exploration, processing and export of oil and gas products. The other large industries in Turkey produce fertilizer, steel and cement. The Turkey Statistical Authority indicates that Turkey engages more than 90.000 people each in mining (including oil and gas) and manufacturing. There are about 100 companies in mining sector and about 2000 companies in manufacturing sector [24]. The numbers especially in the manufacturing sector has been growing in the past due to government's emphasis on the diversification of economy away from oil and gas. The contribution of petroleum industry in Gross Domestic Product (GDP) is over 50 % and manufacturing contributes to about 10 % of GDP. Data indicates that current rate of total GDP growth is about 18 %; the growth in industrial GDP is about 19 % and that of manufacturing is about 27 % [25]. The higher contribution of petroleum industry has an influence in the overall GDP growth in the country. Data indicates that the electricity consumption in industrial sector is growing by about 17 % on a year on year cumulative basis since 2000. This growth rate is almost close to the industrial GDP growth.

3.2. Residential Sector

The data obtained from the Statistics Authority of Turkey's total population stands at about 75.6 million in 2012 [26], which has been increasing at the rate of about 10 % per year due to natural birth and economical migrants. The population is spread in seven municipalities but about 35 % of the population resides in Istanbul, Ankara and Izmir municipalities [27]. Due to higher level of construction and other petrochemical based economic activities, many foreigners have come to Turkey for work. Although the annual population growth was only about 1.41 % until 2002, it shot up to about 1.38 % in 2003 and to about 1.33 % in 2005, thus resulting in a higher population growth over the past decade. Between 2010 and 2014, however, the population growth is recorded as less than 1.15 %. The Statistics Authority of Turkey projects that by 2023, Turkey's resident population can range from about 75.6 million to about 89 million [28].

The data further shows that between 2003 and 2014, the number of residential houses increased from about 137.000 to about 245.000 thus growing at an average rate of about 5 % per year. About 27 % of the residences are villas and apartments and about 53 % of the total houses in Turkey are rented. The household composition has also increased from about 4.3 members per household to about 6.7 members in 2014. Data further shows that 97 % of the residences are connected to grid electricity and the electricity consumption demand in residences has increased by about 7.3 % between 2003 and 2014 [29]. Residences are the largest electricity consumers among all sectors in Turkey. There is a decrease in the per capita energy consumption but increase in total household energy consumption demand in Turkey.

4. COBB-DOUGLAS MODEL AND EMPIRICAL ANALYSIS OF CAUSALITY TEST

In this section, for analyzing electricity demand in Turkey, by economical models static log linear Cobb-Douglas model is used. The final models for electricity consumption in industrial and residential sectors proposed here are based on stepwise elimination of models in terms of their goodness of fit and elimination of variables in terms of their statistical significance. Any model showing goodness of fit below 75 % and those variables which are not statistically significant at the 95 % confidence interval level has been eliminated. Statistical significance of models is measured in terms of F - stat and t - stat. This study frequently employs GDP, electricity price as an argument to determine the income and price elasticities. These elasticities have been used to forecast future demand and design appropriate policy. In modeling electricity demand function, simple standard Cobb-Douglas type function form with constant electricity of scale is used. Cobb-Douglas type function is described by equation 1.

$$E_t = A_t O_t^{\beta} P_t^{\gamma} \quad (1)$$

Where E_t is electricity consumption demand, O_t represents real output and P_t electricity price. A_t is the deterministic term measured as $A_t = C_0 \exp(dt)$ where C_0 is a constant and (dt) is a linear time trend β and γ are the demand elasticities with respect to real output and electricity price respectively. After applying log transformation and substituting the value of A_t, it can be described by equation 2.

$$\log(E_t) = \log C_0 + dt + \beta \log(O_t) + \gamma \log(P_t) \quad (2)$$

The current electricity demand also depends on the previous year's demand. For this purpose, the modified dynamic model can be described by equation 3.

$$\log(E_t) = \log C_0 + dt + \alpha \log(E_{t-1}) + \beta \log(O_t) + \gamma \log(P_t) + \varepsilon \quad (3)$$

The expected sign of lagged value of electricity consumption demand is positive implying $\alpha > 0$. The expected sign of output is positive meaning $\beta > 0$. The prices can have positive or negative sign depending upon the level of development and possibility of alternative energy options. This implies $\gamma \geq 0$. ε is the error term.

4.1. Residential Models

Economical models were developed for residential sector by considering population data, total number of households and the household income, data which are available from the Statistical Authority. Electricity consumption data for a 2003 - 2014 is considered for analysis. The first model was developed by using total number of households and household income as independent variables. The second model was developed by using population and household income as independent variables. The third model was developed by using only population as the independent variable. The fourth model was developed by using only household numbers as the independent variable. The four models are given below.

Model One: *Ln (Residential Electricity) = -3.54 + 0.96 (In of population) – (0.142 In of household income)*

Model Two: *Ln (Residential Electricity) = -5.76 + 0.20 (In of income) + (1.07 In of household number)*

Model Three: *Ln (Residential Electricity) = -2.04 + 0.278 (In of population)*

Model Four: *Ln (Residential Electricity) = -10.6 + 1.59 (In of household number)*

All the four models shown above have more than 90 % of goodness of fit. In terms of validity of the model, therefore, all the models can be considered for further testing. In terms of F - stat, it is found that none of the models posed a problem of collinearity. In model one, only population variable is shown as significant independent variable. In model two, household number shows a significant relationship. In terms of individual variables, the unitary models of population and household size (model three and model four) show high significance as well. As model three has higher goodness of fit and a lower deduction through intercept, model three for the purpose of identifying the trend of electricity consumption demand is used. Figure 1 shows that actual (A-GWh) and predicted (P-GWh) are closely correlated and the mean absolute error is only about 1.3 %.

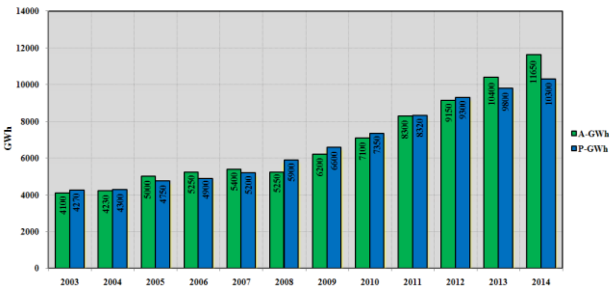

Figure 1: Model for electricity consumption demand in residential sector

4.2. Industrial Models

For the industrial sector, three parameters were found to have an effect on the total electricity consumption Consumer Price Index (CPI) and GDP for mining and quarrying (which include oil and gas), and GDP for manufacturing. These parameters are available from the Statistical Authority. With these variables, six different models are developed as shown below.

Model One: *Ln (Industrial Electricity) = 0.43 + 0.96(In CPI) – 0.038(In mining GDP) + 0.38(manufacturing GDP)*

Model Two: *Ln (Industrial Electricity) = -2.20 + 1.32 (In CPI) + 0.41 (In mining GDP)*

Model Three: *Ln (Industrial Electricity) = 0.27 + 0.36 (In manufacturing GDP) + 0.95 (In CPI)*

Model Four: *Ln (Industrial Electricity) = 2.55 + 0.02 (In mining GDP) + 0.54 (In manufacturing GDP)*

Model Five: *Ln (Industrial Electricity) = -0.66 + 0.76 (In mining GDP)*

Model Six: *Ln (Industrial Electricity) = 2.66 +0.56 (In manufacturing GDP)*

Figure 2 shows the individual fit of actual (A-GWh) and predicted (P-GWh) electricity consumption demand in Turkey's industrial sector. Figure 2 shows more difference between the actual and predicted electricity from the year 2011. The data shows that electricity consumption during 2010 and 2011 were almost the same values. The recession in 2011 could be one of the reasons as the demand might have subsided and this might had an impact on the production capacity of manufacturing sector. This effect can be seen with a lag effect in the projections during 2011 - 2014. Nevertheless, the mean absolute percentage error shows that the projected data is only about 5% out of actual consumption for the period analyzed here. For a vast economical sector like manufacturing, this adjustment of consumption by about 5 % is quite acceptable by planners. All the models have more than 90 % goodness of fit and they do not show any collinearity. However, in terms of individual variables, all models do not fit well in terms of t - stat, the worst one being the model one for which combination of all variables proved insignificant in statistical terms. This shows that, based on the eleven year statistics on data, electricity consumption demand in electricity sector cannot be predicted with a combination of these variables.

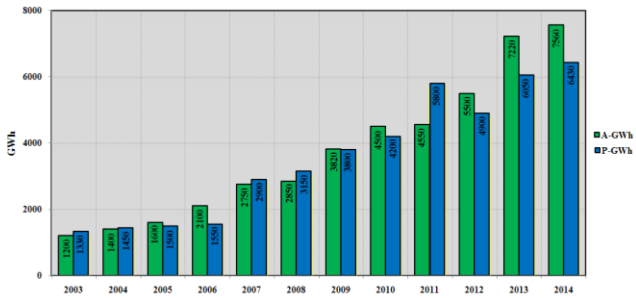

Figure 2: Model for electricity consumption demand in industrial sector

For model two, both variables do not fare well in 95 % confidence interval. For model three, manufacturing GDP is found as significant variable. These two models indicate that CPI may not be a good measure for economical model. CPI in this case was assumed as a proxy of purchasing power for local industrial goods, however, it is not showing any significance in terms statistical relationship. For model four, variables do not show any significance in the relationship. Model five and model six are unitary models and show significance in terms of relationship with variables. Between these two models, the relation with manufacturing GDP (model six) fares better in terms of goodness of fit, collinearity and t - stat. Therefore, model six is used here for trend analysis.

The economic activity of Turkey's economy in industrial sector for the period 2003-2014, the GDP has increased from 162.1 billion TL in 2003 to 679.28 billion TL in 2014. This period represents an approximately constant rapid growth with an annual average growth rate of 11.6%. At the same time, electricity consumption demand has been rising year by year. Figure 1 and figure 2 also show an upward trend both in electricity consumption demand and GDP over this period. Electricity consumption demand came to 32.87 Planning & Management of Maintenance (MTCE) in 2014, compared to 5.77 MTCE in 2003, with an average annual growth rate of 7.39%. During the study period, the share of the residential sector continuously increases from 9.5% to 28.3% and the share of the GDP increases from 11.6% to 79.3%. The industrial sector has a dominant share and its importance has increased from a share of 10.7% in 2003 to 67.2% in 2014.

The findings show that price sensitivity has indeed changed since the 2007: it has decreased in absolute values from 2003 in 2007 to 0.819 in 2014. The elasticity stabilized at approximately 0.76 showing that the industrial sector has experienced an inelastic demand. In other words, the behavior of industrial consumers did not vary significantly during the 2003. These findings demonstrate that sensitivity of consumers to price fluctuations becomes smaller in absolute terms, while the real prices of electricity declined 2003 to 2007 period. There is a substitution between the increasing shares of residential sector, GDP and industrial sector. From the economic analysis, one can conclude that there is a shift in the Turkey economy structure towards industrial sector, but the GDP still remains the dominant position. Therefore, a contribution due to the economical structure effect on electricity consumption demand is expected.

5. CONCLUSIONS

This paper has investigated the causal relationship between electric power consumption demand in residential and industrial sector, GDP and financial development using static log linear Cobb Douglas model and Granger causality tests over the period 2003 - 2014. The efforts of investigation are culminated into two main objectives in this paper. The first objective is focus on examining whether the electric consumption of Turkey exhibit any form of non-linearity that is of economical interest. To this end the Granger causality tests are used in order to determine the presence or lack thereof linear or non-linear dependence.

The data show that electricity consumption demand in residential sector is more than 30% higher than that in the industrial sector, thus signifying the prevalence of low electricity intensity industry in Turkey. That is the reason why there was a statistically insignificant relation of electricity with mining. However, the relation between electricity consumption and manufacturing is significant. In terms of residential sector, the significance is only in terms of population. Electricity requirements in Turkey is mainly used for space conditioning, heating in at least two months in a year to cooling for about eight months in a year. Statistical relation is not significant with households.

The purpose of the paper is to understand the effect of socio economic variables, which have been attained. The difficulty was mainly on the collection of data on socio economical factors, and therefore, the models could be enhanced further by using more factors, like capacity of industries, price of electricity and the type of industry. Surveys might have to be done to see which type of manufacturing industries in Turkey are more energy intensive. The main conclusions drawn from the present study may be summarized as follows;

- Electricity consumption in Turkey has been rising year by year with economical growth. In 2014, electricity consumption demand came to 32.87 MTCE, which accounted for 21.64% of total energy consumption demand. The industrial sector consumed more than 75% of total electricity over the period 2003-2014.
- The economic activity effect is the most important contributor to increase electricity consumption demand in Turkey and the sector electricity share effect is another important factor leading to the rapid growth of electricity demand. The economic structure effect plays a minor role to increase electricity demand over the period 2003 - 2014, and the energy intensity effect plays the dominant role in decreasing electricity consumption demand.
- The period from 2003 - 2007 represents a re-coupling effect, while the other time interval shows a weak decoupling effect. The most important change explaining the achieved dissociation is the energy intensity effect.

Based on the findings, the policies that promote energy consumption and economical growth are recommended. One way of achieving this is through the adoption of appropriate energy pricing framework that takes cognizance of both the present and the future production.

REFERENCES

[1] Lee, C. C., Chang, C. P., "Energy consumption and GDP revisited: a panel analysis of developed and developing countries", ***Energy economics***, 29(1): 1206-1223, (2007)

[2] Wang, H., Nakata, T., "Analysis of the market penetration of clean coal technologies and its impacts in China's electricity sector", ***Energy,*** 31(1): 338-351, (2009)

[3] Gurgul, H., Lach, L., "The electricity consumption versus economic growth of the Polish economy", ***Energy Economics***, 34(2): 500-510, (2011)

[4] Bildirici, M. E., Bakırtaş, T., Kayıkçı, F., "Economic growth and electricity consumption: auto regressive distributed lag analysis", ***Journal of Energy in Southern Africa***, 23(4): 29-45, (2012)

[5] Hu, X., Lin, X., “Study of the relationship between electricity consumption and GDP growth in hainan international tourism island of China”, ***Research in World Economy***, 4(1): 109-115, (2013)

[6] Ogundipe, A. A., Apata, A., “Electricity consumption and economic growth in Nigeria”, ***Journal of Business Management and Applied Economics***, 2(4): 1-14, (2013)

[7] Nazlioglu, S., Kayhan, S., Adiguzel, U., “Electricity consumption and economic growth in Turkey: cointegration, linear and nonlinear granger causality”, ***Energy Sources, Part B: Economics, Planning and Policy***, 9(4): 315-324, (2014)

[8] Roula, I. L., “The sensitivity of the South African industrial sector’s electricity consumption to electricity price fluctuations”, ***Journal of Energy in Southern Africa***, 25(4): 2-10, (2014)

[9] Milorad, B., Alexandre, P. P., Frederic, M., Dimitri, B., Dragan, C., Slobodan, D., Danijela, N., “Photovoltaic electricity production in a residential house on reunion”, ***Journal of Energy in Southern Africa***, 24(2): 50-56, (2013)

[10] Augustine, C. O., Damilola, F. A., “Energy consumption, energy prices and economic growth: causal relationships based on error correction model”, ***International Journal of Energy Economics and Policy***, 5(2): 408-414, (2015)

[11] Atif, S. M., Siddiqi, M. W., “The electricity consumption and economic growth nexus in Pakistan: A new evidence”, ***Leibniz Information Centre for Economics***, http://www.econstor.eu/handle/10419/65688, (2014)

[12] Ibrahim, D. R., Agboola, H. Y., “Energy consumption-economic growth nexus: evidence from linear and nonlinear models in selected African countries”, ***International Journal of Energy Economics and Policy***, 5(2): 558-564, (2015)

[13] Ming, Z., Wenwen, W., “Decoupling analysis of electricity consumption from economic growth in China”, ***Journal of Energy in Southern Africa***, 24(2): 57-66, (2013)

[14] Aslan, A., “Causality between electricity consumption and economic growth in Turkey: An ARDL bounds testing approach”, ***Energy Sources, Part B: Economics, Planning and Policy***, 9(1): 25-31, (2014)

[15] Adom, P. K., “Electricity consumption - economic growth nexus: the Ghanaian case”, ***International Journal of Energy Economics and Policy***, 1(1): 18-31, (2011)

[16] Mohamed, O., “Dynamic asymmetries in the electric consumption of the GCC countries”, ***International Journal of Energy Economics and Policy***, 5(2): 461-467, (2015)

[17] Akinwale, Y., Jesuleye, O., Siyanbola, W., “Empirical analysis of the causal relationship between electricity consumption and economic growth in Nigeria”, ***Journal of Economics, Management & Trade***, 3(3): 277-295, (2013)

[18] Nyakundi, M. M., “Short and long run analysis of factors affecting electricity consumption in sub-sharan Africa”, ***International Journal of Energy Economics and Policy***, 5(3): 639-646, (2015)

[19] Sulukan, E., Sağlam, M., Uyar, T. S., Kırlıdoğ, M., “Determining optimum energy strategies for Turkey by Markal model”, ***Journal of Naval Science and Engineering***, 6(1): 27-38, (2010)

[20] http://www.sei-international.org/projects?prid=189, (2011)

[21] Reister, D. B., Warren, D., Devine, Jr., “Total costs of energy services”, ***Energy***, 6(4): 305-315, (1981)

[22] Lapillone, B., Chateau, B., “The MEDEE models for long term energy demand forecasting”, ***Socio - Economic Planning Sciences***, 15(2): 53-58, (1981)

[23] Worrell, E., Ramesohl, S., Boyd, G., “Advances in energy forecasting models based on engineering economics”, ***Annual Review of Environment and Resources***, 29(1): 345-381, (2004)

[24] State Planning Organization (DPT)., “Ninety-five year development plan”, ***Energy Private Specialization Commission Report***, No: DPT-2610-ÖK-621, Ankara, (in Turkish), (2011)

[25] Lise, W., Montfort, K., “Energy consumption and GDP in Turkey: is there a co-integration relationship?”, ***Energy Economics***, 29(1): 1166-1178, (2007)

[26] http://www.nvi.gov.tr/11,2012ana_Sayfa_Dogum_Olum_Istatistikleri.html, (2012)

[27] Turkish Industrialists’ and Businessmen’s Association (TUSIAD)., “The assesment of Turkey’s energy strategy at 21. century”, ***No: TUSIAD-T/2012-02/239***, İstanbul, (in Turkish), (2011)

[28] Turkish Industrialists’ and Businessmen’s Association (TUSIAD)., “Future view to energy sector supply, demand and policies”, ***No: TUSIAD-T/2012-11/136***, İstanbul, (in Turkish), (2012)

[29] Turkish Electricity Transmission Corporation (TEIAS)., “Electricity statistics”, ***TEIAS Publishing Report***, Ankara, (in Turkish), (2015)