The Link Between Industry Value Added and Electricity Consumption

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Abstract
        This study aims to analyse the link between industry value added and electricity consumption in Turkey for the years between 1970 and 2015. The sectoral distribution of net electricity consumption has been obtained from Turkey Electricity Distribution and Consumption Statistics on GWh basis while industry value added data have been obtained from World Development Indicators' data bases on dollar basis with the fixed prices of the year 2012. The correlations between the variables have been examined by means of Johansen cointegration test and error correction model. According to the results of the study, it has been seen that there exists bidirectional relationship between the electricity consumption and value added variable in the long term. On the other hand, in terms of the Error Correction Model used for a short-term relationship, no short-term relationship has been identified between the variables.

Keywords: Energy consumption, industry value added, Economic Growth and Productivity

Introduction
        Energy consumption has vital importance for sustainable growth. The change in the economic output depends on the consumed energy, and electricity is required for all the industries to survive. This need becomes more obvious during the take-off periods of economies. The main aim in the industrial production is to obtain maximum output with minimum cost. As it is known, energy is one of the most important inputs of the production process. Gaining maximum output with each unit of consumed energy decreases the costs and increases the sectoral competitive power. In this respect, the relationship between energy consumption and output quantity has been taking the interests of the researchers to an increasing extent.

Within the framework of this study, the relationship between the industry electricity consumption and value added was examined. While one of the indicators was the electricity used in the industry, the other one was industry value added. The annual net electrical energy used in industry was obtained from TEDAŞ (Turkish Electricity Distribution Corporation) while the annual fixed price Value Added data were obtained from World Development Indicators. In the second part of the study, the electricity consumption of Turkey's industrial sector as well as industry value added data were examined. In the third part, a relevant literature review was provided. In the following part, the data belonging to the period between 1970-2015 and the cointegration test and error correction model was presented.

Industry value added and electricity consumption in turkey
During the Third Five-Year Development Plan including the years 1973-1977, the Turkish economy grew by 6.9%. Because of energy and raw material constraint that occurred as a result of 1973 world petrol crisis, the targeted growth did not come true during this period. During Third Five-Year Development Plan, some structural goals such as increasing the industry's share within GDP were determined and the industry's share within GDP increased to some extent (DPT, 1979: 7-8). 1970's were the years when Turkey's economy adopted import substitution industry and development policies.

Table 1: Electricity Consumption In Industry % of Total and Industry Value Added % of GDP 1970-1974

	Electricity Consumption In Industry % of Total	**Industry Value Added % of Gdp**
1970	64,2	22,54
1971	64,5	23,40
1972	65,0	24,48
1973	67,3	24,45
1974	66,7	23,23

During the period between 1970 and 1974, the share of industry value added within GDP showed increase until 1974 when Turkish invasion of Cyprus happened. During this period, the share of industry value added within GDP was as average about 23.62%. After the petrol crisis, the increase rate in industry value added started to decrease, ending up with a rate of about 7.45%. In 1970, the total net amount of consumed electricity was 7,308 GWh. 64.2% of the net electricity consumption was used in industry. In 1974, the industry electricity consumption was 66.7% of the total electricity consumption. As of the end of the period, industry electricity

consumption showed a decreasing tendency and the total industry electricity consumption of the period 1970-1974 amounted to 65.54%.

Table 2: Electricity Consumption In Industry % of Total and Industry Value Added % of GDP 1975-1979

	Electricity Consumption In Industry % of Total	Industry Value Added % of Gdp
1975	64,80	23,28
1976	65,30	24,70
1977	66,70	24,10
1978	65,50	23,53
1979	63,90	26,26

During 1975-1979, increase in the industry value added decreased to 3.64%. 64.8% of 1975's total electricity of 13,492 GWh was used in industry. This rate decreased to 63.9% in 1979. During 1975-1979, compared to the previous five-year period, the industry electricity consumption decreased to about 65.24%. During 1975-1979, the share of industry value added within GDP was about 24.37%. While the industry value added increase was 7.27% in 1975, it decreased to -3.44% in 1979.

Table 3: Electricity Consumption In Industry % of Total and Industry Value Added % of GDP 1980-1984

	Electricity Consumption In Industry % of Total	Industry Value Added % of Gdp
1980	63,8	23,82
1981	64,5	27,09
1982	64,4	28,19
1983	63,7	27,20
1984	65,2	26,21

After 1980, the import substitution model of industrialization was given up and "export-based" growth model was adopted. As a result of the narrowing domestic market, price controls and 100% devaluation of TRY against foreign currencies, growth started to increase (Taymaz and Suiçmez, 2005). The effects of 24th January decisions on industrial production were positive. The increase in industrial production also affected GDP and hence about 5.2% growth rate occurred during 1981-1986 (İTO, 1989: 45). During 1980-1984, the share of industry value added within GDP was about 26.50%. The industry value added rate of 1980 (-0.9%) increased to 10.3% in 1984. During 1980-1984, the industry value added rate increased by about 5.44%. In the same year, net electricity consumption was realized as 20,398 GWh while the industry usage amounted to 63.8% of this amount. During 1980-1984, the industry electricity consumption decreased to 64.32%.

Table 4: Electricity Consumption In Industry % of Total and Industry Value
Added % of GDP 1985-1989

	Electricity Consumption In Industry % of Total	**Industry Value Added % of Gdp**
1985	66,0	27,13
1986	64,8	31,93
1987	65,1	32,55
1988	63,6	33,94
1989	64,0	34,00

As of the beginning of 1980's, the ratio of agriculture to GDP continued its downward trend and the industry production especially in the manufacturing sector gained an upward tendency (TCMB, 2002:40). During 1980-88, economic growth was observed on industry basis. When compared to import substitution period, an obvious decline was observed in the national product and industrial sector's growth rate (Eşiyok, 2006:19). During 1985-1989, the share of industry value added within GDP was 31.91%. The industry value added of 1985 (7.71%) decreased to 4.94% at the end of the period. During 1985-1989, the industry value added was 6.85% on average. 66% of the total net electricity consumption of 29,709 GWh in 1985 was consumed in industry. The industry electricity usage rate was 64.70% for the period of 1985-1989. This rate showed increase when compared to the previous five years.

Table 5: Electricity Consumption In Industry % of Total and Industry Value Added % of
GDP 1990-1994

	Electricity Consumption In Industry % of Total	Industry Value Added % of Gdp
1990	62,4	32,16
1991	57,9	32,69
1992	58,4	32,38
1993	57,8	31,10
1994	55,6	33,25

During 1990-1993, GDP increased by 6% on average. However, the growth of this period displayed an instable trend because the increasing domestic demand was supported by high public deficits and short-term capital. Depending upon the stability precautions of 5th April, domestic demand decreased to a serious extent and the GDP with fixed prices declined by 6% in 1994 (7th Five-Year Development Plan, 1996-2000: 6). With the economic crisis of 1994, Turkey's economy experienced the biggest public and current deficit level until that time (Sönmez and Şimşek, 2011: 98-99). While the industry value added increase was 6.59% in 1990, it decreased to -4.96% in 1994. During the analysis period of 1990-1994, the share of industry value added within GDP was 32.32%. During 1990-1994, the value added increase rate was realized at 3.64% on average, implying a

serious decrease compared to the previous period. 1990 was the year when 62.4% of the total electricity consumption of 46,820 GWh belonged to industry. During the analysis period of 1990-1994, the industry electricity consumption was realized as 58.42%, implying a decline compared to the previous period.

Table 6: Electricity Consumption In Industry % of Total and Industry Value Added % of GDP 1995-1999

	Electricity Consumption In Industry % of Total	Industry Value Added % of Gdp
1995	56,4	33,24
1996	54,8	31,60
1997	53,1	31,85
1998	52,6	35,34
1999	51,0	33,15

On the other hand, Asia and Russia's economic crises experienced in 1997 and 1998 respectively created negative outcomes on Turkey's economy (Sönmez and Şimşek, 2011: 98-99). Under these negative conditions, the industry value added rate of 1995 (8.75%) decreased to -4.63% in 1999. The share of industry value added within GDP increased to 33.04% compared to the previous five years. 56.4% of the total net electricity consumption of 67,394 GWh in 1995 was used in industry. The industry electricity consumption of 1995-1999 was 53.8% , implying a decline compared to the previous period.

Table 7: Electricity Consumption In Industry % of Total and Industry Value Added % of GDP 2000-2004

	Electricity Consumption In Industry % of Total	**Industry Value Added % of Gdp**
2000	49,7	31,33
2001	48,4	30,15
2002	49,0	28,62
2003	49,3	28,57
2004	49,2	28,45

In 1997 and 1998, after Asian and Russian crisis, the countries devalued their currencies to a serious amount, but Turkey did not prefer to devalue TRY against foreign currencies because of the stability program it adopted. In 1999, the country entered into a deep economic crisis. Even though IMF-supported "Exchange Rate Based Fight Inflation Program" was implemented, Turkey's economy experienced two serious financial sector-based economic crises during 2000 and 2001 (Şimşek, 2007: 54-57). In the following years, as of the first quarter of 2002, Turkey's economy grew by about 6.5% continuously during twenty-seven quarters (Alpaydın and Tunalı, 2011: 254). In light of these developments, the share of industry

value added within GDP was about 29.43% during 2000-2004, which meant a decline when compared to the previous five years. While the industry value added increase rate was 6.2% in 2000, it increased to 11.6% in 2004. The total electricity consumption that was 98,296 GWh at the beginning of the period of 2000-2004 was realized as 121,142 GWh at the end of this period. The industry electricity consumption during the whole period was 49.12% of the total electricity consumption, which implied a fall-down when compared to the previous five years.

Table 8: Electricity Consumption In Industry % of Total and Industry Value Added % of GDP 2005-2009

	Electricity Consumption In Industry % of Total	Industry Value Added % of Gdp
2005	47,8	28,46
2006	47,5	28,19
2007	47,6	27,75
2008	46,2	27,18
2009	44,9	25,25

During 2005-2009, the share of industry value added within GDP was about 27.37%. This rate was lower than the previous period. Industry value added increase was realized as 2.98%. 47.8% of the total electrical energy consumption of 2005 (130,263 GWh) belonged to the industry. During 2005-2009, 46.8% of the total electricity consumption was used in industry. This rate was lower than the previous period. After the global crisis, Turkey's economy shrinked by 4.8% in 2009 while it showed high growth performance in 2010 and 2011. During the three-year period between 2012-2014, it grew by 3.1%. The economy showed 3.9% growth performance in 2015.

Table 9: Electricity Consumption In Industry % of Total and Industry Value Added % of GDP 2010-2015

	Electricity Consumption In Industry % of Total	Industry Value Added % of Gdp
2010	46,1	26,39
2011	47,3	27,47
2012	47,4	26,67
2013	47,1	26,61
2014	47,2	27,10
2015	47,6	26,51

The share of industry within GDP is one of the most important indicators representing the industrialization level. During 1970-1999, Turkey's industry growth rate was more than GDP growth rate. During 2000's, the gap between GDP growth rate and industry growth rate decreased to a great amount. The fact that the inter-sectoral prices turned against the industry sector was one of the factors affecting the share of

industry within GDP to decrease (Taymaz and Voyvoda, 2015: 31). During 2010-2015, the industry value added within GDP decreased to the levels of the mid-period, amounting to 26.79%. While the industry value added increase rate was 13.9% in 2010, it decreased to 3.3% in 2015. The total electricity consumption was 172,051 GWh in 2010, 46.1% of which was used in industry. 47.11% of the total consumed electricity of 2010-2015 was used in industry, which was higher than the average of the previous five years.

Literature rewiew

Mawejje and Mawejje (2016), analysed the long-term relationhip between electricity consumption and sectoral output in Uganda by means of vector error correction techniques. They also applied Granger Causality test in order to identify the direction of the relationship. According to the results of the study, there is a unidirectional relationship from electricity consumption to GDP and industry in the long term.

Eren Vahit M., Polat A. Melike, Aydın İbrahim H. (2016), researched the link between electricity consumption and economic growth for the period of 1975-2013 in Turkey. According to the results of the analysis, a long-term interaction was found out between the variables. It was also shown that 1% increase in the electricity consumption of Turkey also increased the growth by 0.6%. Savaş and Durğun (2016), examined the long term relationship between GDP per capita and per capita electricity consumption for the period of 1980-2010 by means of cointegration test. According to the empirical results, a long-term relation was found out between electricity consumption and economic growth. The direction of the relationship was from the growth to the electricity consumption. Danmaraya Hassan (2016), analysed the relationship between manufacturing industry efficiency and electricity consumption in Nigeria for the period of 1980-2013. The results show a bidirectional relationship between the variables.

Husaini and Lean (2015), analysed the relationship between output and price in electricity consumption and manufacturing sector in Malaysia. According to the results, it was seen that electricity consumption, output and prices were co-integrated in the long term and there was a positive correlation among them. In the long term, there exists a unidirectional relationship from the manufacturing industry output to electricity consumption. Kermani et al. (2015), studied the correlation between industry value added, electricity consumption and CO_2 emission for the period of 1998-2011 in Iran by means of Granger Causality Test, Johansen cointegration test and Vector Error Correction Model. According to the results of Granger Causality Test, there does not exist any relationship between industry value added and electricity consumption.

İsmiç (2015), analysed the relationship between population, economic growth and electricity consumption for eight countries listed among the developing ones according to IMF country list for the period of 1990-2012 by using Swamy's Random Coefficients Model and Seemingly Unrelated Regression (SUR) models. According to the obtained findings, it was concluded that economic growth had positive effect on electricity consumption and the population did not have any effect on electricity consumption of these two countries. Olufemi (2015), analysed the link between electricity consumption and economic growth in Nigeria for the period of 1980-2012 by means of cointegration and error correction techniques. The results indicate a positive correlation between electricity consumption and economic growth, employment and exchange rate. Teraoui (2015), examined the relationship between electricity consumption and economic growth for the period of 1980-2010 in Tunisia by means of a multivariate approach to cointegration and error correction model. According to the findings of the study, there exists a unidirectional relationship between electricity consumption and GDP in Tunisia.

Kargı (2014), analysed the relationship between electricity consumption and GDP in Turkey for the period of 1970-2010 under the category of industry, housing and the others. The results showed that there was a co-integrating vector between GDP and industry and housing sector electricity consumption in the long term as well as a bidirectional causality relationship. Karakaş (2014), examined the national income, population and electricity consumption of twenty OECD and twenty non-OECD countries for the period of 1990-2011 through Panel data analysis. At the end of the analysis, it was seen that there was a bidirectional causality relationship between income and electricity consumption. Hepatkan and Sertkaya, surveyed the relationship between per capita electricity consumption, GDP per capita, CO2 emission and oil consumption in Turkey for the period of 1980-2014. According to the results of the study, a relationship was discovered between the series in the long term by means of co-integration analysis. The direction of the long-term relationship between the variables was examined through Granger Causality analysis. As a result, a unidirectional relationship from GDP per capita, CO2 emission and oil consumption to per capita electricity consumption was found out. Patrick (2014), surveyed the conditions affecting electricity consumption in Ghana as well as the sectors on which electricity consumption had an effect. According to the results of the study, electricity consumption had a positive effect on the manufacturing sector.

Saatçi and Dumrul (2013), examined the relationship between electricity consumption and economic growth in Turkey during the period of 1960-2008 by means of Dynamic Ordinary Least Square (DOLS) and Fully

Modified Ordinary Least Square Method (FMOLS). The results show that electricity consumption in Turkey has an effect on economic growth. Karumba (2012), studied the correlation between electricity consumption and manufacturing industry in Kenya for the period of 1970-2008 by using VECM model. The results indicate a unidirectional relationship from the manufacturing sector output to electricity consumption. Sami (2012), analysed the long-term relationship between electricity consumption and growth in industry, trade and housing sectors in Philippines for the period of 1973-2008 by means of bounds testing procedure (2001), Johansen multivariate cointegration procedure (1988, 1990), Toda and Yamamoto tests (1995). The results indicate a long-term balance between industry sector and electricity consumption.

Kapusuzoğlu and Karan (2010), examined the long term relationship between electricity consumption and GDP in Turkey for the period of 1975-2006. As a result of the co-integration analysis, it was seen that there exists a long-term relationship between electricity consumption and GDP. The Granger causality analysis carried out with vector error correction model showed that there was a unidirectional causality between electricity consumption and GDP. Dilaver and Hunt (2010), analysed the relationship between industrial electricity consumption, industrial value added and electricity prices in Turkey during 1960-2008 by using structural time series technique. With this technique, they foregrounded the Universal Energy Demand Trend (UEDT) for Turkish sector. The results underline the importance of real electricity prices and UEDT in the electricity demand of Turkish industry.

Aktaş (2009), studied the relationship between electricity consumption, employment and GDP in Turkey for the period of 1970-2006 by means of Granger causality test. The study indicated a unidirectional causality relationship from economic growth and employment to electricity consumption and bidirectional causality relationship between employment and growth both in short and long term. Karagöl et al. (2007), surveyed the correlation between economic growth and electricity consumption in Turkey for 1974-2004 period through Bound Testing approach. According to this approach, a co-integration relationship was discovered and it was seen that the correlation was positive in the short term while it was negative in the long term.

Ghaderi et el. (2006), analysed the relationship between value added and electricity consumption in Iran industry. According to the results of the study, there does not exist any relationship between value added and electricity consumption in Iran's many industrial sub-sectors. Electricity consumption is only the reason of chemical, oil, metal and non-metal, transporting and measuring machined in industry. Gupta and Sahu, analysed

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the relationship between electricity consumption and economic growth in India for 1960-2006 period by means of Granger Engel causality model. The obtained findings show that electricity consumption has a positive effect on the growth. Terzi (1998), examined the Turkey's energy consumption's price and income flexibility in short/long term on sectoral basis as well as the relationship between electricity consumption and economic growth. As the results of the error correction model show, there was bidirectional causality between total electricity consumption and GDP. On sectoral level, on the other hand, bidirectional causality was identified between industry and trade electricity consumption and GDP. Nişancı, analysed a causality relationship between electricity consumption and national income through co-integration and vector error correction models. According to the results, there is a co-integration between electricity consumption and national income as well as a unidirectional causality from electricity consumption to national income.

Model

Graph 1: Industry Value Added 1970-2015
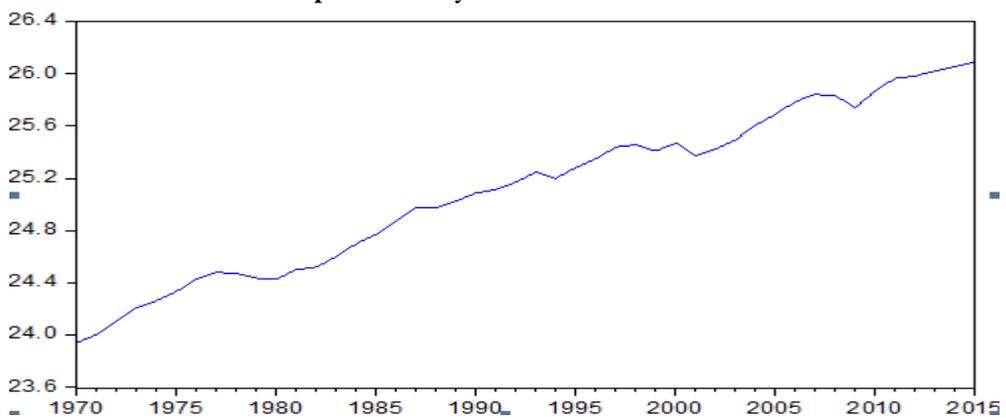
Graph 2: Electricity Consumption in Industry 1970-2015
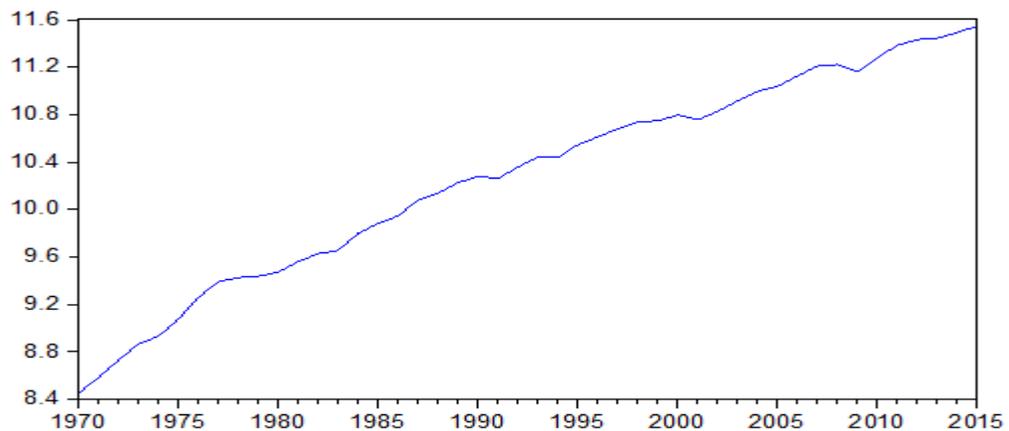
The analysis started first with the unit root tests belonging to reserve, production and consumption variables of the countries and the results of the adopted ADF unit root test are given below:

Table 10: The Results of the ADF unit root test

Variables	Delay Number	Test statistics
Value added	0	-2.71132*
Consumption	0	-2.97489*
ΔValue added	0	-3.72752
ΔConsumption	1	-4.71373

Note: * shows that the unit root on the level of 5% significance level is not rejected

When the results of the adopted ADF unit root test given in the table are examined, it is understood that Value Added and Consumption variables are not stationary. According to the results of the unit root test applied to the first differences of the variables, it is seen that these variables become stationary in their first difference.

After realizing that the variables were first-rank stationary variables, Johansen cointegration test and error correction model were used for analysing the relationship between the variables.

The cointegration tests results showing the relationship between the variables are given in the Table.

Table 11: Johansen Cointegration Test Results

Cointegrated Vector Number	İz Statistics	Critic value	Maximum Eigenvalue Statistics	Critic value
Zero	71.87050*	20.26184	66.23836*	15.89210
Maximum 1	5.63213	9.16455	5.63213	9.16455

Not: * implied that zero hypothesis is rejected at 5% significance level.

When the results of the Table is examined, it is seen that there does not wxist a cointegrated relationship between the variables. In other words, when the zero hypothesis implying that the cointegrated vector number is zero is tested against the alternative hypothesis accepting the existence of one cointegrated vector, the zero hypothesis is rejected at 5% significance level according to both iz statistics and max-ergen statistics. It means that there is a cointegrated, namely long-term, relationship between value added and consumption variables. The obtained results indicate the existence of one cointegrated vector between the variables.

After determining the existence of one coitegrated vector, the exogeneity of the variables was tried to be identified. The results of the weak exogeneity test of the variables are presented in the Table.

Table 12: Weak Exogeneity Texts Results of the Variables

Exogenous Variable	χ^2 Test Statistics	Decision
Value Added	23.42156*	Exogenous
Consumption	53.43638*	Exogenous

Note: showing that the zero hypothesis claiming that it is not weak exogenous at 5% significance level is rejected.

Depending on the results obtained from the weak exogeneity test, it was understood that both of the variables were weak exogenous variables at 5% significance level. According to these results, one cointegrated vector, value added and consumption variables can be explained in two different ways as long-term models, where each of them is an exogenous variable. The obtained long terms models are as follows:

$$ValueAdded = 16.112 + 0.848 Consumption$$

$$(SE) \qquad (0.317) \quad (0.030)$$

$$t \qquad\qquad 50.751 \quad 27.456$$

$$Consumption = -18.990 + 1.178 ValueAdded$$

$$(SE) \qquad (1.281) \quad (0.051)$$

$$t \qquad\qquad -14.816 \quad 23.077$$

When the long-term models are examined, it is seen that the consumption variable is effective on the value added variable because the obtained t values are higher than the t table value at 5% significance level. 1% increase in consumption increases the value added by 0.84%. In addition, Value Added variable has an effect on consumption. 1% increase in Value Added increases Consumption by 1.17%. On the other hand, error correction models (short-term models) could not be predicted as the delay length was determined as 0 by Akaike Information Criterion (AIC). For the short-term relationship between the variables, no results was obtained.

Conclusion

This study explains the economical effect of electricity consumption on value added basis. For this purpose, the relationship between the consumed electricity and industry value added for the period of 1970-2015 by using Johansen cointegration test and error correction model. According to the findings of the study, there does not exist a short-term relationship between industry electricity consumption and value added in Turkey while there exists a bidirectional relationship between the variables in the long-term. This result indicates that the industry development of Turkey in the long-term has increased the consumption of electricity. The increase in electricity consumption is higher than that of the industry value added. On the other hand, the results show that electricity consumption promotes an increase in industry value added in the long term. The industry electricity consumption increase is less than that of the industry value added in the long term. In this respect, it will be significant to take this close relationship into

consideration while planning the development plans of Turkey as well as providing the required resources for the sector.

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