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IMPACT OF ELECTRIC POWER GENERATION, CONSUMPTION AND IMPORT ON ECONOMIC GROWTH IN TURKEY

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ABSTRACT

It is obligatory for Turkey to develop energy generation policies which would enable it to cope with the energy demand increasing with economic growth. The aim of this study is to define the theoretical and econometrical relation between energy and economic growth which needs to be revealed to develop policies for the resolution of this problem. After examining the empirical studies carried out in the world and in Turkey to the extent possible, the study applies Vector Autoregressive (VAR) model to examine the relation between electric power generation, its import, consumption and economic growth in Turkey between 1975 and 2013. Essentially the questions that this study examining the impact of energy sector on economic growth aims to reply focus on how the energy sector affects economic growth and if it is the energy generation or energy consumption that affects economic growth more. The findings imply that causality exists between electric power generation, consumption, import and economic growth whereas there is another causality existing between electric power consumption, import and electric power generation. It was concluded that the most influential variable which affects economic growth in the long term is electric power consumption and that economic growth could be represented by electric power import and electric power generation shocks.

Keywords: ***Electrical energy, economic growth, Vector Autoregressive (VAR) Model, Turkey.***

1. INTRODUCTION

We are faced with a problem related to increasing demand in the world towards energy which is the basis of economic growth and development. When compared with other energy sources, electric power is the most widely used kind of energy and the demand towards electric power has been increasing every passing day. Therefore, figures related to electric power generation are higher than those related to consumption. Although electric power consumption has been continuously increasing, it seems that generation meets this demand. However, the majority of the sources that are used to generate electric power are imported energy sources. Dependence on imported sources which appears in connection with increasing energy demand is the most significant problem that needs to be resolved. The aim of this study is to define the theoretical and econometrical relation between energy and economic growth which needs to be revealed to develop policies for the resolution of this problem. Therefore, the second and third chapters of this study focus on energy and electric power sector in general both in the world and in Turkey. The fourth chapter explains the relation between economic growth and energy whereas the fifth chapter focuses on literature review. The sixth chapter includes econometrical analysis and suggestions.

2. OVERVIEW TO ENERGY SECTOR IN THE WORLD AND IN TURKEY

There have been significant development and changes since 1990 in primary energy supply in the world and share of sources in global energy generation.

The increase in the primary energy supply in the last twenty one years was 117%, 49%, 17%, 14% and solely 5% in Turkey, in the world, in OECD, in the US and in Japan respectively. When such values are compared to one another, it is evident that Turkey has had a huge increase in energy utilization in Turkey. However, the increase seen in the primary energy supply in the same period in Brazil, India and China was 94%, 137% and 212% respectively (World Energy Council, 2014: 3).

In 2011, oil, coal and natural gas amounted to 37%, 25% and 19% of the global primary energy supply, which comprises 81% of the total supply. The total primary energy supply was 8760 Mtep in 1990 in the

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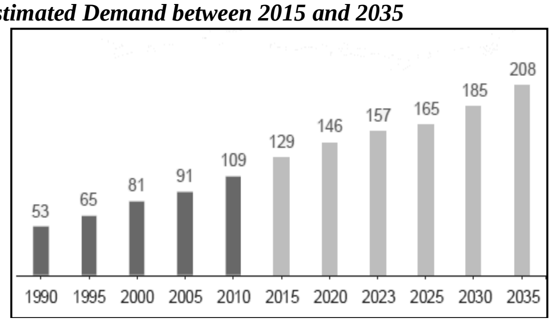
world; however it increased by 49% in 2011 which amounted to 13070 Mtep after 21 years. (World Energy Council, 2014: 5).

International Energy Agency develops scenarios considering the global climate change, the decrease in the sources used, developments related to technology and energy efficiency and challenges related to economic and social conditions. In this framework, the new policies which are developed in addition to current policies foresee that current trends in the total primary energy supply in the world and the composition of sources will no longer be followed in the future. The scenario based on current policies suggest the values that can be achieved in case the current trend related to global total energy supply and supply amounts of energy remains same in the future. Whereas the scenario based on current policies suggests that total energy supply in the world in 2035 will be increased by 43% when compared to the year 2011 amounting to 18646 Mtep, the scenario based on new policies estimates that the increase will be 33% which will amount to 17387 Mtep (World Energy Council, 2014: 3).

Figures related to the growth in energy sector in Turkey are very much higher than those seen in developed countries. Turkey has ranked the first in the Europe in the last decade as far as the increase in the demand towards electricity and natural gas is concerned. It was calculated that per capita energy consumption increased by 2.58% amounting to 1588 kep as of 2012 in Turkey where the total population is approximately 75.6 million whereas the electricity consumption increased by %3.49 amounting to 2577 kWh. (EÜAŞ, 2013: 11).

Figure 1. Total Primary Energy Supply in Turkey and Estimated Demand between 2015 and 2035

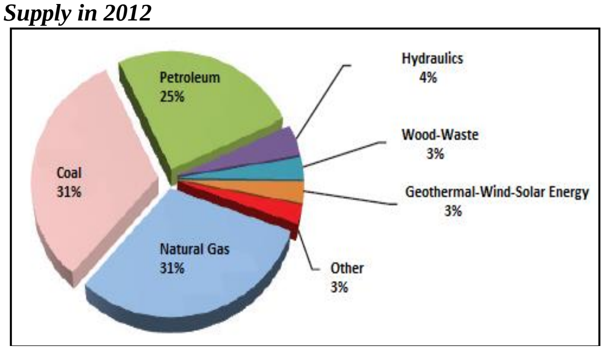


Source: World Energy Council, 2014: 7.

As seen in Figure 1, it is estimated that total primary energy supply in Turkey which was 109 million tep in 2010 would be 129 in 2015, 146 in 2020, 157 in 2023, 165 in 2025, 185 in 2030 and 208 million tep in 2035. Any deviation in the demand estimations which is of reasonable magnitude would undoubtedly be regarded as normal. However, deviations exceeding 30% were experienced in estimations related to demand for electricity and primary energy supply. Such large deviations from the estimations caused concluding more natural gas import agreements than what is necessary. Such agreements increased our dependence on imported sources in the energy. In addition they made coal mines and coal-fired power plants limit their capacities to a large extent. (World Energy Council, 2014: 8).

Total primary energy supply in Turkey in 2012 was 121 million tep. The distribution of sources which were used for this supply is shown in Figure 2.

Figure 2. Share of Sources in Turkey's Primary Energy Supply in 2012



Source: World Energy Council, 2014: 9.

As it is obvious in Figure 2, coal ranks the first in 2012 in the distribution of Turkey's total primary energy supply since 38 million tep of coal was used and the share of coal in the total supply was 31%. The other sources which come after coal in the list are natural gas with the total amount of 37.3 million tep and a share of 31% , oil with total amount of 30.6 million tep and a share of 25%, hydraulic sources with a total amount of 5 million tep and a share of 4%, wood-waste, animal and plant waste, geothermal sources, wind and solar energy sources with the total amount of 3.5 million tep and a share of 3% and other sources with total amount of 3.1 million tep and a share of 3% (World Energy Council, 2014: 8).

Table 1 shows the amount and share of sources in the total primary energy supply in Turkey.

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Table 1. Amount and Share of Sources in Turkey's Total Primary Energy Supply

Years		1990	2000	2011	2012
Coal	Mtep	16110	22928	33879	37977
	%	30	29	30	31
Petroluem	Mtep	23901	32297	30499	30614
	%	45	40	27	25
Natural Gas	Mtep	3110	13729	36909	37373
	%	6	17	32	31
Hydraulics	Mtep	1991	2656	4504	4976
	%	4	3	4	4
Wood, waste, etc.	Mtep	7208	6457	3537	3465
	%	14	8	3	3
Geothermal, Wind, Solar	Mtep	461	978	3096	3508
	%	1	1	3	3
Other	Mtep	206	1456	2071	3071
	%	1	2	2	3
Turkey's Primary Energy	Mtep	52987	80500	114490	120984
	%	100	100	100	100

Source: World Energy Council, 2014: 10.

As seen in Table 1, the summary of the explanation regarding the share of sources in the total primary energy source in Turkey between 1990 and 2012 is given below: (World Energy Council, 2014: 10-11):

- **Coal;** the share of coal in Turkey's total primary energy source in the period between 1990-2012 rose from 30% to 31% and achieved an increase of 136% amounting to 1867 thousand tep when compared to 1990 and reached 33.488 thousand tep in 2012. This increase in 2012 was 65% more than the figures in 2000 and 12% more than 2011.

- **Share of oil;** although it dropped from %45 in 1990 to 25% in 2012, the amount increased in the last twenty two years by 6713 thousand tep in 2012 when compared to 1990 and reached 30.614 thousand in 2012. This rise in 2012 was just 0.4% more than what it was in 2011 whereas there was - 5% decrease when compared to 2000.

- **Share of natural gas;** it rose from 6% in 1990 to 32% in 2012. When it comes to the increase in terms of amount, twelve fold increase was achieved compared to 1990 which amounts to 34.263 thousand tep. This rise in 2012 was 1.3% more than what it was in 2011 whereas it was 2.7 times greater than what it was in 2000.

- **Share of hydraulic sources;** This share was 4% both in 1990 and 2012; however the amount increased 2.5 times which amounts to 2985 thousand tep. This rise in 2012 was 11% more than what it was in 2011 whereas it was 1.9 times greater than what it was in 2000.

- **Share of wood, waste, animal waste etc.;** This share was 14% in 1990 whereas it dropped to 3% in 2012. The amount decreased by 2.1 times amounting to 3743 thousand tep. This decrease in 2012 was -%2 lower than what it was in 2011 and 1.9 times greater than what it was in 2000.

- **Total share of renewable energy such as wind, geothermal and solar sources;** This share was 1% in 1990 whereas it increased to 3% in 2012. The amount increased 7.6 times when compared to the year 1990. This rise in 2012 was 2.4 times greater than what it was in 2000 whereas the rise was 13% greater than what it was in 2011.

Total primary energy generation in a period of twenty two years between 1990 and 2012 rose by 35% and increased from 25.478 thousand tep to 34.467 thousand tep. Total primary energy supply in the same period increased by 128% or 2.3 times. The coverage ratio of energy generation to total primary energy supply was 48% in 1990 whereas it dropped to 32%, 28% and 28.5% in 2000, 2011 and 2012 respectively. Therefore, our energy generation between 1990 and 2012 dropped by approximately 20% or, in other words, dependence on imported sources increased by 20% (World Energy Council, 2014: 11). Figure 3 depicts the share of sources in the energy generation in question.

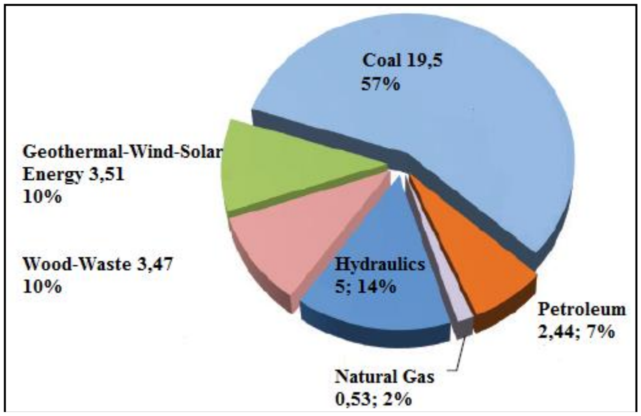

Figure 3. Primary Energy Generation in Turkey in 2012 by Sources (Mtep; %)

Source: World Energy Council, 2014: 12.

The figure 3 shows that total primary energy generation in Turkey was 32.23 million tep in 2011 whereas it

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increased by 7% and reached 34.47 million tep in 2012. Coal production, ninety four per cent of which is comprised of lignite production, represents 57% of the total energy generation in 2012 amounting to 19.52 million tep of the total energy generation. Coal is followed by hydraulic sources with a total amount of 4.98 million tep and a share of 14%, by renewable energy sources such as geothermal, wind and solar energy with a total amount of 3.51 million tep and a share of 10%, by wood, waste and animal waste with a total amount of 3.47 Mtep and a share of 10%, by oil with a total amount 2.44 million tep and by natural gas with a total amount of 0.53 million tep. (World Energy Council, 2014: 12).

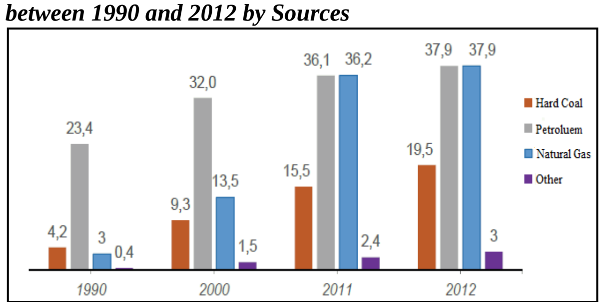
Primary energy consumption in the world was 12.3 billion tep in 2011. Turkey ranks the 23rd in primary energy consumption in the world. Primary energy generation covers 28% of the consumption. Dependence on imported sources in energy was 52% and 68% in 1990 and 2000 respectively whereas it rose to 72% in 2011. Dependence on imported sources in energy has been steadily increasing (World Energy Council, Turkey Energy Date 2012: 1).

Turkey, which is a net importer country as far as fossil energy sources are concerned, imported 92% of oil, 99% of natural gas and 95% of hard coal in 2012 in terms of energy supply. In other words, 73.4% of the total energy supply in that period was met through imported sources.

54% of the natural gas imported in 2012 came from Russia (which was 55% in 2011), 19% from Iran (which was 21% in 2011), 10 % from Algeria (which was 11% in 2011) 8% from Azerbaijan (which was 10% in 2011 and 3% from Nigeria (which was %3 in 2011) whereas 6% of the natural gas is obtained from spot LNG market. 50.8% of the natural gas sold within the country is used for electricity generation (which was 48.1% in 2011), 23.8% in households (which was 25.8% in 2011) whereas 23.9% of this natural gas is used by the industry (which was 24.2% in 2011). The remaining share of 1.5% is exported. The natural gas consumption in Turkey increased from 16.7 billion m3 in 2002 to 38.7 billion m3 in 2011. In 2012, the consumption set a historic record with a total amount of 40.7 m3. The consumption increased by 5% in 2012 when compared to the previous year. The total amount of natural gas used in electricity and industry sector increased in 2012 by 11% and 3.5% respectively whereas it decreased by 3.5% in household sector (EÜAŞ, 2013: 12).

Energy exports in Turkey amounted to 2.46 Mtep in 1990 whereas the exports increased by four times and reached 8.4 Mtep in 2012 and 10.32 Mtep in 2011. Turkey imported a total amount of 31 Mtep energy in 1990 which increased 3.2 times in 2012 amounting to 98.7 Mtep. Total energy imports in 2011 amounted 90.3 Mtep (World Energy Council, 2014: 13). Figure 4 shows energy import in Turkey between 1990 and 2012 by sources.

Figure 4. Distribution of Energy Imported by Turkey between 1990 and 2012 by Sources



Source: World Energy Council, 2014: 13.

Energy imported by Turkey increased steadily between 1990 and 2012. When one examines the development of this imported energy based on sources, it becomes evident that the amount of natural gas increased approximately by 13 times in the last twenty two years and reached 38 Mtep. Figures expressed as tep related to imports of oil and natural gas in the last two years are close to one another. Oil import in 2012 increased by 62% when compared to what it was in 1990 and amounted to 38 Mtep. When it comes to imported hard coal, it was 4.2 Mtep in 1990 and increased approximately by 5 times in 2012 amounting to 19.5 Mtep. Another important imported commodity is petroleum coke and electricity; however petroleum coke comprises almost the entire commodity included in this section. Total amount of imported petroleum coke was 350 thousand tep in 1990 which increased to 2936 thousand tep in 2012. This amount increased by 8.4 times in the last 22 years (World Energy Council, 2014: 14).

According to energy data related to Turkey in 2012 published by World Energy Council, the total amount of payment made for energy imports was 29.9 billion dollars in 2009 which has a share of 21% in total imports in Turkey. The energy imported in 2010 cost 38.5 billion dollars and had a share of 21% in the total imports whereas this amount cost 54 billion dollars and the share was 23% in 2011.

When one examines the period of 22 years between 1990 and 2012, it becomes evident that net ratio of

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imports in Turkey's primary energy supply increased from 52% to 72% which constitutes a significant risk. On the other hand, energy imported in 2012 increased by 11% when compared to 2011 amounting to 60.1 billion dollars and its share in Turkey's total imports was 25.4%. In addition, estimations related to energy demand which involve big deviations because of defining objectives too ambitiously may lead to increase in imported energy and decrease in production (World Energy Council, 2014: 14).

3. GENERAL SITUATION OF ELECTRİC POWER IN THE WORLD AND TURKEY

Total amount of electric power generated in the world between 1971 and 2010 rose approximately by four times increasing from 5.245,03 TWh to 21.431,47 TWh. The electric power generated in the world which was 21.431 TWh in 2010 was obtained from coal which had a share of 40.6%, from natural gas which had a share of 22.2%, from hydraulic sources which had a share of 16.0%, from nuclear sources which had a share of 12.9% and from petroleum products and other sources with shares of 4.6% and 3.7% respectively.

The electric power generated out of coal in 2010 was 41% of the total net electric power generation in the world whereas it is estimated to be 43% in 2035. Net electric power generation value is estimated to increase from 8.7 trillion kWh to 15.0 trillion kWh. The fact that using coal is more economical than oil and natural gas would play an efficient role in this increase.
Electric power generated from natural gas in the period between 2010 and 2035 is estimated to rise by 2.1% annually and to increase from 4.8 trillion kWh in 2010 to 6.8 trillion kWh in 2035. High efficiency introduced by natural gas fuelled combined cycle technologies and the effect of shale gas which may decrease natural gas prices play an important role in this increase.

No increase is expected when it comes to oil used for electric power generation. Electric power generated by fuel oil is estimated to drop annually and to decrease from 0.99 trillion kWh in 2010 to 0.8 trillion kWh in 2035.

Electric power generated from nuclear energy was 2.8 trillion kWh in 2010 whereas it is expected to rise to 4.6 trillion kWh in 2035. This increase would be affected by security of nuclear energy supply and low amount of released emissions.

The share of renewable energy sources in electric power generation was 20% in 2010 whereas this share is estimated to increase to 23% in 2035 (World Energy Council, 2014: 237).
When the development of installed power in Turkey's electric power system, it is observed that natural gas fired installed power has increased with a larger amount and ratio than other sources.

A significant increase has also been experienced in the installed power of plants fired by wind energy which have recently started to be constructed in our country. Although installed capacity of the natural gas which showed a speedy increase in the examined period did not use to exist in the system in 1984, it showed a speedy development till 2013 amounting to 23% of the total installed power and 44% of the production. The reason for this imbalance in natural gas installed power and production is the fact that power plants which seem to be multi fuelled power plants on installed power table mostly generate energy using natural gas.

A significant increase was observed in electric power generation between 1985 and 2013. In addition, energy generated by thermal power plants in the same period increased faster than energy generated in other plants whereas energy generated by hydraulic and renewable energy sources grew more slowly depending on precipitation conditions. The energy generated in 2013 lagged behind the production in 2012 and the difference was made up through imports. The amount of imported energy in 2013 was 7.4 billion kWh whereas the amount of exported energy was 1.2 billion kWh. Although exports outnumbered imports till 2011, imports exceeded exports between 2011 and 2013. (World Energy Council, 2014: 244).

When it comes to distribution by sources, as seen in Figure 5, %43.8 of total electric power generation was generated from natural gas, 26.2% from coal, 24.7% from hydraulic sources, 3.1% from wind, 1.0% from fuel oil and asphaltite and 1.0% from waste and geothermal sources in 2013. When compared to the year 2012, it is seen that the ratio of utilization of sources such as wind, natural gas and hydraulic sources increased whereas the utilization of coal dropped. (EÜAŞ, 2013: 13).

Figure 5. Electric Power Generation in Turkey by Sources as of 2013 (GWh)

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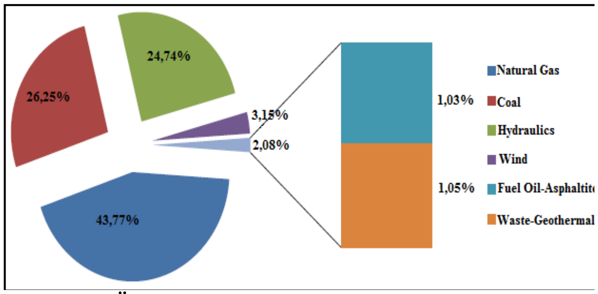
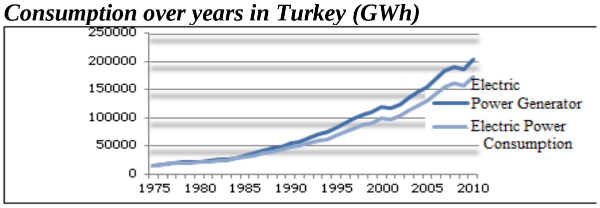


Source: EÜAŞ, 2013: 13.

Since electric power is the most widely used energy source when compared to other sources and the demand to electric power continuously increases day by day, the figures related to electric power generation are higher than those related to consumption as can be seen in Graphic 1. Although electric power consumption is continuously increasing, the generation seems to be covering this increase. However, as mentioned before, the majority of sources used in electric power generation are imported energy sources.

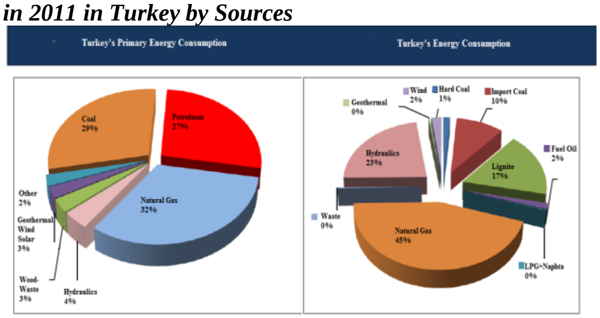
Graphic 1. Change in Electric Power Generation and Consumption over years in Turkey (GWh)



Source: Turkish Electricity Transmission Company, 2012.

Total electric power generation in Turkey increased by 4% in 2012 whereas it decreased by 1% in 2013 (Ministry of Energy and Natural Resources, 2013: 7). Gross electric power consumption in Turkey (Gross production in Turkey + import – exports) increased by 9% in 2011 amounting to 229,3 billion kWh, 5.2% in 2012 amounting to 242,4 billion kWh and by 1.0% in 2013 amounting to 245,3 billion kWh 2013 (World Energy Council, 2014: 238).

Figure 6. Primary Energy and Electric Power Consumption in 2011 in Turkey by Sources



Source: World Energy Council, Turkey Energy Data 2012: 1.

Figure 6 reveals that natural gas has the biggest share, namely 32%, in Turkey's primary energy consumption as of 2011 and that natural gas ranks the first with a share of 45% in electric power consumption. This situation is an indicator representing the fact that electric power is more commonly used than other sources.

High demand scenario suggests that demand for electric power would reach 453.56 billion kW-hours till 2022 (foreseeing an average annual increase of 6.1%) whereas the low demand scenario (foreseeing an average annual increase of 4.2%) implies that the demand would amount to 378.00 billion kW-hours (EÜAŞ, 2013: 12-13).

Policies which take energy supply security in Turkey as the basis define giving priority to local sources and therefore enhancing source diversity as priority objectives. In this scope, it is aimed to use up all the known lignite and hard coal sources in Turkey for electric power generation, to commission two nuclear power plants, to start the construction for the third nuclear power plant, to increase the share of renewable energy sources in energy supply to 30%, to use the full potential of hydroelectric sources that can be evaluated technically and economically in electric power generation, to increase the installed capacity of wind energy to 20.000 MW, to commission full potential geothermal sources amounting to 600 MW, to decrease energy density at least by 20% (amount of energy consumed per GDP), to increase installed power capacity for electric power energy to more than 110.000 MW and to rise total electric power production to 440 billion kW-hour by 2023 (EÜAŞ, 2013: 11).

4. LINKAGE BETWEEN ENERGY AND ECONOMIC GROWTH

This chapter of the article dwells on the general impact of energy on production and GDP and carries out analyses of growth model. It is necessary to analyse the role of energy in production to understand the role of energy in economic growth. When a different perspective is applied to economic activities, it becomes evident that commodity and service production is actually an outcome of an energy transformation; because no change and transformation can occur without the expense of energy (Shahid, 2006: 3). This understanding which handles economy as an energy system leads to the conclusion that energy should be

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considered in addition to labour and capital as the sources of sources.

4.1. Theoretical Framework of the Linkage between Energy and Economic Growth

Classical growth theory recognizes labour, capital and land as main factors of production and oil and other energy substances as intermediate good. Classical economists do not include intermediate goods into classical growth theories which focus on labour and capital. Therefore, energy is not included in main factors of production (Stern, 2004: 37). Neo-classical growth theory explains economic growth by focusing on labour, capital and technology. It is alleged that differences among countries in terms of technology can create disparities among countries in terms of per capita income. Although the reason for technological advancement cannot be explained, it is alleged that technological advancement is the reason for economic growth. Neo-classical economists treat energy as raw material or intermediate good and consider energy yielding products such as electricity, oil and fertilizers as analytically equivalent to substances such as steel, timber, glass and raw cotton. Therefore, they have ignored the fundamental distinction in the function that energy and matter perform in the economy, given an indirect role to energy and excluded energy from the economy. (Shahid, 2006: 23). Endogenous growth theory explains the reasons for technological progress with economic choices and decisions taken by firms and individuals. AK type models which include human capital present an approach suggesting that the knowledge can become available as a free good accessible to others, focus on social learning and investigate the trade-off between consumption and human capital. The second endogenous growth approach focuses on active and deliberate knowledge creation and suggests that economic growth is based on research and development and the production of new technologies (Dizdarević, Žiković, 2010: 38). Energy is assessed as another factor which allows use of technology. However, investments involving high technology are required to make sure that energy is transformed and becomes available to use. Such investments are made not only to generate energy but ensure efficiency in energy utilization as well. Consequently, energy factor which is supplied at a low cost and used efficiently in the production process ensures an increase in national output level on the basis of technology factor (Mucuk, Uysal, 2009: 106). Alternative views have appeared over time focusing on economic growth. In models which treat energy as main factor of production (Biophysical Growth Model), capital and labour are assessed based on the energy they involve. The price for commodities and services is set based on energy costs. The more energy they involve, the higher the prices would be for the commodities and services. Economists who are interested in ecology suggest that when the quality of sources such as oil and natural gas is decreased over time, more energy would be used up to produce input and thus the value in use of increasing energy cost would represent an increase in scarcity. When it comes to models which involve renewable and non-renewable sources, discussions about environmental sustainability focus on the role of natural sources. The models which involve non-renewable sources assume that sources that are important for production are non-renewable sources. On the other hand, the models involving renewable sources put the emphasis on renewable sources and other sources which diminish environmental pollution instead of non-renewable sources and those which harm the environment.

4.2. Factors Affecting the Linkage between Energy and Economic Growth

Stern (2004) has analysed the production function from a neo-classical perspective to examine the factors that could reduce or strengthen the linkage between energy use and economic activity over time and expressed the general production function as shown in equation (1):

$$(Q_1, \ldots\ldots . Q_m)' = f(A, X_1, \ldots . . X_n E_1, \ldots . E_p) \quad (1)$$

In equation number (1), Q_i are various outputs (such as manufactured goods and services), X_j are various inputs (such as labour and capital), E_k are the different energy inputs (such as coal, oil) and A is the state of technology as defined by the total factor productivity indicator.

The relationship between energy and an aggregate of output such as gross domestic product can then be affected by substitution between energy and other inputs, technological change (a change in A), shifts in the composition of the energy input, and shifts in the composition of output. Also, shifts in the mix of the other inputs— for example, to a more capital-intensive economy from a more labour-intensive economy—can affect the relationship between energy and output. (Stern, 2004: 44).

5. LITERATURE REVIEW

There are many studies analysing the linkage between energy consumption, generation and growth in Turkish economy. Terzi (1998) who carried out first examples of such studies focused on the period between 1950 and 1991 in order to examine the price and income flexibility in electric power consumption in the short and long term and define the linkage between economic growth and electric power usage. As a result of Granger Causality Test which is applied in the framework of Error Correction Model, dual causality was revealed between GDP and total electric power consumption. Soytaş ve Sarı (2004) investigated to what extent energy sources and employment explain the change in growth in the framework of Variance Decomposition Method which is based on Vector Error Correction Model. The empirical findings of the study suggest that energy consumption explains 21% of GDP change variance and energy consumption is at least as important as employment. Karagöl et al. (2007) examined the linkage between economic growth and electric power consumption for the period between 1974 and 2004. This study which uses Bounds Testing Approach developed by Pesaran (2001) identified cointegration relation among series and revealed positive relation among series in the short term but negative relation in the long term. Balat (2008) carried out a research about the linkage between energy consumption and economic growth in Turkey. This study summarized data regarding electricity generation and consumption, oil demand and imports, natural gas need and import, coal demand and its import and contribution of local sources to energy consumption in Turkey between 1983 and 2005. Various ideas were presented in this study discussing that energy demand in Turkey increases fast as a consequence of social and economic development, total primary energy generation covers only 27% of total primary energy demand and energy strategy of the country should focus on a satisfactory demand without inhibiting economic growth. The study further emphasizes that local hard coal and lignite reserves in Turkey as well as other renewable sources such as hydrogen, wind and solar energy should aim to meet increasing demand in a sustainable manner, that renewable energy sources in Turkey constitute the most important alternative to fossil fuels to meet energy demand and that Turkey has a huge potential to improve geothermal energy sources but this potential would have an insignificant contribution to the energy demand in the country. When the development in wind energy in the country is considered, the study suggested that the number of wind energy power plants would increase significantly in the future. Mucuk and Uysal (2009) used cointegration and Granger Causality Tests to understand if there is an empirical linkage between energy consumption and economic growth in Turkey for the period between 1960 and 2006. The study concluded that the variables are cointegrated, Granger's causality is directed from energy consumption towards economic growth and energy consumption has a positive impact on growth.

The majority of the studies in the literature suggest that energy consumption increases economic growth. In this sense, the desired increase in energy consumption for countries can only be achieved through either energy production or importing energy from the external markets if energy generation is not possible. Since all countries in the world do not share potential for energy sources homogeneously, international trade is also available in energy sector as it is the case for goods and service purchases. In case energy factor which is one of the main inputs of production is not generated sufficiently in the country, consumption opportunities created thanks to imports contribute to economic growth. The number of studies in the literature handling the linkage between energy and economic growth is limited.

Çalışkan (2009) analysed data about energy production, consumption and import in Turkey and in the world and examined the problem regarding energy supply security which is caused by ever increasing dependence in Turkey on imported energy. To ensure energy supply security in Turkey, this study suggested to make more efficient use of local sources for generating energy in the short term, to diversify energy sources by increasing the number of countries from which primary energy sources such as natural gas are imported and to make investment in alternative energy sources such as nuclear power plants which diminish dependence on imported sources in the long run.

Yanar and Kerimoğlu (2011) analysed if current deficit is an outcome of growth, if growth would increase energy consumption and what the causality affects as well. Co-integration test analysed the linkage between energy consumption, economic growth and current deficit in Turkey between 1975 and 2009. Johansen Co-integration Analysis Test identified a long term relation between energy consumption, economic growth and current deficit based on the obtained outcomes. The findings obtained after applying Vector Error Correction Model suggest that energy consumption would increase with increased growth and the increase in energy consumption would have an increasing effect on current deficit. In other words, whereas there is strong causality linkage between energy consumption and growth, there is a dual but weak relation between growth and current deficit.

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Demir (2013) analysed the direction and quality of the linkage among industrial production, current deficit and energy import as indicators of economic growth by applying co-integration, error correction models and Granger Causality Tests in the scope of VAR Analysis. The obtained results suggest that the causality in Turkey, which is a unilateral causality, runs from industrial production and energy import towards current deficit in compliance with institutional framework in the country.

6. ECONOMETRICAL ANALYSIS

Although there are many studies in the literature examining the linkage between energy and economic growth, the number of studies focusing on dependence on imported energy is few. Therefore, this study aims to overcome this deficit in the literature. It uses Time Series Analysis to investigate the linkage among electric power generation, import, consumption and economic growth in Turkey between 1975 and 2013. The data used in this study are included in this study with the following abbreviations:

rgdp: logarithm of real gross domestic product (GDP) variable. This variable was obtained from country data of the World Bank.

ep: logarithm of net electric power production variable. Relevant variable was obtained from statistics generated in 2013 by Turkish Electricity Transmission Company (TEIAS).

ec: logarithm of net electric power consumption variable. Relevant variable was obtained from statistics generated in 2013 by Turkish Electricity Transmission Company (TEIAS).

ei: logarithm of electric power import variable. Relevant variable was obtained from statistics generated in 2013 by Turkish Electricity Transmission Company (TEIAS).

Macroeconomic time series are generally not stationary. Granger and Newbold (1974) demonstrated that spurious regression problem may arise when non-stationary time series are used. In such a case, the results obtained by regression analysis do not reflect the true relation; because such test statistics lose their validity since they do not have standard distribution (Gujarati, 1999: 726). Therefore, before working on time series, one has to test the stationarity of series. There are various tests used to test the stationarity of time series. One of the most commonly used tests in this respect is "Augmented Dickey-Fuller" (ADF) test developed by Dickey and Fuller (1981). This test is applied with the equation number (2):

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (2)$$

In equation number (2), ΔY_t denotes first difference of the variable the stationarity of which is tested, t denotes trend variable and ΔY_{t-i}denotes lagged difference. This model is integrated with lagged difference terms enough to make the error term without serial correlation. The number of "m" lagging in the equation can be selected by using the Akaike and Schwarz information criteria.

ADF test reveals if the coefficient δ included in the equation number (1) is statistically equal to zero or not. Null hypothesis suggest that series have a unit root when their difference is not taken in other words they are not stationary. If the coefficient δ is statistically significant, then this hypothesis is rejected. This means that the series is stationary. If the δ coefficient is statistically not significant, the series have a unit root, in other words, series are not stationary. In such a case, the difference has to be taken till the series become stationary (Kızılgöl, 2006b: 4).

Augmented Dickey-Fuller (ADF) unit root test results which are used to analyse the stationarity of time series are sensitive to time lags. Therefore, Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test which considers this deficiency must be applied.

Null hypotheses (H0) of ADF and KPSS tests are opposite to each other. Null hypothesis of ADF test refers to the existence of unit root and the fact that series are not stationary whereas the null hypothesis of KPSS test represents the stationarity of the series.

This study used ADF and KPSS Unit Root tests to examine stationarity of variables by taking the natural logarithm of data relevant to these variables. The results are shown in Table 2.

Table 2. Unit Root Test Statistics

Variables		ADF		KPSS	
		Intercept	Trend+ Intercept	Intercept	Trend+ Intercept
Level	ec	1.17 (8)	0.23 (9)	0.69 (5)*	0.21 (4)*
	rgdp	1.20 (0)	-1,68 (0)	0.69 (5)*	0.18 (4)*
	ep	1,58 (9)	2.44 (9)	0.69 (5)*	0.21 (4)*
	ei	-2.89 (1)	-2.84 (1)	0.1 (4)*	0.06 (4)*
1st Difference	ec	0.49 (9)	-4.36 (8)*	0.64 (4)*	0.18 (13)*
	rgdp	-5.52 (0)*	-5.95 (0)*	0.29 (0)*	0.10 (6)*

	ep	-0.92 (9)	-1.35 (9)	0.65 (4)*	0.18 (9)*
	ei	-4.37 (0)*	-4.31 (0)*	0.07 (2)*	0.05 (2)*
2nd Difference	ep	-4.56 (8)*	-4,52 (8)*	0.50(33)*	0.50 (33)*

Note: Natural logarithm of the used variables is taken. Stable critical values of the ADF test statistics include %1 -3,63, %5 -2,95, %10 -2,61 at the order; %1 -3,64, %5 -2,95, %10 -2,61 at the first difference; % 1 -3,72, % 5 -2,99, % 10 -2,63 at the second difference; %1 -4,24, %5 -3,54, %10 -3,2 at stable and trend order; %1 -4,25, %5 -3,55, %10 -3,21 at the first difference; % 1 -4,37, % 5 -3,6, % 10 -3,24 at the second difference. Critical values of KPSS test include %1 0,74, %5 0,46, %10 0,35 at stable order and %1 0,22, %5 0,15; %10 0,12 at stable and trend order. The values between parentheses show the optimum length of lag.

Based on ADF and KPSS test results, Table 2 shows that all series include unit root in the form of data order, in other words they are not stationary. First or second difference of the series with such properties is taken and the series then become stationary. It is observed that when the second difference of the series I(2) related to electric power generation data is taken and when the first difference I(1) for the other variables is taken, the series become stationary.

The method to be used in the study is Vector Autoregressive (VAR) model. VAR model which has two variables can be expresses as follows in a standard manner:

$$y_t = a_1 + \sum_{i=1}^{p} b_{1i}\, y_{t-i} + \sum_{i=1}^{p} b_{2i}\, x_{t-i} + v_{1t} \quad (3)$$

$$x_t = c_1 + \sum_{i=1}^{p} d_{1i}\, y_{t-i} + \sum_{i=1}^{p} d_{2i}\, x_{t-i} + v_{2t} \quad (4)$$

In models number (3) and (4), p denotes the lag length and v denotes random error terms which are zero on average, have zero covariance with their own lagged values and stable variances (Özgen and Güloğlu, 2004: 96-98).

This study has created a VAR model and the calculated optimum lag length of the model is shown in Table 3.

Table 3. VAR Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	39.55	NA	1.36e-06	-2.15	-1.97	-2.09
1	188.89	253.43	4.26e-10	-10.24	-9.33*	-9.93
2	213.81	36.24*	2.60e-10*	-10.78*	-9.14	-10.23*

* Indicates the lag order selected by the criterion. LR: Sequential modified Likelihood Ratio (LR) Test Statistic. FPE: Final Prediction Error. AIC: Akaike Information Criterion. SC: Schwarz Information Criterion. HQ: Hannan-Quinn Information Criterion.

Table 3 implies that LR, FPE, AIC and HQ values are in the same direction, error mean square for 2 lags give the minimum value and SC criterion provides the minimum value for 1 lag.
AIC criterion is based on the minimization of error mean square and should be observed rather for prospective forecasting whereas HQ criterion is considered to identify consistent lag order (Lütkepohl, 1993: 130-133). Therefore, the optimum lag length of the model was defined as 2 due to the necessity to identify a coherent lag order.

It was analysed if the VAR model, which is estimated on the basis of the already defined optimum lag length, is stable or not. In addition, it was investigated if modulus values are outside the reference intervals or not.

Block Externality Wald Test was applied in the VAR model which was identified as stationary in order to examine the causality relation among variables included in the system. The obtained results which are significant are shown in Table 4.

Table 4. Outcomes of VAR Granger Causality Test

Dependent Variable: rgdp			
Excluded Variable	χ^2	**Degree of Freedom**	**Probability**
ep1	5.756.804	2	0.0562 ***
ec	8.369.069	2	0.0152 **
ei	4.869.196	2	0.0876 ***
Dependent Variable: lnep1			
ec	3.353.456	2	0.0000 *
ei	6.791.894	2	0.0335 **

(*) Null hypothesis is rejected at (H0) $\alpha = 0.01$ level.
(**)Null hypothesis is rejected at (H0) $\alpha = 0.05$ level.
(***)Null hypothesis is rejected at (H0) $\alpha = 0.10$ level.

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Results obtained from VAR Granger Causality Test indicate that lagged values of electric power generation, consumption and import affect economic growth rate whereas the lagged values of electric power consumption and import affect electric power generation. The findings suggest that the causality runs from electric power generation, consumption and import towards economic growth rate and from electric power consumption and import towards electric power generation.

The variable that has the greatest influence on the variables examined in our study was identified by employing Variance Decomposition Analysis. The results of Variance Decomposition Analysis indicate to what extent any change in the variables included in the model stems from the variable itself or other variables and the results that belong to the economic growth variable are shown in Table 5.

Table 5. Results of Variance Decomposition Analysis that are relevant to Economic Growth Variable

Period	**rgdp**	**ep**	**ec**	**ei**
1	100.00	0.00	0.00	0.00
2	90.16	1.46	6.39	1.98
3	71.83	3.31	18.45	6.40
4	61.97	4.68	24.42	8.93
5	57.32	5.15	27.89	9.64
6	55.53	5.24	29.64	9.59
7	54.64	5.12	30.85	9.38
8	53.90	4.93	31.94	9.22
9	53.03	4.71	33.10	9.15
10	52.03	4.51	34.30	9.17
11	50.97	4.34	35.48	9.21
12	49.91	4.23	36.60	9.26
Ordering: rgdp ep ec ei				

According to the results of Variance Decomposition Analysis that are relevant to economic growth, economic growth variable is defined mostly by its own shocks at the beginning of the period i.e. in the short term as shown in Table 5. At the end of the period i.e. in the long term, this variable is defined by its own shock, electric power consumption, electric power import and electric energy generation at ratios of approximately 50%, 37%, 9% and 4% respectively, which is also shown in Table 5.

Table 6 includes the results of impulse-response analysis which has an important function in terms of analysing the impact of a random shock that may take place in any variable on other variables and thus guiding economy policies that are relevant to economic growth variable.

Table 6. Results of Impulse-Response Analysis that are relevant to Economic Growth Variable

Period	**rgdp**	**ep**	**ec**	**ei**
1	0.0404	0.0000	0.0000	0.0000
2	0.0036	-0.0059	0.0124	-0.0069
3	0.0203	-0.0091	0.0226	-0.0135
4	0.0108	-0.0092	0.0200	-0.0126
5	0.0099	-0.0069	0.0172	-0.0090
6	0.0098	-0.0046	0.0135	-0.0054
7	0.0103	-0.0028	0.0122	-0.0039
8	0.0101	-0.0015	0.0120	-0.0039
9	0.0096	-0.0004	0.0125	-0.0045
10	0.0092	0.0005	0.0129	-0.0051
11	0.0089	0.0014	0.0132	-0.0054
12	0.0086	0.0022	0.0134	-0.0054
Ordering: rgdp ep ec ei				

When one analyses the results of impulse-response analysis that are relevant to economic growth variable, it is observed that economic growth steadily decreases in case of one standard deviation shock in economic growth and electric power consumption. When the column of rgdp in Table 6 is studied, the values increased in response to electric power consumption; however this increased has dropped in each period. The response of economic growth to one standard deviation shock in electric power generation was floating and had a decreasing trend whereas economic growth showed a decreasing response to one standard deviation shock in electric power imports.

7. CONCLUSION AND SUGGESTIONS

This study focuses on the linkage between electric power generation, consumption, import and real GDP in Turkey between 1975 and 2013. The findings revealed that the variable which has the greatest influence on economic growth was electric power consumption. This conclusion suggests that policies which aim to decrease electric power consumption would have a negative impact on economic growth. Therefore, Turkey should put the emphasis on policies which can stimulate demand. Energy prices in Turkey are high due to reasons such as Value Added Tax imposed on energy prices and other burdens, high loss-illegal consumption ratios and concluding costly energy agreements. The reason for this situation is the fact that unit price per KWh of electricity generated in Turkey is completely set by external factors. It is highly important for economic growth that Turkey supplies low-cost energy sources particularly to manufacturers by benefiting from price and tax policies in the energy sector. In addition, high-technology investments are required for ensuring efficiency in energy use. Charging low interest rates to enhance access to the financing required for such investment is a feasible practice as a policy tool which can stimulate demand. One of the weaknesses that Turkey has is defined as the fact that the sole energy source that is locally available in significant amount is coal and that this situation makes the country increasingly dependent on imported sources. Furthermore, one must remember that almost all of the natural gas which is the most important source used to generate electricity is imported. In this sense, it is greatly significant that Turkey puts the emphasis on local sources in order to diversify the sources in this manner and adopts the aim of decreasing dependence on imported sources. It is necessary that local sources within the country are mobilized to initiate energy generation activities which can meet the domestic demand and current sources are used in a manner to ensure energy efficiency; because the possibilities that Turkey has to meet the energy demand by sustaining its current production level decrease each year. Privatization and liberalisation policies which Turkey has started to implement recently need to provide incentives to electric power generation facilities which rely on imported natural gas. Furthermore, commercial commitments given to natural gas fired power plants require lignite fired power plants and hydroelectric power plants initiate the necessary improvement, capacity enhancement, maintenance and repair activities. Turkey needs to avoid situations where the public sector withdraws from energy investments and where the country does not make best use of hydraulic sources and lignite reserves as well as local and renewable energy sources such as wind, geothermal and solar energy.

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