LONG TERM ELECTRICAL SUPPLY-DEMAND BALANCE OF TURKEY (2013-2023)

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ABSTRACT

LONG TERM ELECTICAL SUPPLY-DEMAND BALANCE OF TURKEY
(2013-2023)

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In this thesis long term supply demand balance of Turkey is studied. Initially long term electrical energy demand and peak power demand forecasts are made. For forecasting, two different methods are used. First method is Artificial Neural Network (ANN), and second method is Time Series Method. Then electrical energy demand forecast by sector is done. Finally by considering the construction times of new generation plants, electrical energy production capacity and peak power production capacity projections are done. By comparing the capacity projection with demand forecast, long term supply demand balance of Turkey is examined.

Keywords: Artificial Neural Network, Time Series, Long Term Electrical Energy Demand Forecast, Electrical Energy Production Capacity Projection, Long Term Electrical Supply Demand Balance

ÖZ

TÜRKİYE'NİN UZUN VADELİ ELEKTRİK ARZ-TALEP DENGESİ
(2013-2023)

Polater, Hüseyin Murat
Yüksek Lisans, Elektrik ve Elektronik Mühendisliği Bölümü
Tez Yöneticisi: Prof. Dr. Osman Sevaioğlu

Temmuz 2013, 138 sayfa

Bu tezde Türkiye'nin uzun vadeli elektrik arz talep dengesi incelenmiştir. İlk olarak uzun vadeli elektrik enerji talebi ve puant güç talebi tahminleri yapılmıştır. Tahmin yöntemi olarak iki farklı yöntem kullanılmıştır. Bu yöntemlerden birincisi Yapay Sinir Ağları, ikincisi Zaman Serileri yöntemidir. Daha sonra sektörel bazda elektrik enerjisi tüketim tahmini yapılmıştır. Son olarak yeni santrallerin inşa süreleri göz önüne alınarak, elektrik enerjisi üretim ve puant güç üretim kapasiteleri projeksiyonu çıkarılmıştır. Talep tahminleri ile üretim projeksiyonları kıyaslanarak Türkiye'nin uzun vadeli elektrik arz talep dengesi incelenmiştir.
Anahtar Kelimeler: Yapay Sinir Ağları, Zaman Serileri, Uzun Vadeli Elektrik Enerjisi Talep Tahmini, Elektrik Enerjisi Üretim Kapasitesi Projeksiyonu, Uzun Vadeli Elektrik Arz Talep Dengesi

To My Family

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TABLE OF CONTENTS

LIST OF FIGURES

FIGURES

LIST OF TABLES

TABLES

CHAPTER 1

INTRODUCTION

In this chapter historical development of Turkish Electricity Market will be explained. Then overview of the market reforms will be given. In second and third chapters forecasting methods will be explained. Finally future electricity energy demand and peak power demand of Turkey until 2023 will be forecasted by using Artificial Neural Network (ANN) and Auto Regressive Integrated Moving Average (ARIMA) modeling, and then forecasting results will be compared with the electricity generation capacity of Turkey until 2023.

1.1 General Overview of Turkish Electricity Market

In Turkey before 1990s electricity market was dominated by a public owned company TEK. After 1993 TEK was separated into TEDAS for distribution and TEAS for generation, transmission and wholesale. In 2001 Electricity Market Law was accepted and TEAS divided into three groups; TEIAS for transmission, TETAS for trading, EUAS for generation [1]. In Figure 1 historical development of Turkish Electricity Market is shown. In Figure 2 current Turkish Electricity Market structure is shown.

According to the data from TEIAS, total installed capacity of Turkey is 57.072MW by 31 December 2012 [3]. Public company EUAS is dominating the market but its percentage keeps falling as the private companies joining to the market. In Table 1 installed capacity of Turkish electricity generation by companies is shown.

In Table 2 installed capacity by resources is shown [3]. % 61,4 of total installed capacity of Turkey is dependent on thermal resources. In 2012 according to the data from TEIAS % 43,2 of the total electricity production was made from natural gas [3]. In Table 3 total electricity production in 2012 by resources is shown.

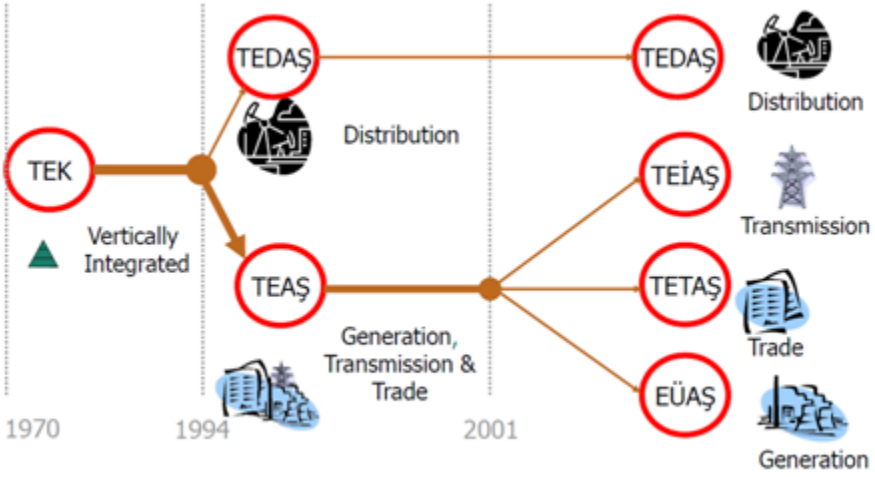

Figure 1. Historical Development of Turkish Electricity Market [2]

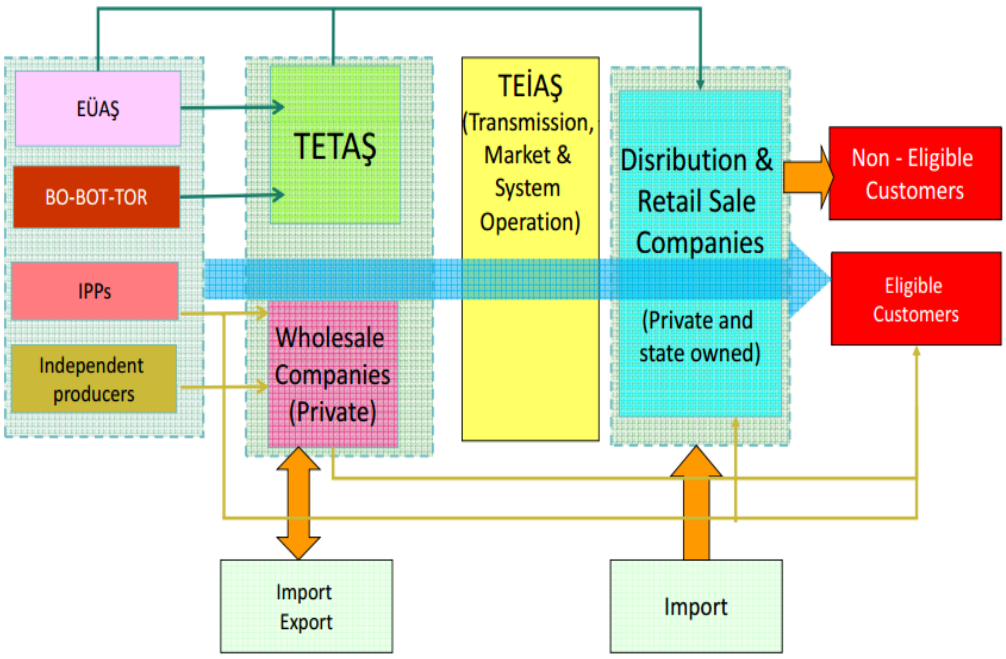

Figure 2. Turkish Electricity Martket Structure [28]

Table 1. Installed Capacities of Generation Companies (31 December 2012) [3]

Company	Installed Capacity (MW)	Installed Capacity (%)
EUAS	20.904,80	36,6
EUAS Affiliates	3.870,00	6,8
Transfer of Operation Rights	747,7	1,3
Build - Operate	6.101,80	10,7
Build - Operate - Transfer	2.419,80	4,2
Independent Generation Companies	19.823,00	34,7
Autoproducers	3.204,40	5,6
Total	**57.071,50**	**100**

Table 2. Installed Capacity by Resources (31 December 2012) [3]

Source	Installed Capacity (MW)	Installed Capacity (%)
Natural Gas + LNG	17.164	30,1
Coal	12.395	21,7
Thermal-other	5.470	9,6
Hydro	19.620	34,3
Wind	2.261	4,0
Geothermal	162	0,3

Table 3. Electricity Production by Resources in 2012 [3]

Source	Production (%)
Natural Gas	43,2
Coal	27,2
Thermal-Other	2,6
Hydro	24,2
Wind	2,4
Geothermal	0,4

1.2 Planning in Electrical Energy

Energy is the one of the key parameters of economical development, especially for developing countries. Electrical energy has higher importance in the era of technology. Electrical energy cannot be stored; it should be produced by the same amount as it's consumed in real time. This is called supply demand balance. To satisfy supply demand balance in real time and under all system operation conditions, always sufficient amount of spare generation, transmission and distribution capacity should exist for sudden, unexpected faults in the system [4]. For quality of electricity, supply demand balance is very important because system frequency which is an important parameter for quality of electricity is determined by supply demand balance.

In planning and installing of electrical energy systems there are two important factors. There should be enough capacity for generation, transmission and distribution for maximum power consumption. In the case of any unexpected faults in the system, there should be spare generation, transmission and distribution reserves to prevent blackouts. These can be done only be the help of correct load forecasting.

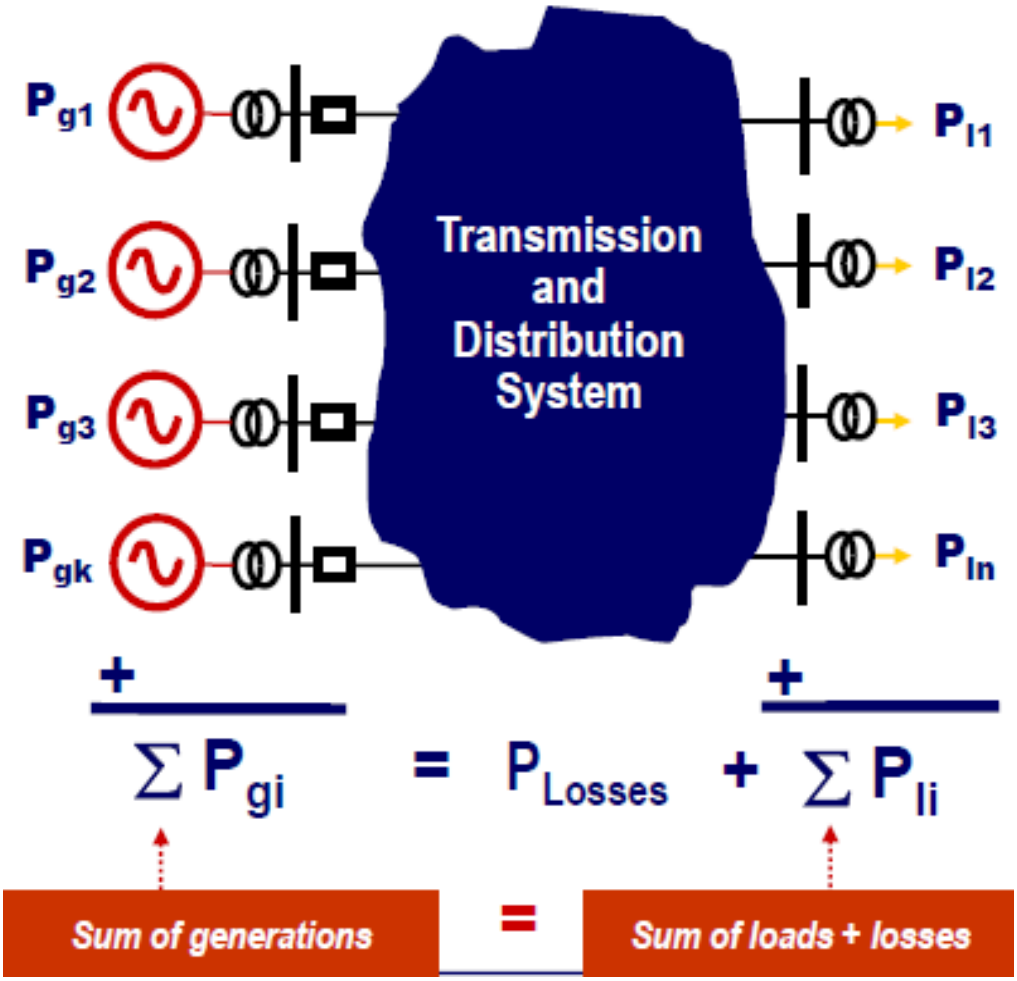

Figure 3. Supply Demand Balance [4]

Turkish electricity market is one of the fastest growing energy markets in the world. By 2012, electricity consumption in Turkey per capita is 3.199kWh[1]. Turkey's consumption per capita is above the world average but almost one third of the average consumption in OECD member countries. On the other hand the rate of increase in electrical energy consumption in Turkey is very high compared to the world average and average of developed countries [2]. Average increase of the electrical energy consumption is almost %5,5. As industrialization and urbanization increase the consumption will increase and there will be need for new investments on generation, transmission, and distribution. In Table 4 development of energy and peak power demand is shown.

[1] OECD-member countries average 8.486kWh, worldwide average 2.782kWh

Table 4. Development of Electrical Energy and Peak Power Consumption [3]

	Peak Power Demand		**Energy Demand**	
Years	**MW**	**Incr (%)**	**TWh**	**Incr (%)**
2001	19.612	1,1	126,8	-1,1
2002	21.006	7,1	132,5	4,5
2003	21.729	3,4	141,1	6,5
2004	23.485	8,1	150,0	6,3
2005	25.174	7,2	160,8	7,2
2006	27.594	9,6	174,6	8,6
2007	29.249	6,0	190,0	8,8
2008	30.517	4,3	198,1	4,2
2009	29.870	-2,1	194,1	-2,0
2010	33.392	11,8	210,4	8,4
2011	36.122	8,2	230,3	9,4
2012	39.045	8,1	241,9	5,0
Average		6,06		5,48

In Turkey planning and estimation of future electric load demand by using modern statistical methods started in 1984. World Bank recommended MENR to use the simulation model MAED (Model for Analysis Energy Demand) which is developed by IAEA (International Atomic Energy Agency) for predicting the future energy and electricity demand. MAED makes medium term and long term forecasts by taking economical, social, technological inputs about the country [5].

MENR has made forecast for peak power demand and energy demand until 2021 according to two scenarios (high consumption, low consumption). According to the high consumption scenario, the average demand will increase % 7,5 annually, according to the low demand scenario average demand will increase %6,5 annually [6]. In Table 5 and Table 6 high and low demand scenarios are presented.

Table 5. High Demand Scenario Prediction of MENR [6]

Years	Peak Power Demand		Energy Demand	
	MW	Incr (%)	GWh	Incr (%)
2012	38.000	5,2	244.026	6,0
2013	41.000	7,9	262.010	7,4
2014	43.800	6,8	281.850	7,6
2015	46.800	6,8	303.140	7,6
2016	50.210	7,3	325.920	7,5
2017	53.965	7,5	350.300	7,5
2018	57.980	7,4	376.350	7,4
2019	62.265	7,4	404.160	7,4
2020	66.845	7,4	433.900	7,4
2021	71.985	7,7	467.260	7,7

Table 6. Low Demand Scenario Prediction of MENR [6]

Years	Peak Power Demand		Energy Demand	
	MW	Incr (%)	GWh	Incr (%)
2012	38.000	5,2	244.026	6,0
2013	40.130	5,6	257.060	5,3
2014	42.360	5,6	273.900	6,6
2015	44.955	6,1	291.790	6,5
2016	47.870	6,5	310.730	6,5
2017	50.965	6,5	330.800	6,5
2018	54.230	6,4	352.010	6,4
2019	57.685	6,4	374.430	6,4
2020	61.340	6,3	398.160	6,3
2021	65.440	6,7	424.780	6,7

According to the demand forecast made by MENR, TEIAS makes generation capacity projection to guide market participants for installing new generators. TEIAS developed two scenarios according to rate of progress of constructions of new plants. In Scenario 1, operation date of the projects whose rate of progress is less than %10 and operation date of the projects which did not give any information about their progress rate are taken as uncertain. Operation date of the projects whose rate of progress is more than %70 is taken as 2012. For the projects whose rate of progress is between %35-%70, operation date is assumed as follows:

- If the capacity of the plant is less than 100MW, operation date is taken as 2013
- If the capacity of the plant is between 100MW-1000MW, operation date is taken as 2014
- If the capacity of the plant is more than 1000MW, operation date is taken as 2015

For the projects whose rate of progress is between %10-%35 one year is added to the operation dates above [6].

For the Scenario 2, the same methodology as in the Scenario 1 is used but the limit %10 is increased to %15, the limit %35 is increased to %40, the limit %70 is increased to %80 [6]. The total production capacity of uncertain projects is divided into five and equally added to production capacity of final five year period.

In Table 7-10 Turkey's installed power capacity against peak power demand according to various scenarios is shown. In Table 11- 14 Turkey's reliable energy production capacity against energy demand according to various scenarios is shown.

Table 7. Installed Power Capacity (High Demand-Scenario 1)[2] [6]

Year	Peak Power Demand (MW)	Installed Capacity (MW)	Reserve (%)
2013	41.000	59.292	44,6
2014	43.800	64.288	46,8
2015	46.800	71.993	53,8
2016	50.210	76.821	53,0
2017	53.965	81.237	50,5
2018	57.980	84.285	45,4
2019	62.265	88.113	41,5
2020	66.845	91.941	37,5
2021	71.985	95.769	33,0

[2] MENR's high demand scenario for power demand and TEIAS's Scenario 1 for installed capacity

Table 8. Installed Power Capacity (High Demand-Scenario 2)[3] [6]

Year	Peak Power Demand (MW)	Installed Capacity (MW)	Reserve (%)
2013	41.000	58.436	42,5
2014	43.800	62.516	42,7
2015	46.800	67.307	43,8
2016	50.210	72.686	44,8
2017	53.965	77.971	44,5
2018	57.980	84.002	44,9
2019	62.265	87.924	41,2
2020	66.845	91.847	37,4
2021	71.985	95.769	33,0

Table 9. Installed Power Capacity (Low Demand-Scenario 1)[4] [6]

Year	Peak Power Demand (MW)	Installed Capacity (MW)	Reserve (%)
2013	40.130	59.292	47,8
2014	42.360	64.288	51,8
2015	44.955	71.993	60,1
2016	47.870	76.821	60,5
2017	50.965	81.237	59,4
2018	54.230	84.285	55,4
2019	57.685	88.113	52,7
2020	61.340	91.941	49,9
2021	65.440	95.769	46,3

[3] MENR's high demand scenario for power demand and TEIAS's Scenario 2 for installed capacity

[4] MENR's low demand scenario for power demand and TEIAS's Scenario 1 for installed capacity

Table 10. Installed Power Capacity (Low Demand-Scenario 2)[5] [6]

Year	Peak Power Demand (MW)	Installed Capacity (MW)	Reserve (%)
2013	40.130	58.436	45,6
2014	42.360	62.516	47,6
2015	44.955	67.307	49,7
2016	47.870	72.686	51,8
2017	50.965	77.971	53
2018	54.230	84.002	54,9
2019	57.685	87.924	52,4
2020	61.340	91.847	49,7
2021	65.440	95.769	46,3

Table 11. Reliable Energy Production Capacity (High Demand-Scenario 1)[6] [6]

Year	Energy Demand (GWh)	Installed Capacity (GWh)	Reserve (%)
2013	262.010	282.192	7,7
2014	281.850	296.234	5,1
2015	303.140	325.031	7,2
2016	325.920	349.516	7,2
2017	350.300	364.648	4,1
2018	376.350	383.148	1,8
2019	404.160	403.665	-0,1
2020	433.900	427.942	-1,4
2021	467.260	460.156	-1,5

[5] MENR's low demand scenario for power demand and TEIAS's Scenario 2 for installed capacity

[6] MENR's high demand scenario for electrical energy demand and TEIAS's Scenario 1 for reliable energy production

Table 12. Reliable Energy Production Capacity (High Demand-Scenario 2)[7] [6]

Year	Energy Demand (GWh)	Installed Capacity (GWh)	Reserve (%)
2013	262.010	278.453	6,3
2014	281.850	291.837	3,5
2015	303.140	312.151	3
2016	325.920	331.249	1,6
2017	350.300	349.584	-0,2
2018	376.350	375.271	-0,3
2019	404.160	401.940	-0,5
2020	433.900	426.907	-1,6
2021	467.260	460.156	-1,5

Table 13. Reliable Energy Production Capacity (Low Demand-Scenario 1)[8] [6]

Year	Energy Demand (GWh)	Installed Capacity (GWh)	Reserve (%)
2013	257.060	282.192	9,8
2014	273.900	296.234	8,2
2015	291.790	325.031	11,4
2016	310.730	349.516	12,5
2017	330.800	364.648	10,2
2018	352.010	383.148	8,8
2019	374.430	403.665	7,8
2020	398.160	427.942	7,5
2021	424.780	460.156	8,3

[7] MENR's high demand scenario for electrical energy demand and TEIAS's Scenario 2 for reliable energy production

[8] MENR's low demand scenario for electrical energy demand and TEIAS's Scenario 1 for reliable energy production

Table 14. Reliable Energy Production Capacity (Low Demand-Scenario 2)[9]

Year	Energy Demand (GWh)	Installed Capacity (GWh)	Reserve (%)
2013	257.060	278.453	8,3
2014	273.900	291.837	6,5
2015	291.790	312.151	7
2016	310.730	331.249	6,6
2017	330.800	349.584	5,7
2018	352.010	375.271	6,6
2019	374.430	401.940	7,3
2020	398.160	426.907	7,2
2021	424.780	460.156	8,3

According to MENR and TEIAS scenarios there will be lack of supply form the point of reliable energy starting from 2017. Since construction time of plants is between 3-5 years, from now on precautions should be taken. New generators should start production form 2017 [6].

On the other hand demand forecast of MENR has been criticized because of the fact that the older estimates are excessively overestimated. Some argue that model which is used by MENR is not suitable for Turkey or electricity demand may be shown higher than the nominal values to justify the construction of new natural gas plants [7]. In Table 15 deviations of electrical energy forecasts made by MENR from real electrical energy consumptions are shown [6].

[9] MENR's low demand scenario for electrical energy demand and TEIAS's Scenario 2 for reliable energy production

Table 15. Deviations of MENR's Forecast from Real Energy Consumption (%) [6]

Year	PROJECTION ERRORS (%)					
	1990	1990/2	1993	1994	1996	2000
1989	0	0				
1990	-0,5	0				
1991	12,7	12,7				
1992	12,1	12,1				
1993	13,2	13,2	-2,3			
1994	18	18	3,3	4,1		
1995	18,4	8,8	3,4	2		
1996	16,7	6,3	2,1	-0,2		
1997	14,3	3,6	0,5	-2,8	-0,2	
1998	15,4	3,9	1,8	-2,5	-0,2	
1999	21,1	8,4	7,3	1,5	4,4	0
2000	22	8,6	8,6	1,6	4,7	-1,2
2001	32,4	18,8	18,8	11	15,2	9,4
2002	35,9	23,1	23,1	14,4	19,2	14,2
2003	37	25,2	25,2	15,8	21	17
2004	38,3	27,5	27,5	17,3	23,1	20
2005	38,5	28,8	28,8	17,9	24,1	22,3
2006	37,4	28,4	28,4	16,7	23,3	22,1
2007	36,1	27,7	27,7	15,2	22	21,6
2008	40,7	32,7	32,7	18,7	26,1	26,6
2009	54,6	46,6	46,6	30,1	38,6	40
2010	53,7	46,3	46,3	29	37,7	40

From Table 15 it's seen that critiques are right. Even the forecast made by MENR in 2000 for 2010 is deviated from the real consumption in 2010 by %40. This causes overinvestment and construction of thermal generators to supply the urgent need of energy in short time.

Furthermore TEIAS is suggesting constructing of thermal generators more than wind generator and hydroelectric generators to increase the reliable production. TEIAS asserts that the capacity required for wind and hydroelectric generators to give the same amount of reliable energy with the thermal generators is two times higher [6].

In Table 16 world electricity generation by resources is shown [8]. When we compare the fuel shares of the world average with full shares of Turkey, it's seen that Turkey's natural gas consumption (%43,2 in 2012) is almost two times more than the world average (%21,3). Turkey does not have natural gas resources and highly dependent on import. Overestimation on the electricity energy demand increases Turkey's dependency on energy imports. Turkey imports %92 of its oil and %98 of its gas, this causes threats against Turkish energy security. Turkey spent $54 billion for oil and gas imports in 2011 which is %22 of total Turkey's import payments [9].

Table 16. World Electricity Generation by Sources [8]

Source	Production (%)
Gas	21,3
Coal	41,0
Nuclear	13,5
Hydro	15,9
Oil	5,5
Other	2,8

Turkey imports natural gas from five different countries. In 2011 Turkey imported %57 of total gas from Russia, %18 from Iran, %9 from Algeria and Azerbaijan, %3 from Nigeria. Local production is only %2 of total consumption in 2011. It's seen that Turkey is highly dependent on Russia, who supplies %57 of Turkey's natural gas. This creates serious problems for Turkish energy security. Furthermore according to the agreement between Republic of Turkey and Russian Federation, new nuclear plant will be installed in Turkey whose project will be owned by the Russian Federation. This project will increase dependency of Turkey on Russia [9].

Overestimation of gas demands also causes serious problems for Turkey. Turkey's estimated gas demand for 2010 was 55 billion cubic meters (bcm), but only 38bcm was consumed. Because of take or pay contracts, Turkey paid $4.6 billion to Iran, Russia and Azerbaijan during 2009, 2010 and 2011 [9].

In Turkey electricity price is highly dependent on gas prices. Because of this fact electricity price increases by rate of %88,8 from 2007 to 2011. In Table 17 the change in the electricity prices is shown [10]. This table clearly shows the danger of dependency on imported gas. As long as Turkey does not find new sources for generating electricity, electricity price will continue to rise up.

Table 17. Electricity Price [10]

	Price (Kr/kWh)	Incr (%)
December 2007	15,81	-
January 2008	18,9	19,5
July 2008	22,87	21
October 2008	24,69	7,9
January 2009	24,93	1
April 2009	24,53	-1,6
October 2009	26,93	9,8
January 2010	27,24	1,1
October 2011	29,85	9,6
Total Increase		88,8

Turkey has significant amount of local energy resources and most of these resources are renewable energy resources. In Table 18 some of the local energy resources and their capacities are shown. When we consider that Turkey's total electrical energy consumption in 2012 was 241,9TWh, it's seen that Turkey has enough resources to generate her electricity and most of these resources are renewable [9].

Table 18. Turkey's Indigenous Resources [9]

Resource	Yearly Generation (TWh)
Hydro	100
Lignite	116
Wind	120
Geothermal	16
Solar	380
Biogas	35

Moreover Turkey can save a lot of source by increasing efficiency of transmission and distribution systems and preventing theft. In Figure 4 distribution losses by year in Turkey is shown. It's seen that average distribution loss in Turkey is more than %15. Compared to OECD average (% 7), and world average (%8), in Turkey system losses are extremely high [11]. In some regions of Turkey (east and south east) the loss rate is higher than %50. Turkey should urgently solve the theft problem in east and south east regions.

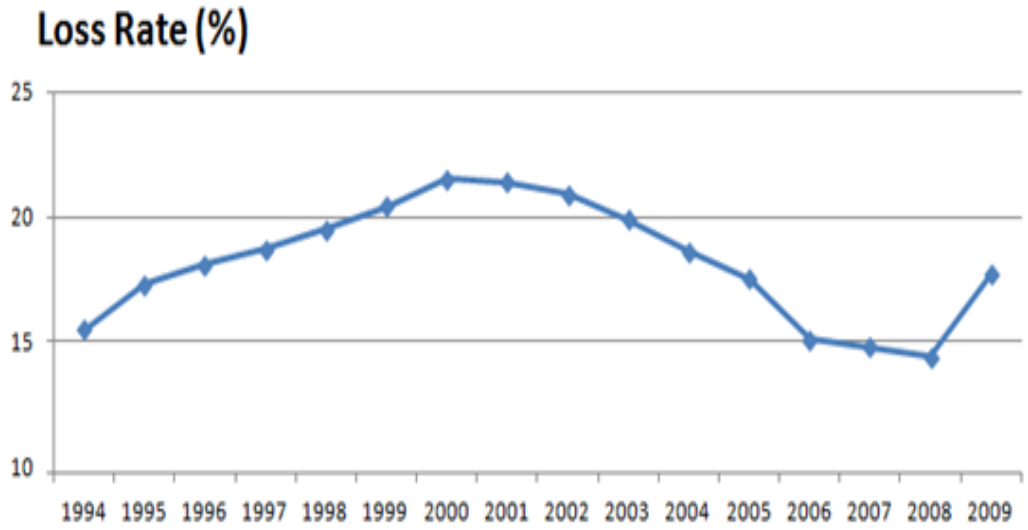

Figure 4. Distribution Losses in Turkey [11]

In energy sector before taking a decision, the effects of this action in long term should be considered carefully. Shortcuts to solve a problem in short term can cause serious problems in long run. Turkish Government in 1994 and 1997 took some decisions to increase the private sector participation. TEAS signed contracts with private investors on BOT (build operate transfer) and BO (build operate) plants. These contracts provide take or pay obligation which is guaranteed by Treasury within a time period from 15 to 30 years [12]. Because of these contracts, the private investors do not have any commercial risk. If the effectiveness of a generation plant is increased, investors will earn extra money but this will not provide any benefit to the consumers because of the take of pay contracts in which the price of the electricity is calculated by a formula. All in all it's understood that take or pay contracts have a negative influence on a fair competitive market, and these contracts are the one of the biggest problems in Turkish Electricity Market.

Moreover political influence on the electricity market until the year 2006 caused the absence of price signals for the new investments. In an electricity market, price of the electricity should be determined from aggregating supply demand curve. Point where the supply curve crosses the demand curve gives the market price. As seen from the Figure 5 as demand increases, price increases. For demand Curve-2 in the Figure 5, generation becomes scarce and the price of the electricity increases, this mechanism gives messages for the new investments.

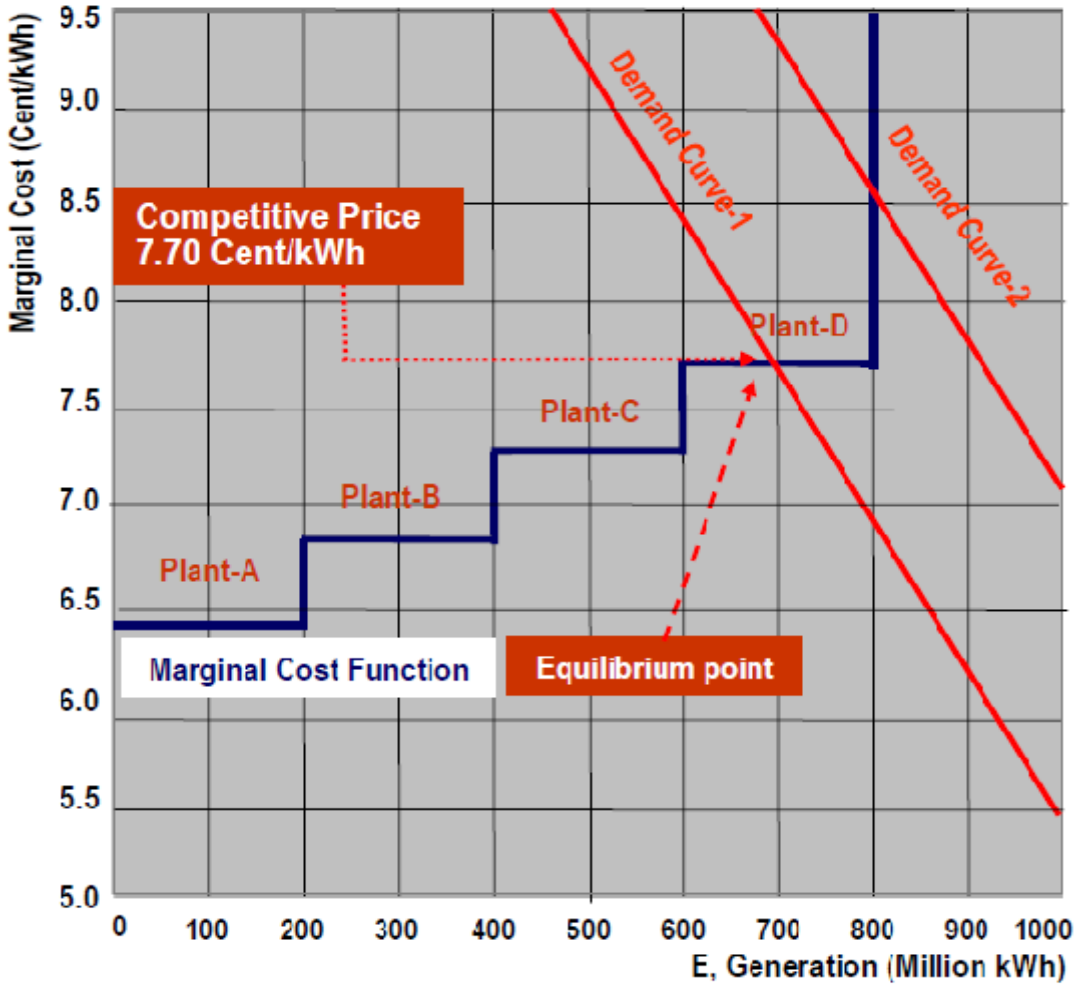

Figure 5. Marginal Cost in Electricity Markets [13]

In Turkey until 2006 (balancing market starts to work) all the prices in the system administratively determined [11]. In Figure 6, TEDAS industry tariff is shown. From the figure it's shown that until the year 2008, electricity price was kept constant. Although natural gas prices increased by almost %60 between June 2004 and August 2006, electricity retail prices remained constant. In Figure 7, ratio of electricity price to gas price is shown. Political influence on the electricity prices prevented the role of the price to give signal for new investments.

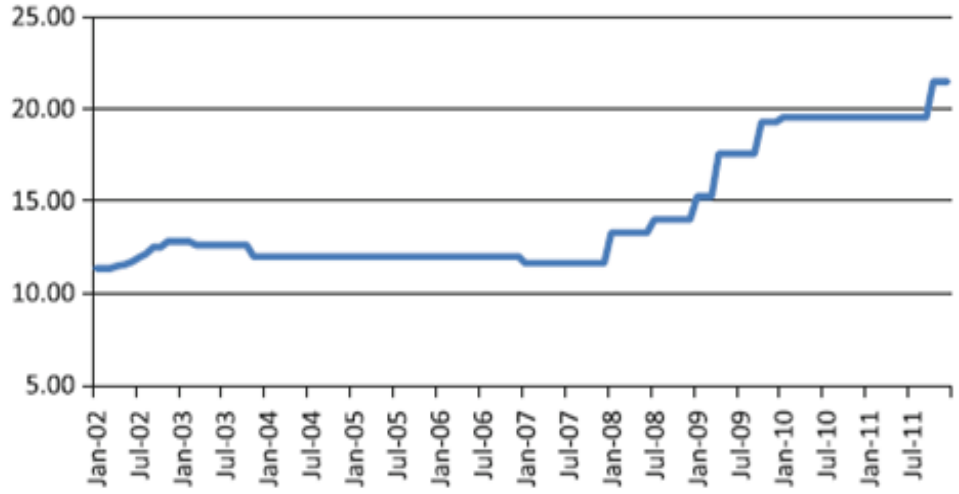

Figure 6. TEDAS Industrial Tariffs (Kr/kWh) [11]

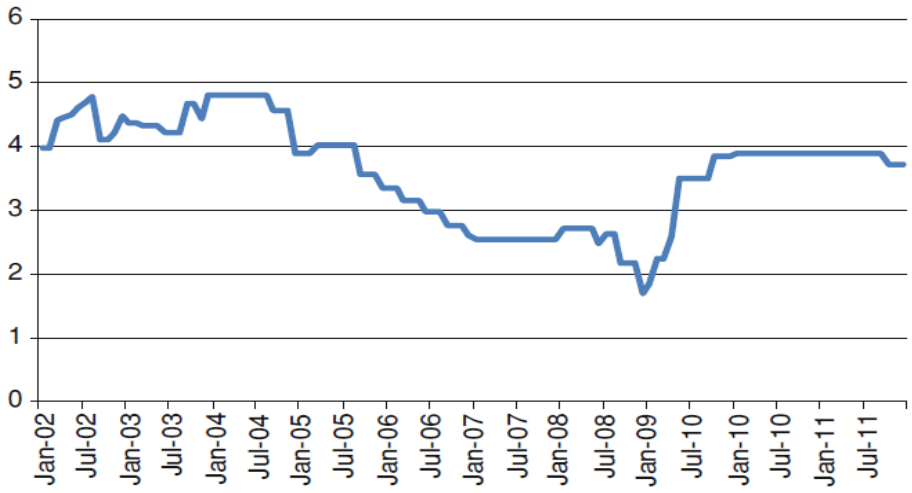

Figure 7. Ratio of TEDAS Retail Prices to Gas Coast [11]

In conclusion for electrical energy system, planning is very important. For energy security of Turkey and ensure a clean future to the next generation Turkey should make long term plans. The first step of long term plans is making a demand forecast for the next 10 years.

In this thesis, long term electrical energy demand and peak power demand forecasting until 2023 by using ANN and ARIMA [22] modeling will be done. Their results will be compared to increase the reliability of the forecast. Then electrical energy production and peak power production capacities will be investigated. The production capacities will be compared with the demand forecast, and is there a thread against supply demand balance of Turkey until 2023 will be understood.

CHAPTER 2

ARTIFICIAL NEURAL NETWORK METHOD

2.1 Artificial Neural Network

Artificial Neural Network is mathematical or computational model which is designed to simulate the operation of human brain. Artificial Neural Network consists of artificial neurons; these neurons are connected to each other in different forms. Artificial Neural Network (ANN) has the ability of learning, it learns from examples as human brain. ANN can solve the problems which require the ability of thinking and making observations.

Learning process of ANN is similar to learning process of a human brain. In biological systems, learning takes place by adjusting of the synaptic connections that exist between the neurons. Similarly ANN adjusts the connecting weights in the learning process.

2.2 Brief History of Artificial Neural Network

McCulloch (neurobiologist) and Pitts (mathematician) developed an elementary mathematical model of a neuron in 1943. They found that a neuron has a threshold level and once that level is reached the neuron fires [15].

In 1949 Dr. Hebb published a book and he developed the first learning rule which is called Hebb's rule [14].

In 1958, Rosenblatt developed a model called perceptron. Perceptron is one layer artificial neural network. In the learning process of perceptron, weight adjustment method is used which is more effective than Hebb's learning rule.

In 1969 Minsky and Paper wrote a book and showed that perceptron has limitations. It can only solve problems which are linearly separable. They showed that perceptron cannot solve XOR problem which is not linearly separable.

Studies on neural network reduced because of limitations of perceptron. In 1986 Rumelhart and McClelland found back propagation algorithm for multilayer networks. It was found that multilayer networks can solve XOR problem and the other problems which are not linearly separable.

2.3 Properties of ANN

ANN has a lot of advantages on traditional methods. Because of these advantages ANN is used in many applications such as finance, engineering, medicine… Some of the advantages of ANN can be listed as below [16]:

- **Nonlinearity:** Most of the problems in real life are nonlinear. ANN has the ability of solving non linear problems. ANN is composed of non linear neurons. Interconnections of non linear neurons form Neural Network which is also non linear.
- **Parallel Structure:** Traditional systems use sequential information processing. Because of sequential processing, if one of the processing units is slow, this slows down the all process. ANN uses parallel processing therefore speed of one processing unit does not affect the speed of overall system very much.
- **Learning:** Learning process of ANN is similar to learning process of human brain. ANN learns from the examples. An example set of data is applied to ANN and ANN produces an output. This output is compared with target output and according to the error between output and target; the weights of synaptic connections are adjusted.
- **Generalization:** Once the ANN is trained with example data, it can make generalization and give correct solutions for the new data. By the help of this property ANN can be used in forecasting, signal processing and pattern recognition applications.
- **Fault Tolerance:** Traditional systems use sequential processing. If one of the units in the sequential system fails, this causes failure of the whole system. On the other hand ANN is composed of parallel distributed neurons. Even if the some neurons fail, this situation does not cause the failure of the whole system. Moreover ANN can work with noisy data. Effect of noisy data is distributed on the overall network and effect of the noise at the output is reduced.
- **VLSI Implementability:** Parallel structure of ANN can be realized with VLSI chips. By the help of this property, ANN can process data very fast and work in real time data processing applications.

Besides the advantages of ANN there are some disadvantages of using ANN. Some of these advantages are listed below:

- Finding the best structure of the network for solving a problem is made by try and error process. There is not exact method for choosing the best network structure.
- There is no guarantee for an optimum solution. ANN only finds a solution with an error rate lower than a defined limit.
- ANN only works with numerical data; the non-numeric data should be turned into numeric data.
- The behavior of the ANN cannot be explained. Some researchers see ANN as a black box [17].

2.4 Application Areas of ANN

ANN has a lot of application areas. Some of these areas can be listed as follows [18]:

- Pattern classification
- Clustering , categorization
- Function approximation
- Prediction, forecasting
- Optimization
- Control
- Signal filtering
- Non linear system modeling

2.5 Artificial Neuron Model

Artificial neuron is an information processing unit which is the fundamental part of a neural network. In Figure 8 the model of an artificial neuron is shown. An artificial neuron consists of five fundamental elements.

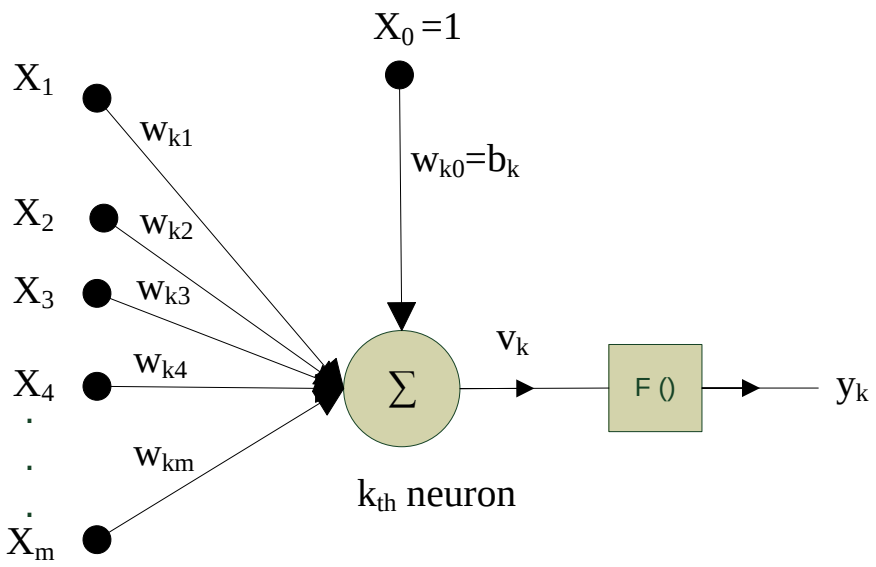

Figure 8. Model of an Artificial Neuron

- **Inputs:** X_1, X_2, X_3, …, X_m are the inputs to the neuron from outside world. X_0 is the bias signal which is equal to 1.
- **Synaptic Weights:** Input signals are multiplied with synaptic weights. The synaptic weight between X_0 and k_{th} neuron is shown as w_{k0}, between X_1 and k_{th} neuron as w_{k1}, and between X_m and k_{th} neuron as w_{km}, b_k is the synaptic weight of the bias signal.
- **Adder:** All inputs are multiplied by their synaptic weights and summed up as shown below:

$$v_k = \sum_{j=1}^{m} w_{kj} x_j + b_k \qquad \text{(Eq. 1)}$$

- **Activation Function:** Activation function (F) processes the output of adder (v_k) and produces output of the artificial neuron (y_k) as shown below:

$$y_k = F(v_k) \qquad \text{(Eq. 2)}$$

- **Output:** Output of the artificial neuron is determined by activation function. Output signal is send to the outside world or can be used as an input signal for another artificial neuron.

2.6 Types of Activation Function

There are different types of activation function which is used in artificial neurons as a processing unit. Activation function is selected according to the problem and structure of the artificial network. Some of the most common activation functions can be listed as follows [19]:

- **Linear Function:** Linear activation function is generally used in the output layers of the multilayer neural networks. Mathematical formula and the graph of linear activation function is as follows:

$$F(x) = x \qquad \text{(Eq. 3)}$$

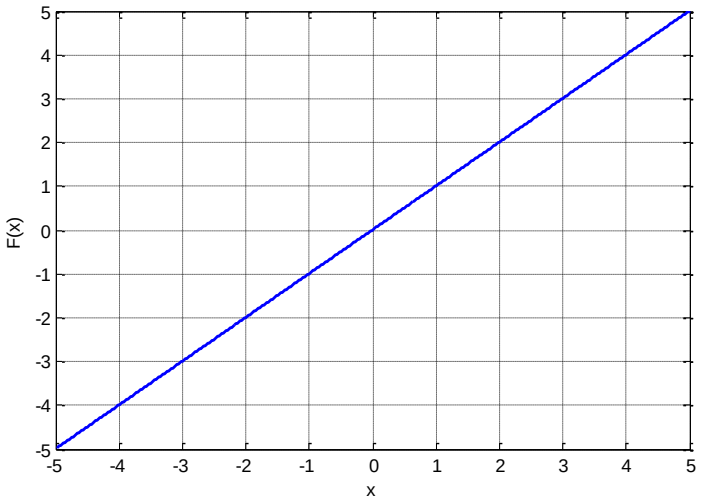

Figure 9. Linear Activation Function

- **Threshold Function:** Threshold activation function is generally used in single layer artificial neural networks. Mathematical formula and graph of threshold activation function is shown below:

$$F(x) = \begin{cases} 1 & \text{x} \geq 0 \\ 0 & \text{x} < 0 \end{cases} \qquad \text{(Eq. 4)}$$

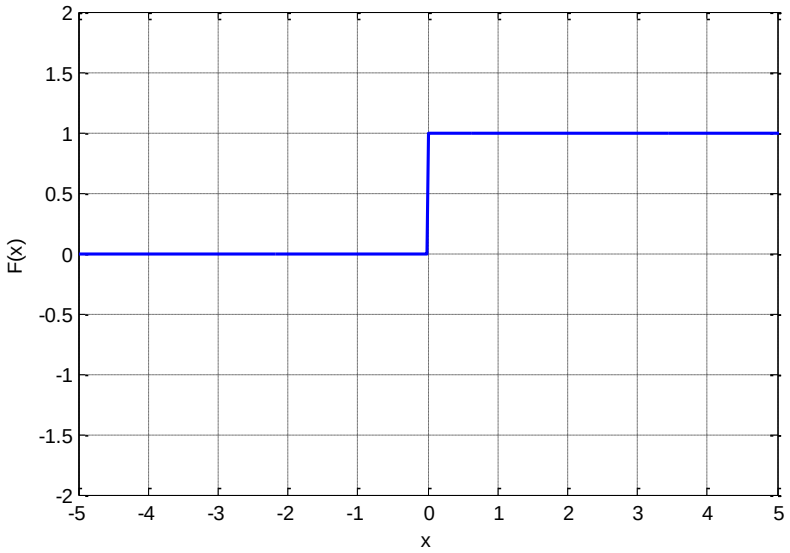

Figure 10. Threshold Activation Function

- **Sigmoid Function:** This function is generally used in hidden layers of the multilayer neural networks. It gives output between 0 and 1. Mathematical formula and graph of sigmoid activation function is shown below:

$$F(x) = \frac{1}{1+e^{-x}} \qquad \text{(Eq. 5)}$$

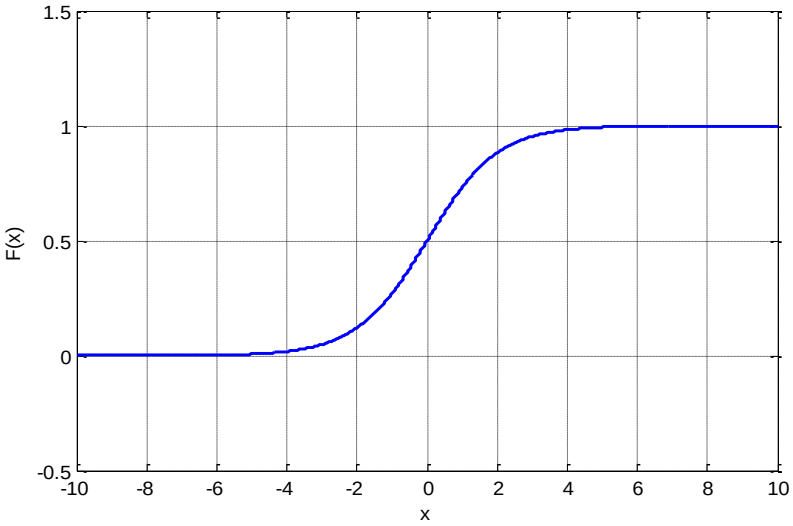

Figure 11. Sigmoid Activation Function

- **Hyperbolic Tangent Sigmoid Function:** This function is similar to sigmoid function. The only difference is that, it gives output value between -1 and 1. Mathematical formula and graph of this function is shown below:

$$F(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}} \qquad \text{(Eq. 6)}$$

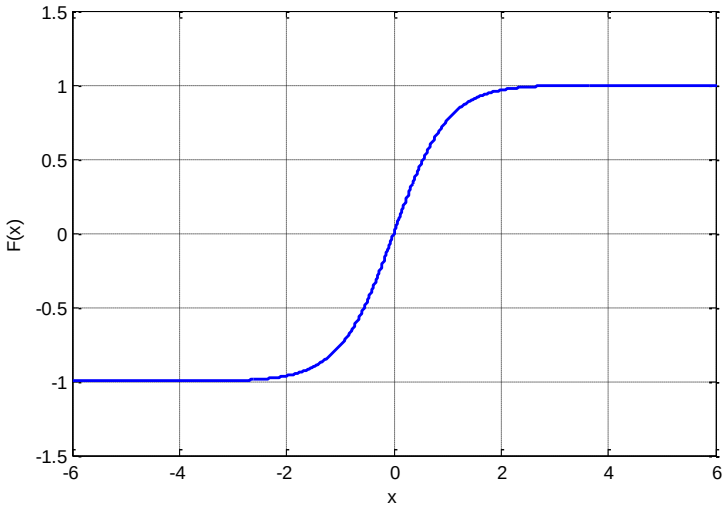

Figure 12. Hyperbolic Tangent Sigmoid Activation Function

2.7 Learning of a Neural Network

In a neural network the output of the neural network is a function of synaptic weights (W) and input signals (x). We can express output of the neural network (y) as in Equation 7:

$$y = F(W, x) \quad \text{(Eq. 7)}$$

Learning of a neural network is a systematic process of changing synaptic weights (W) so that neural network can perform a given task as pattern recognition, forecasting, classification, etc…

In a learning process, the input signals which will be used in training the network are called training set (S_{TR}). $S_{TR}= \{x^1,x^2,x^3,\ldots,x^N\}$ are the inputs which will be used in the learning process of the neural network. In the beginning of the learning process, the synaptic weights are assigned randomly. If W(1) is the initial weight, the output signal for x^1 will be as in Equation 8, then based on a learning criterion synaptic weights will be updated as in Equation 9. ΔW term in the Equation 9 is called learning rule. Then x^2 is applied to the network and y(2) is calculated as shown in Equation 10. This procedure is continues until all training set examples are applied to the network. This is called an epoch in learning. At the end of the epoch (Equation 11) we will obtain synaptic coefficients W(N). If W(N) does not satisfy performance criteria, another epoch will be started and synaptic coefficients will be updated again.

$$y(1) = F(W(1), x^1) \quad \text{(Eq. 8)}$$

$$W(2) = W(1) + \Delta W(1) \quad \text{(Eq. 9)}$$

$$y(2) = F(W(2), x^2) \quad \text{(Eq. 10)}$$

$$\vdots$$

$$y(N) = F(W(N), x^N) \quad \text{(Eq. 11)}$$

There are there fundamental learning methods in artificial neural network. They are supervised learning, unsupervised learning and reinforced learning methods.

2.7.1 Supervised Learning Rule

In this learning method, correct outputs are known (target outputs). Outputs of the neural network and target outputs are compared and error signal is generated. Synaptic weights are updated to minimize the error term. This process continues until error is reduced to an acceptable value. Other name of this learning method is learning with teacher. In Figure 13, supervised learning method is shown. Output of the network (O) is compared to the target output (t) and weights (W) are updated according to the error between output and target.

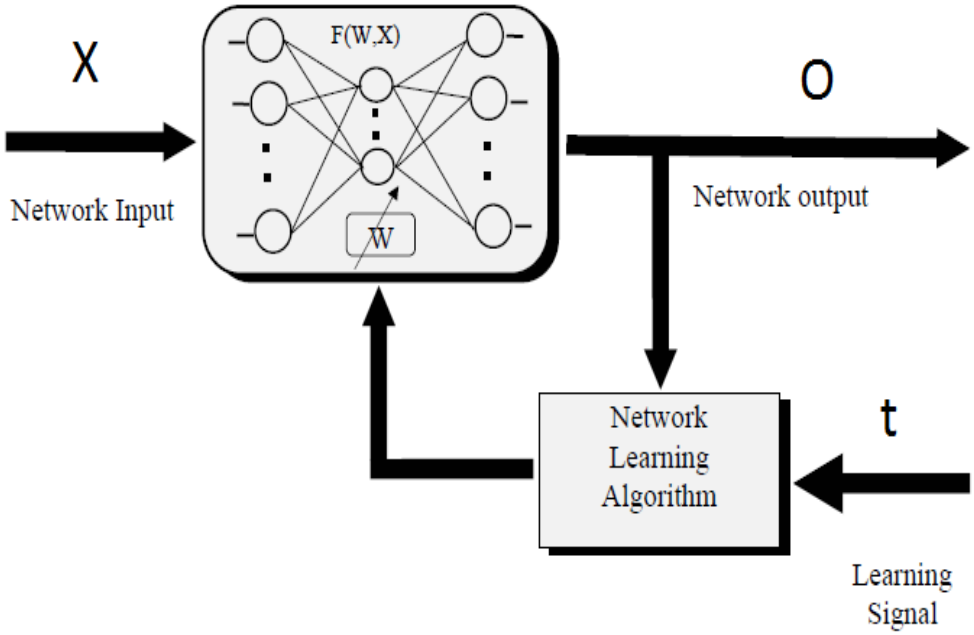

Figure 13. Supervised Learning Rule

2.7.2 Unsupervised Learning Rule

In this learning rule target output does not exist. Weights are updated in response to the input signals. Network learns from clustering input patterns. In Figure 14 the unsupervised learning rule is shown.

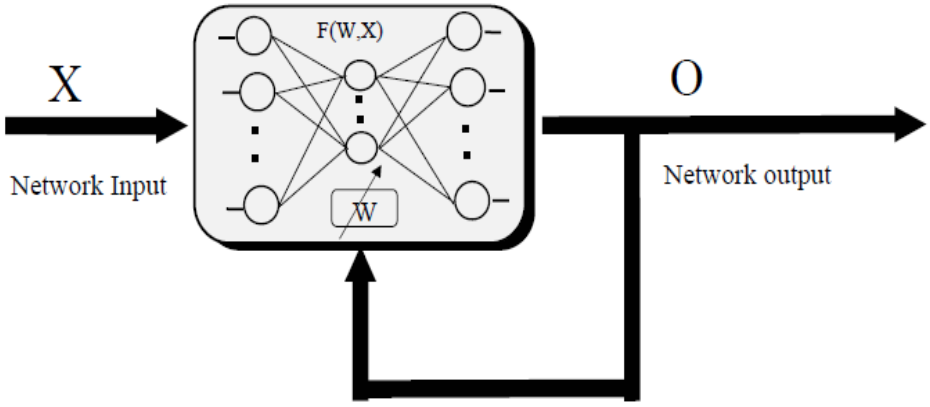

Figure 14. Unsupervised Learning Rule

2.7.3 Reinforced Learning Rule

In this learning method a teacher exist but teacher only gives information about the correctness of the calculated output. Correct answers are rewarded and the incorrect answers are punished.

2.8 Neural Network Architectures

There are three fundamental network architectures: Single layer feedforward, multilayer feedforward and recurrent networks.

2.8.1 Single Layer Feedforward Networks

In single layer feedforward network input signals are directly connected to the output signals via synaptic weights as shown in the Figure 15. Data flows from input to the output. In this type of network there is only input and output layer. Since calculations are made only at the output layer, this type of network is called single layer network.

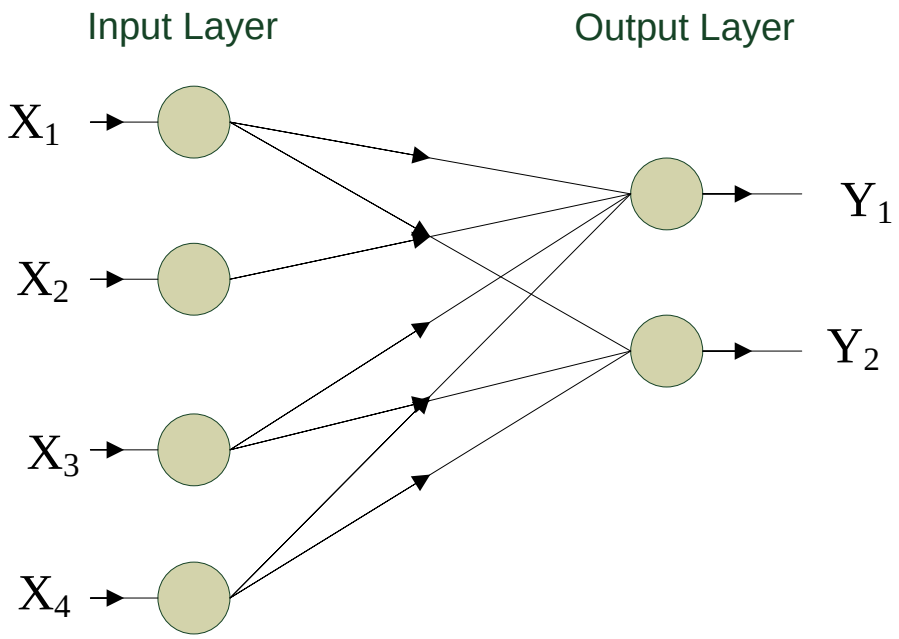

Figure 15. Single Layer Feedforward Network

2.8.2 Multi Layer Feedforward Networks

In multi layer neural networks there are one or more hidden layers between input and output layers. Hidden layer does intermediate computation before directing input signals to the output layer. Structure of multi layer feedforward networks is shown in Figure 16.

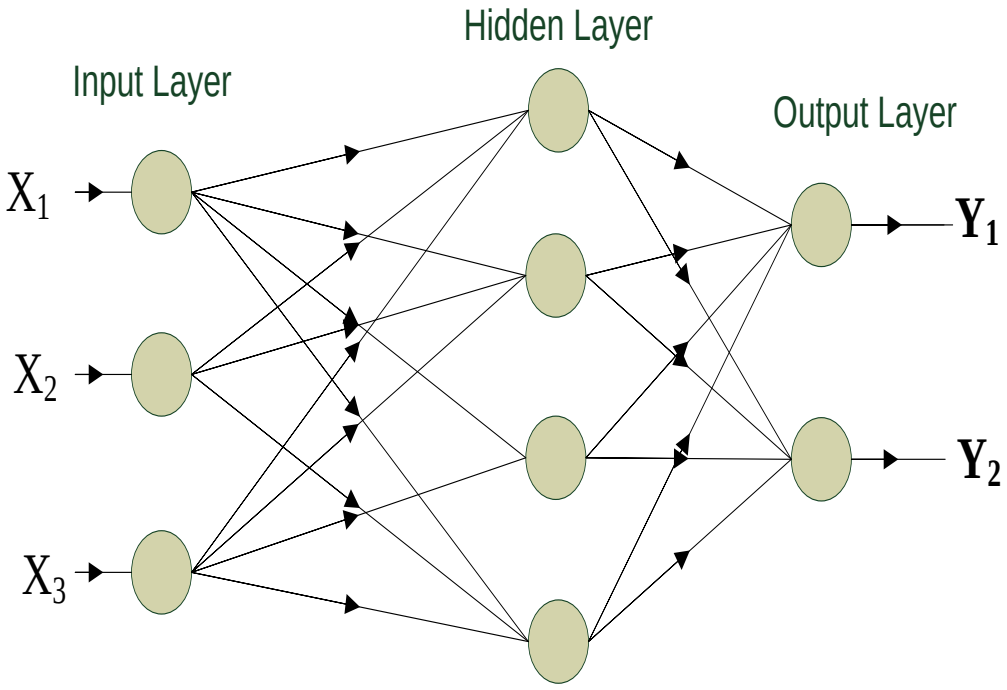

Figure 16. Multi Layer Feedforward Network

2.8.3 Recurrent Networks

Recurrent networks have at least one feedback loop. Output of the network can be used as input in this type of network. Structure of recurrent networks is shown in Figure 17.

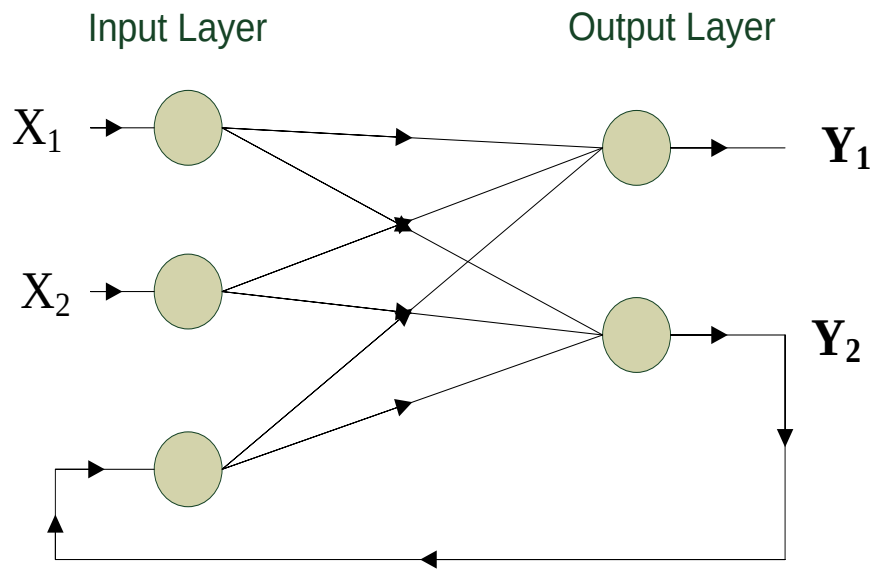

Figure 17. Recurrent Networks

2.9 Back Propagation Algorithm

Multi layered feedforward neural networks use supervised learning rule. In this type of learning correct outputs are known. For learning process of multilayered neural networks, back propagation algorithm is used. In back propagation algorithm there are two passes of calculation: forward pass and backward pass. In forward pass an input signal from example set is applied to the network and the output of network is calculated. In backward pass the synaptic weights are updated according to the error term.

Assume that we have a train set $S_{TR}= \{x^1,x^2,\ldots,x^N\}$ and we have target outputs $\{t^1,t^2,\ldots,t^N\}$. These are both vectors. Assume that at the output layer we have R neurons. In backward pass firstly the synaptic weights between output layer and hidden layer are updated then the weights between hidden layer and input layer are updated. In Figure 18 the j_{th} output neuron and the connections between the j_{th} output neuron and hidden layer neurons are shown.

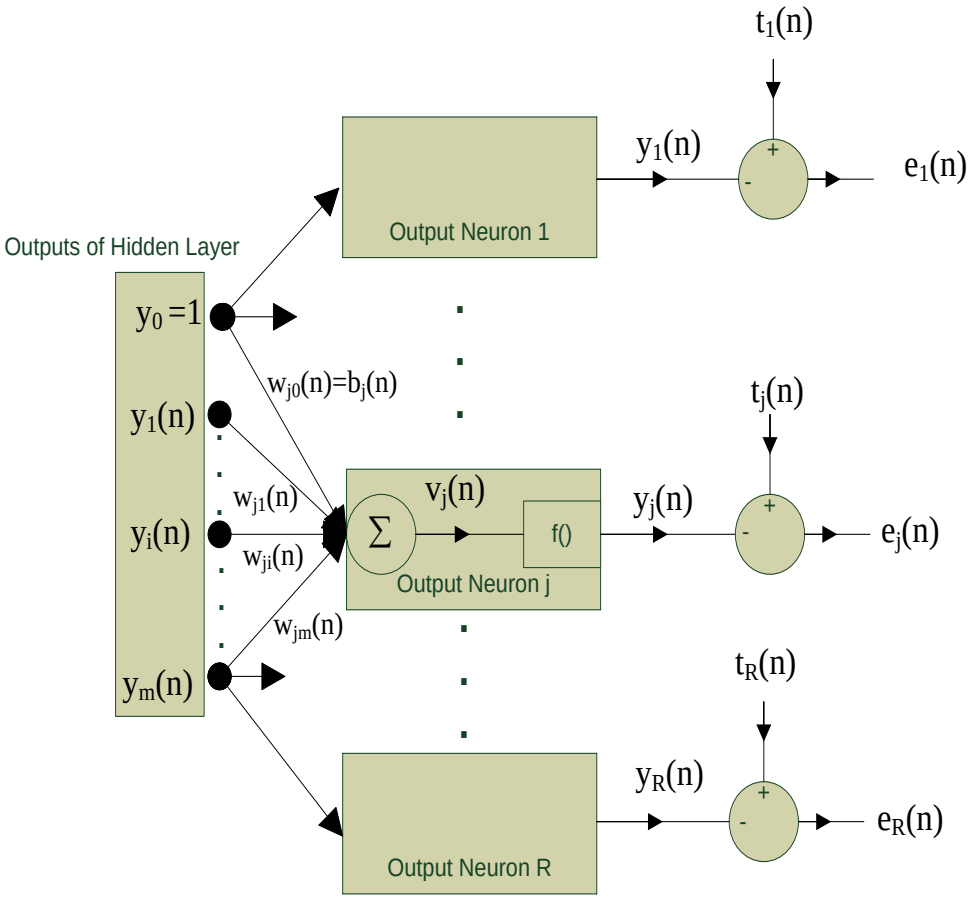

Figure 18. Connections Between j_{th} Output Neuron and Hidden Layer Neurons

For the j_{th} output neuron, error term can be calculated as in Equation 12. Error energy can be calculated as in Equation 13. To find $\Delta w_{ji}(n)$, we need to calculate Equation 14 where "η" is the learning rate which is a small number [20].

$$e_j(n) = t_j(n) - y_j(n) \quad \text{(Eq. 12)}$$

$$E(n) = \frac{1}{2}\sum_{j=1}^{R} e_j^2(n) \quad \text{(Eq. 13)}$$

$$\Delta w_{ji}(n) = -\eta \frac{\partial E(n)}{\partial w_{ji}(n)} \quad \text{(Eq. 14)}$$

To calculate Equation 14, chain rule should be applied as Equation 15.Where $v_j(n)$ and $y_j(n)$ are shown in Equation 16 and Equation 17 respectively.

$$\frac{\partial E(n)}{\partial w_{ji}(n)} = \frac{\partial E(n)}{\partial e_j(n)} \cdot \frac{\partial e_j(n)}{\partial y_j(n)} \cdot \frac{\partial y_j(n)}{\partial v_j(n)} \cdot \frac{\partial v_j(n)}{\partial w_{ji}(n)} \quad \text{(Eq. 15)}$$

$$v_j(n) = \sum_{i=0}^{m} w_{ji}(n) y_i(n) \quad \text{(Eq. 16)}$$

$$y_j(n) = f(v_j(n)) \quad \text{(Eq. 17)}$$

By using Equation 12, Equation 13, Equation 16 and Equation 17; Equation 15 can be calculated as follows:

$$\frac{\partial E(n)}{\partial e_j(n)} = e_j(n) \quad \text{(Eq. 18)}$$

$$\frac{\partial e_j(n)}{\partial y_j(n)} = -1 \quad \text{(Eq. 19)}$$

$$\frac{\partial y_j(n)}{\partial v_j(n)} = f'(v_j(n)) \quad \text{(Eq. 20)}$$

$$\frac{\partial v_j(n)}{\partial w_{ji}(n)} = y_i(n) \quad \text{(Eq. 21)}$$

$$\frac{\partial E(n)}{\partial w_{ji}(n)} = -e_j(n) \cdot f'(v_j(n)) \cdot y_i(n) \quad \text{(Eq. 22)}$$

We can define local gradient as in Equation 23 and express $\Delta w_{ji}(n)$ in Equation 24.

$$\delta_j(n) = -\frac{\partial E(n)}{\partial v_j(n)} = e_j(n) \cdot f'(v_j(n)) \quad \text{(Eq. 23)}$$

$$\Delta w_{ji}(n) = \eta \cdot \delta_j(n) \cdot y_i(n) \quad \text{(Eq. 24)}$$

For calculating the Δw_{ji} term for the connections between the hidden layer and input layer we will use similar approach. In Figure 19 connections of j_{th} hidden layer neuron is shown. We need to calculate Δw_{ji} for the j_{th} hidden layer neuron and i_{th} input layer neuron.

Calculations start with calculating $\delta_j(n)$ as shown in Equation 25. By using chain rule on Equation 13, Equation 26 can be calculated.

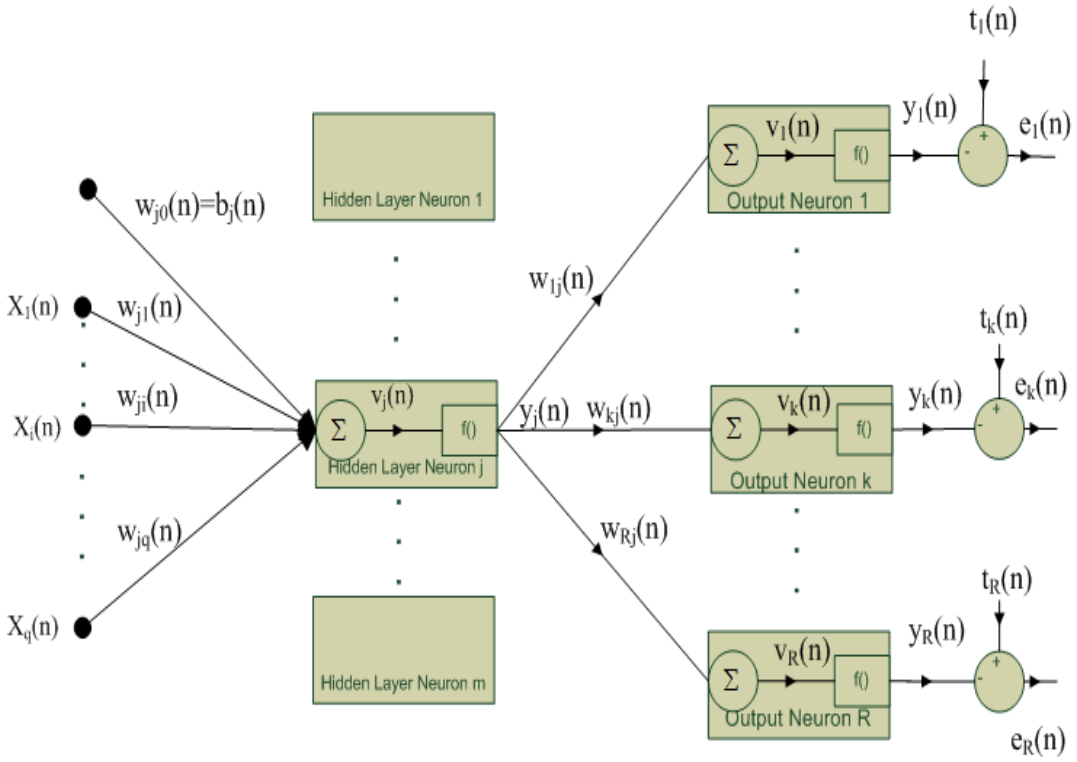

Figure 19. Connections of j_{th} Hidden Layer Neuron

$$\delta_j(n) = -\frac{\partial E(n)}{\partial v_j(n)} = -\frac{\partial E(n)}{\partial y_j(n)} \cdot f_j'(v_j(n)) \qquad \text{(Eq. 25)}$$

$$\frac{\partial E(n)}{\partial y_j(n)} = \sum_{k=1}^{R} e_k(n) \cdot \frac{\partial e_k(n)}{\partial v_k(n)} \cdot \frac{\partial v_k(n)}{\partial y_j(n)} \qquad \text{(Eq. 26)}$$

By calculating partial derivatives in Equation 26, Equation 27 can be calculated. Equation 27 can be simplified as in Equation 28. Now Equation 25 can be written as in Equation 29. $\Delta w_{ji}(n)$ term for the connections between hidden layer and input layer can be calculated as in Equation 30.

$$\frac{\partial E(n)}{\partial y_j(n)} = -\sum_{k=1}^{R} e_k(n) \cdot f_k'(v_k(n)) \cdot w_{kj}(n) \quad \text{(Eq. 27)}$$

$$\frac{\partial E(n)}{\partial y_j(n)} = -\sum_{k=1}^{R} \delta_k(n) \cdot w_{kj}(n) \quad \text{(Eq. 28)}$$

$$\delta_j(n) = f_j'(v_j(n)) \cdot \sum_{k=1}^{R} \delta_k(n) \cdot w_{kj}(n) \quad \text{(Eq. 29)}$$

$$\Delta w_{ji}(n) = \eta \cdot \delta_j(n) \cdot x_i(n) \quad \text{(Eq. 30)}$$

We can apply the Equation 24 for updating the weights between output layer and hidden layer; Equation 30 for updating the weights between hidden layer and input layer. Sometimes an additional term is added to prevent the back propagation algorithm from stucking at local minima as shown in Equation 31. The "α" term in Equation 31 is called momentum constant. Its value should be between zero and one.

$$\Delta w_{ji}(n) = \alpha \cdot \Delta w_{ji}(n-1) + \eta \cdot \delta_j(n) \cdot y_i(n) \quad \text{(Eq. 31)}$$

CHAPTER 3

TIME SERIES METHOD

3.1 Time Series

A time series is a realization of a certain stochastic process. Data is usually collected at regular intervals. Data is set of observations and the observations are depended to each other. The observed data in the past can be used to forecast the future value of the data. In time series data can contain the following elements [22]:

- Trend : Long term movements in the mean
- Seasonal Effects: Monthly or seasonal fluctuations
- Cycles: Fluctuations period longer than one year
- Residuals: Random fluctuations

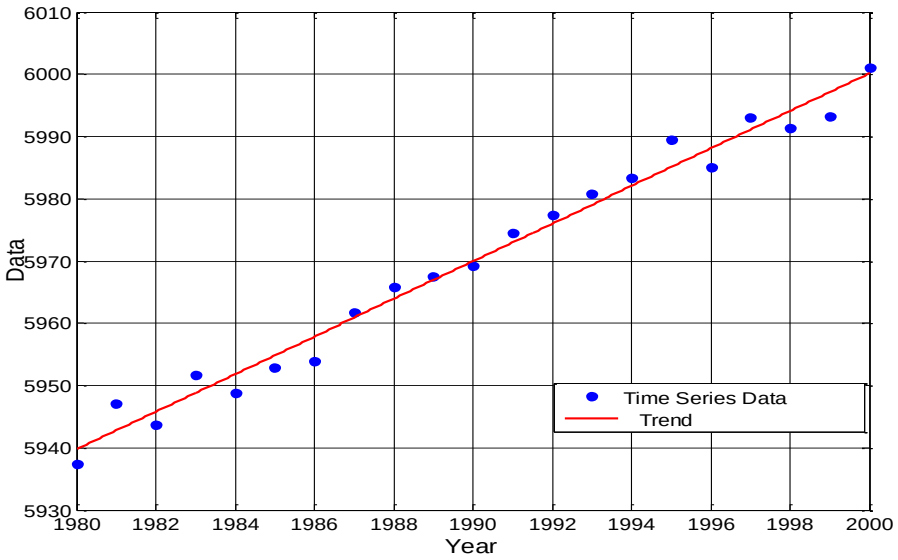

Figure 20. Trend in Time Series Data

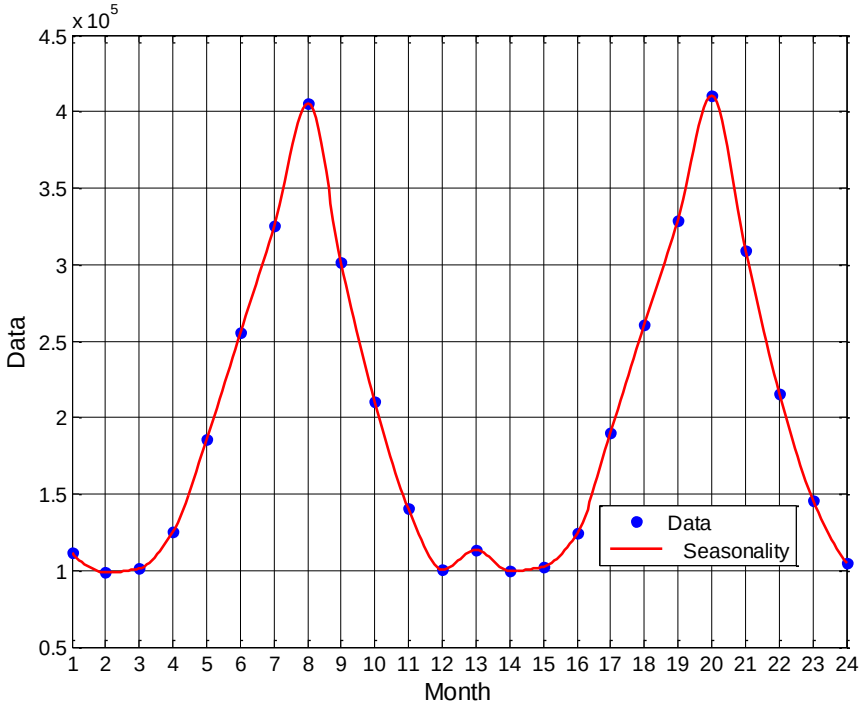

Figure 21. Seasonal Effects in Time Series Data

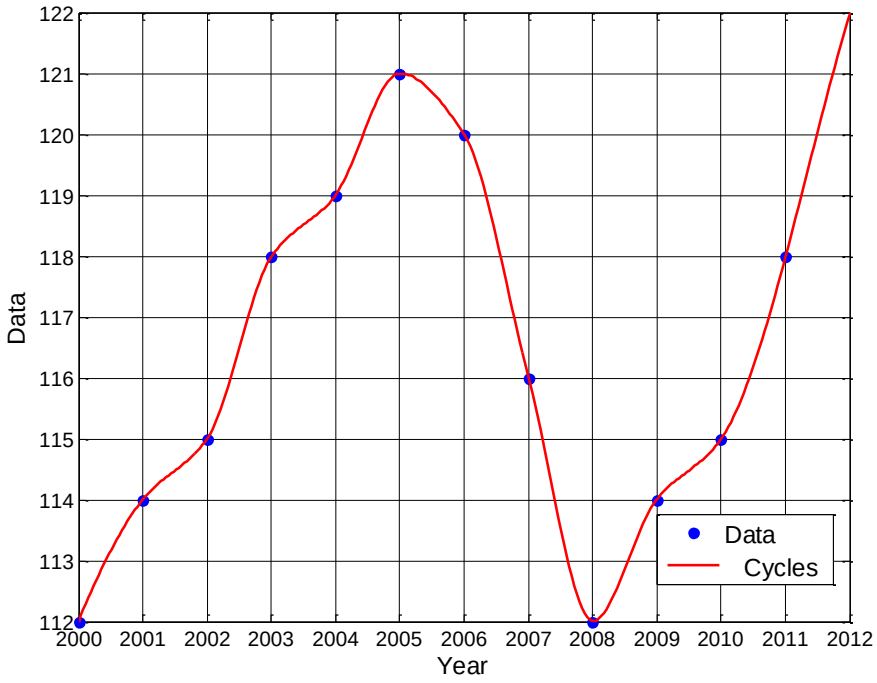

Figure 22 Cycles in Time Series Data

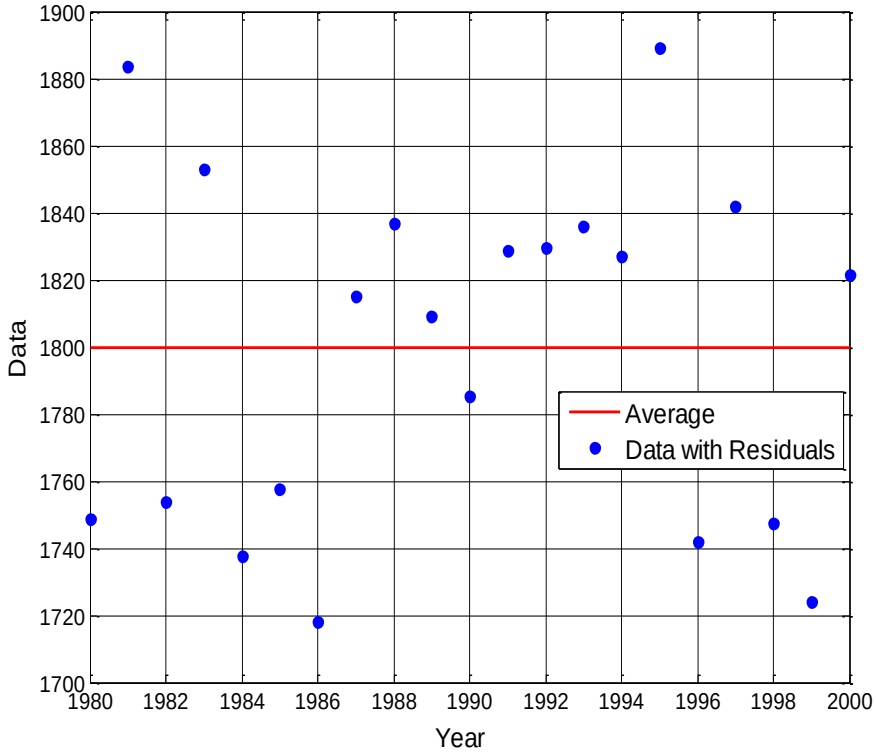

Figure 23 Residual in Time Series Data

3.1.1 Stationary Process

In time series, it is very important if the data is stationary or non stationary. Most of the analysis depends on the assumption that the process is stationary. In time series analysis usually the weak stationary term is used which is defined as follows:

Let $\{ X_t \}$ be a series with $E(X_t^2) < \infty$. Mean ($\mu_x(t)$) and covariance ($\gamma_x(r,s)$) of $\{ X_t \}$ is defined as in Equation 32 and Equation 33 respectively [22]:

$$\mu_x(t) = E(X_t) \qquad \text{(Eq. 32)}$$

$$\gamma_x(r,s) = Cov(X_r, X_s) = E[(X_r - \mu_x(r))(X_s - \mu_x(s))] \qquad \text{(Eq. 33)}$$

{ X_t } is (weakly) stationary if:

- $\mu_x(t)$ is independent of t
- $\gamma_x(t+h,t)$ is independent of t for each h

For a stationary time series { X_t } autocovariance function at lag h ($\gamma_x(h)$) and autocorrelation function at lag h ($\rho_x(h)$) can be defined as in Equation 34 and Equation 35 respectively:

$$\gamma_x(h) = Cov(X_{t+h}, X_t) \quad \text{(Eq. 34)}$$

$$\rho_x(h) = \frac{\gamma_x(h)}{\gamma_x(0)} = Cor(X_{t+h}, X_t) \quad \text{(Eq. 35)}$$

In nature, most of the processes are non stationary. Observed data in these processes may contain trend, seasonal effects or cycles. In time series analyses methods, the first step is the removal of the trends, seasonal effects and cycles from the data, so the non stationary data is turned into a stationary data. Removing of the trends, seasonal effects and cycles is done by differencing the data.

Some of the non stationary data has a linearly increasing or decreasing trend as in the Figure 24. In this case trend can be eliminated by applying first order difference to the data as in the Equation 36. "∇" operator is the difference operator and "B" is the backshift operator. As shown in the Figure 24 and Figure 25, X_t is non stationary but ∇X_t is stationary.

$$\nabla X_t = X_t - X_{t-1} = (1-B)X_t \quad \text{(Eq. 36)}$$

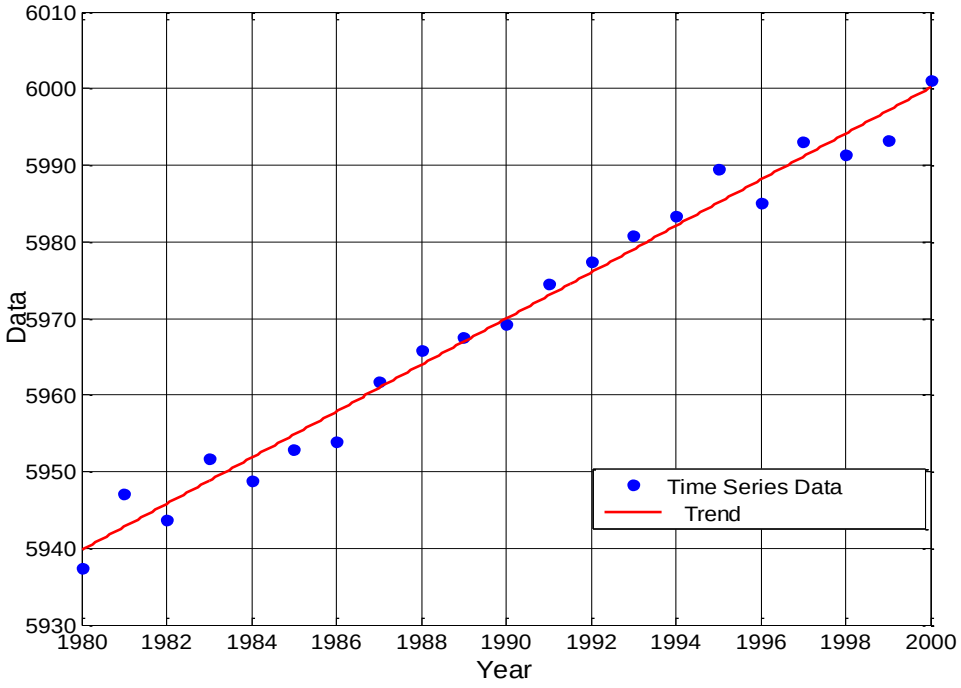

Figure 24. Time Series Data with First Order Trend

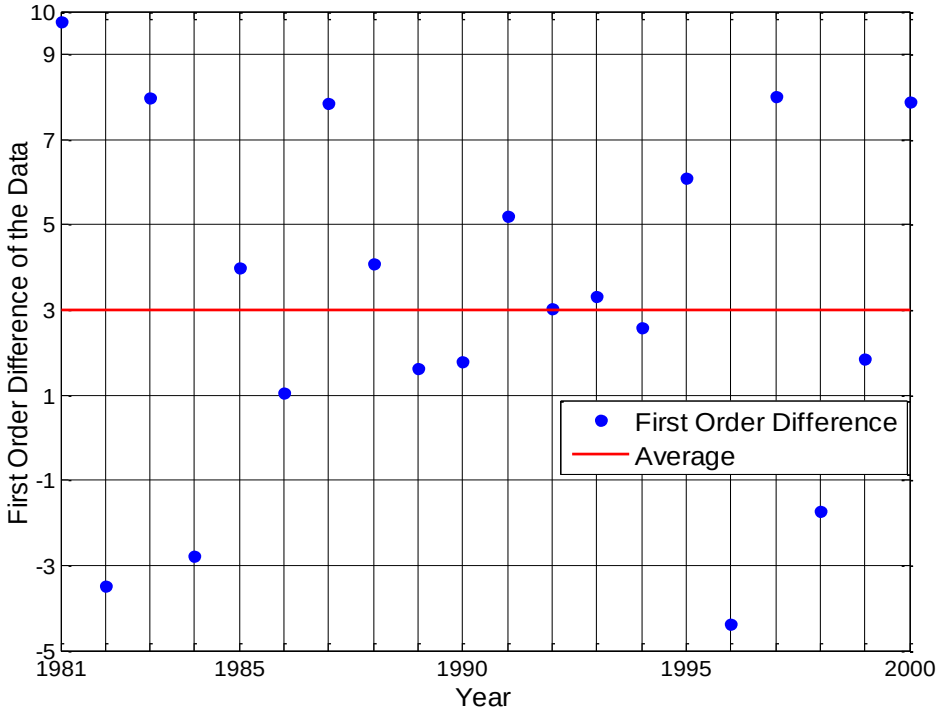

Figure 25. Elimination of First Order Trend

In some applications, observed data can have a second order trend as in the Figure 26. In this case second order difference should be applied to the data as shown in the Equation 37. Generalized difference equation with order "d" is shown in Equation 38. Second order difference of the data is stationary as shown in Figure 27.

$$\nabla^2 X_t = (1-B)(1-B)X_t = (1-2B+B^2)X_t$$
$$\nabla^2 X_t = X_t - 2X_{t-1} + X_{t-2} \quad \text{(Eq. 37)}$$

$$\nabla^d X_t = (1-B)^d X_t \quad \text{(Eq. 38)}$$

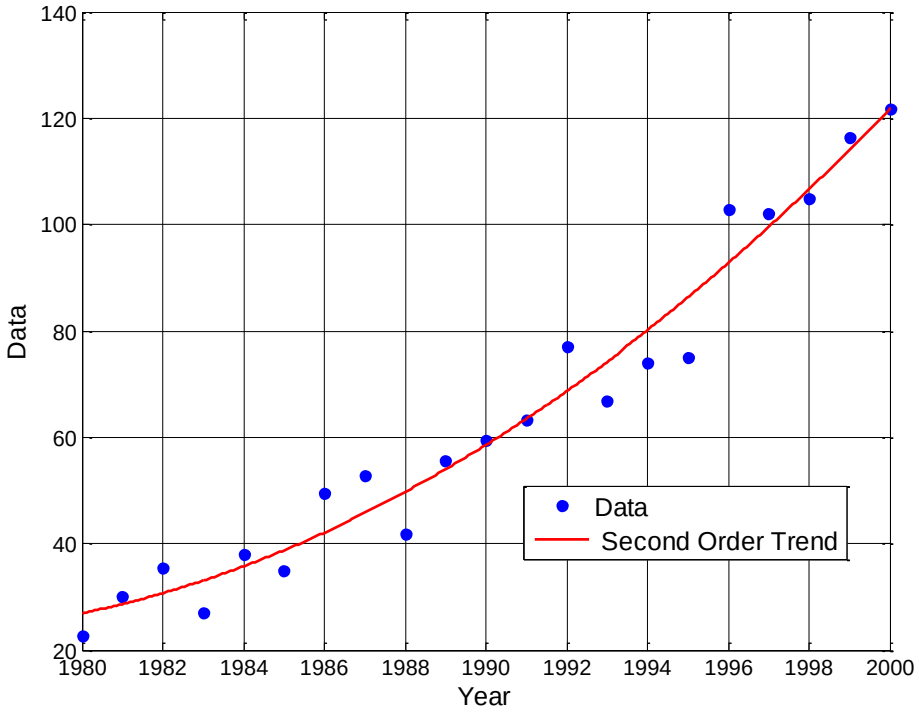

Figure 26. Time Series Data with Second Order Trend

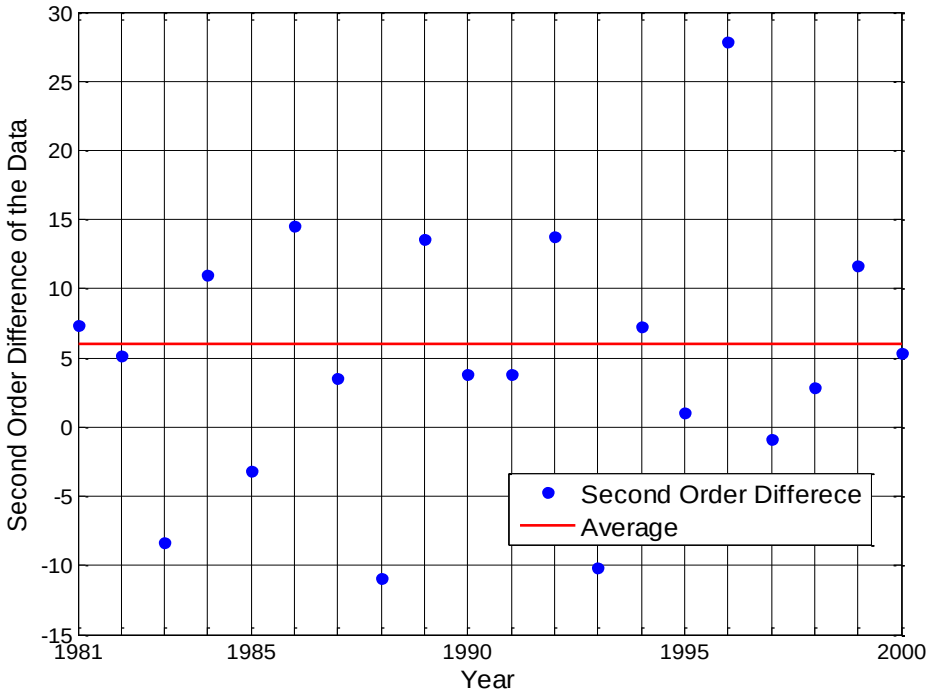

Figure 27. Elimination of Second Order Trend

3.2 Auto Regressive Process (AR)

Auto regressive process uses the past observation values to make forecasting. This process can only be used for stationary time series. The auto regressive process of order "p" is shown as AR(p). The formulation of AR(p) process is shown in Equation 39. In Equation 39 "ϕ_r" is the parameter or AR(p) process and "ε_t" is error term which is white noise with zero mean and variance "σ^2".

$$X_t = \sum_{r=1}^{p} \phi_r X_{t-r} + \varepsilon_t \qquad \text{(Eq. 39)}$$

AR(1) process is defined as in Equation 40.

$$X_t = \phi_1 X_{t-1} + \varepsilon_t \qquad \text{(Eq. 40)}$$

3.3 Moving Average Process (MA)

Moving average process (MA) uses the error term and its past values to make forecasting. This process can only be used for stationary time series. Moving average process of order "q" is shown as MA(q). The formulation of MA(q) process is shown in Equation 41. In Equation 41 "θ_s" is the parameter of MA(q) process and "ε_t" is error term which is white noise with zero mean and variance "σ^2".

$$X_t = \sum_{s=0}^{q} \theta_s \varepsilon_{t-s} \qquad \text{(Eq. 41)}$$

3.4 Auto Regressive Moving Average Process (ARMA)

Auto Regressive Moving Average Process (ARMA) is combination of AR and MA processes. It uses the past observation values and error values. This process can only be used for stationary time series. The formulation of ARMA(p,q) process is shown in Equation 42.

$$X_t - \sum_{r=1}^{p} \phi_r X_{t-r} = \sum_{s=0}^{q} \theta_s \varepsilon_{t-s} \qquad \text{(Eq. 42)}$$

3.5 Auto Regressive Integrated Moving Average (ARIMA)

In nature most of the processes are non stationary. In non stationary processes, to make forecasting firstly the processes should be turned into stationary. This is done by differencing. In ARIMA(p,d,q) process the "d" is the order of difference. Assume that Y_t is a non stationary process, X_t is defined as in Equation 43 and Equation 44.

$$X_t = \nabla^d Y_t \qquad \text{(Eq. 43)}$$

$$X_t - \sum_{r=1}^{p} \phi_r X_{t-r} = \sum_{s=0}^{q} \theta_s \varepsilon_{t-s} \qquad \text{(Eq. 44)}$$

CHAPTER 4

CASE STUDIES

In this part, Turkey's total electrical energy demand and peak electric power demand from 2013 to 2023 will be forecasted by using two different methods (ANN and ARIMA). Before making forecast some points on long term forecast should be noted [23]:

- Long term forecast is always inaccurate
- Peak demand is dependent on temperature but it's not possible to use weather forecast in long term forecasting because forecasted period is too long.
- Some of the necessary economical data for the long term forecasting does not exist.

In this part results of two different methods will be compared to increase the reliability of the forecast.

4.1 Electrical Energy Demand Forecasting Using ANN

In long term electrical load forecasting economical, social and demographical factors determine the growth of the demand. In this part effects of Gross Domestic Product (GDP), Index of Industrial Production (IIP) and population will be examined. Then a neural network whose inputs are GDP, IIP and population and whose output is electrical energy demand will be formed. Firstly the network will be trained and tested with the data from 1992-2011 then, forecasting will be made until 2023. GDP is the market value of all officially recognized final goods and services produced within a country in a given period [24]. IIP is an abstract number, the magnitude of which represents the status of production in the industrial sector for a given period of time as compared to a reference period of time [24]. In Table 19 the development of IIP and GDP from 1992 to 2011 is shown [25].

Table 19. Development of IIP and GDP [25]

Year	GDP (Million TL)	IIP	Year	GDP (Million TL)	IIP
1992	51.554	56,1	2002	72.520	79,5
1993	56.099	60,7	2003	76.338	86,5
1994	52.847	56,9	2004	83.486	95,0
1995	57.472	64,0	2005	90.500	100,0
1996	61.865	69,0	2006	96.738	107,3
1997	67.465	76,9	2007	101.255	114,8
1998	70.203	77,9	2008	101.922	114,2
1999	67.841	75,0	2009	97.003	102,9
2000	72.436	79,5	2010	105.886	116,4
2001	68.309	72,6	2011	114.874	126,8

In Figure 28 and Figure 29 the developments of GDP and IIP are shown respectively. To make forecast of the future values of electrical energy demand, forecasted values of GDP and IIP are needed. They are forecasted by using curve fitting tool in MATLAB.

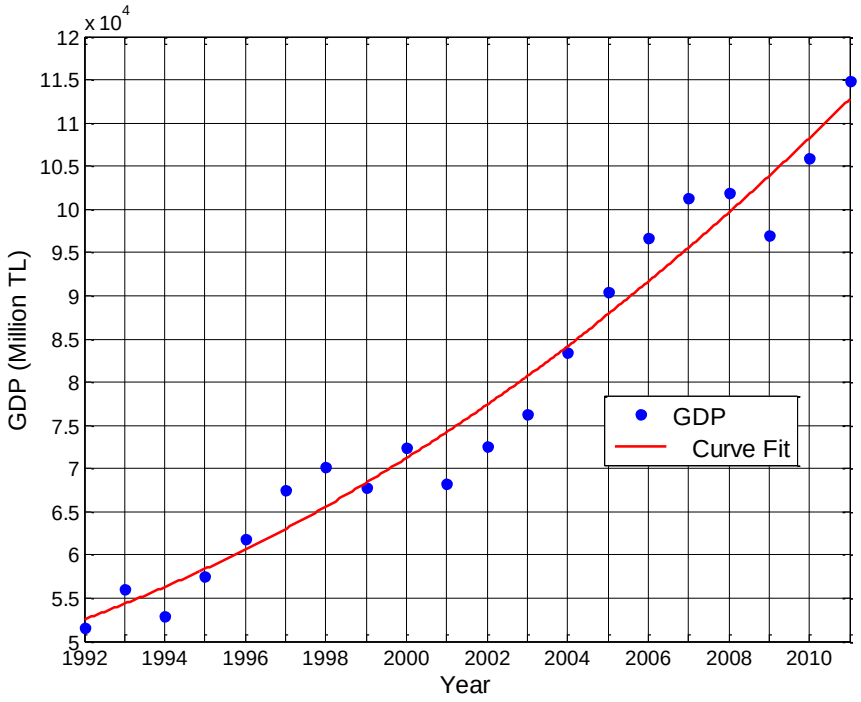

Figure 28. Development of GDP (Million TL)

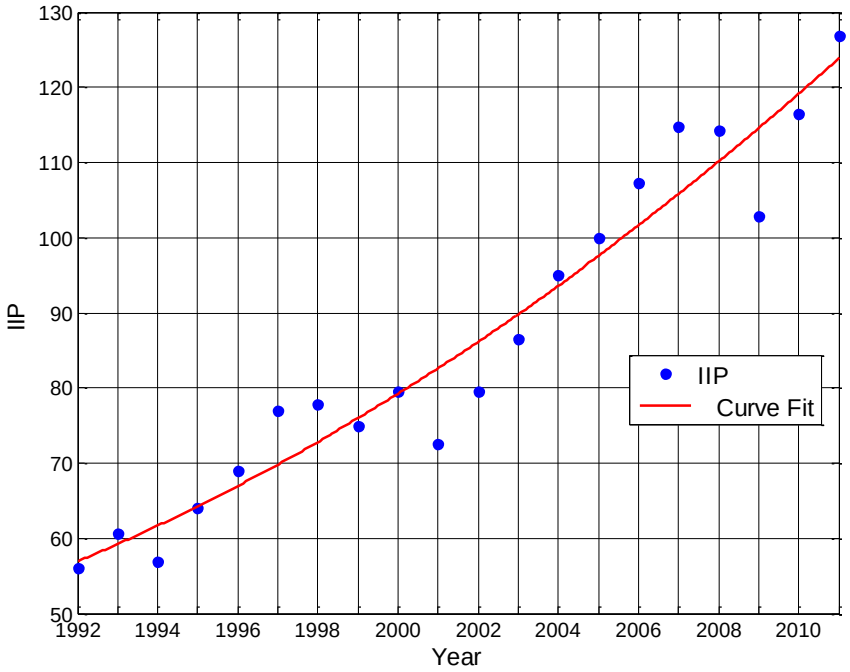

Figure 29. Development of IIP

Table 20 Future Development of GDP and IIP

Year	**GDP (Million TL)**	**IIP**	**Year**	**GDP (Million TL)**	**IIP**
2013	122.403	133,79	2019	154.744	166,61
2014	127.412	138,93	2020	160.668	172,54
2015	132.572	144,20	2021	166.746	178,61
2016	137.886	149,60	2022	172.976	184,82
2017	143.353	155,13	2023	179.359	191,15
2018	148.972	160,80			

In Table 21 development of Turkey's population is shown. The population foracast is taken from TUIK [25].

Table 21. Population Projection of Turkey [25]

Year	Population(000)	Year	Population(000)
1992	56.986	2008	71.095
1993	57.913	2009	72.050
1994	58.837	2010	73.003
1995	59.756	2011	73.950
1996	60.671	2012	74.885
1997	61.582	2013	75.811
1998	62.464	2014	76.707
1999	63.364	2015	77.601
2000	64.252	2016	78.478
2001	65.133	2017	79.337
2002	66.008	2018	80.173
2003	66.873	2019	80.983
2004	67.723	2020	81.778
2005	68.566	2021	82.558
2006	69.395	2022	83.328
2007	70.215	2023	84.053

In Figure 30, relation between electrical energy demand and GDP is shown. As seen from the figure there is a linear relation between electrical energy demand and GDP.

In Figure 31, relation between electrical energy demand and IIP is shown. As seen from the figure there is a linear relation between electrical energy demand and IIP.

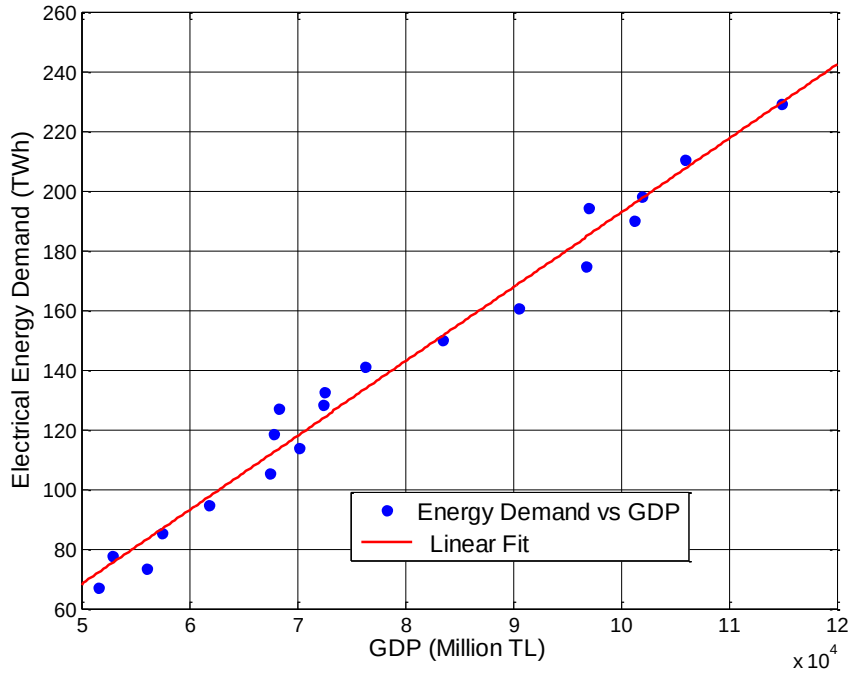

Figure 30. Electrical Energy Demand vs GDP

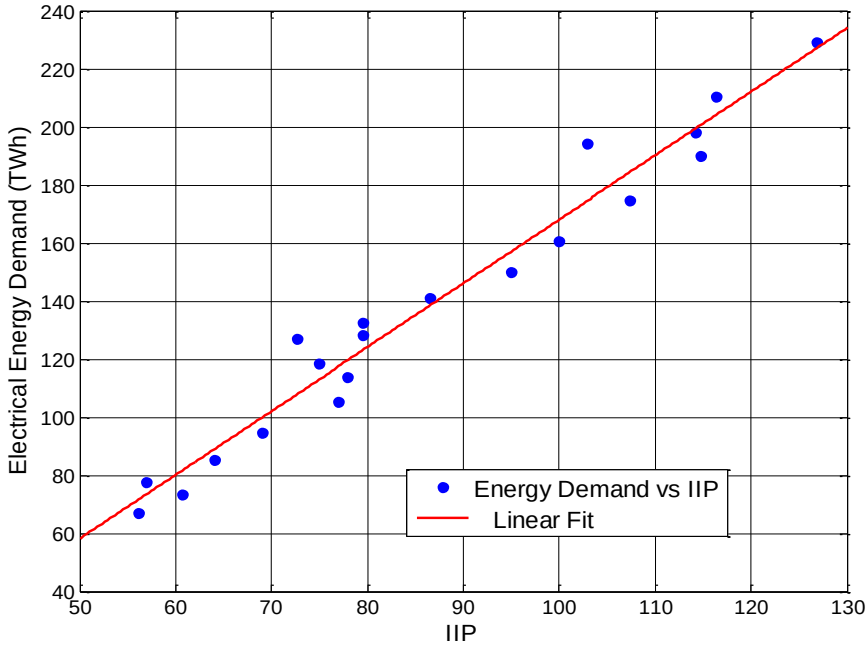

Figure 31. Electrical Energy Demand vs IIP

In Figure 32, relation between electrical energy demand and population is shown. As seen from the figure there is a second order relation between electrical energy demand and population.

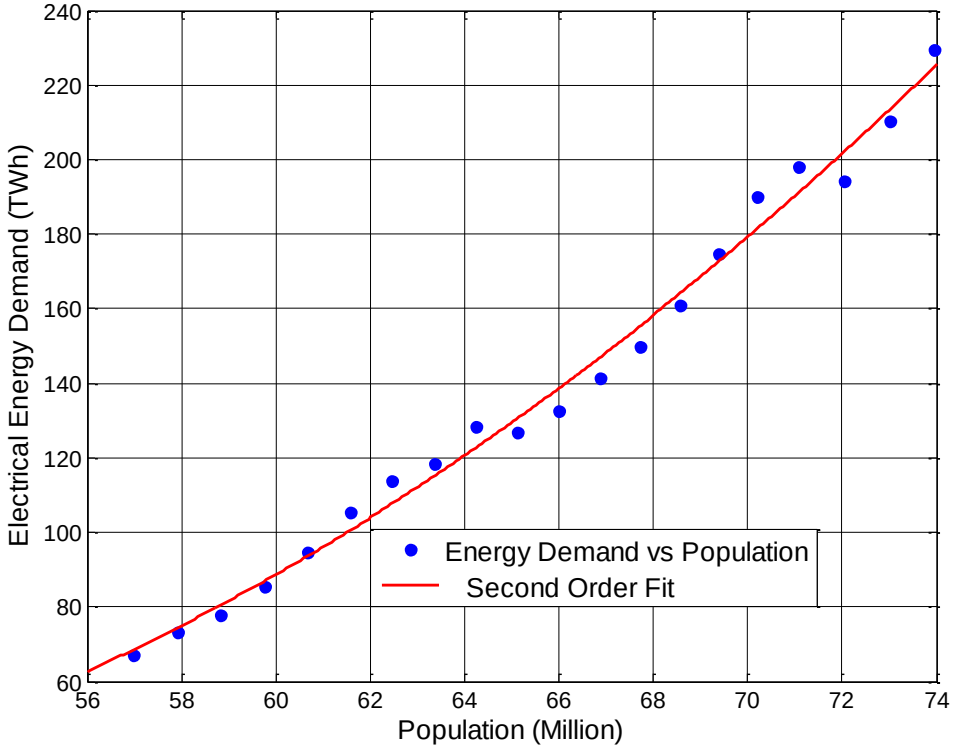

Figure 32. Electrical Energy Demand vs Population

For forecasting the electrical energy demand between 2013 and 2023 a neural network with three input layers, one hidden layer and one output layer is chosen. Data between 1992 and 2011 is used to train, validate and test the network. %70 part of the data is used in the training, % 15 parts of the data is used in the validation and the remaining %15 part of the data is used in the test process. Training result of the network is shown in the Figure 33. As shown in the figure the R value is close to 1 which is a proof of good match.

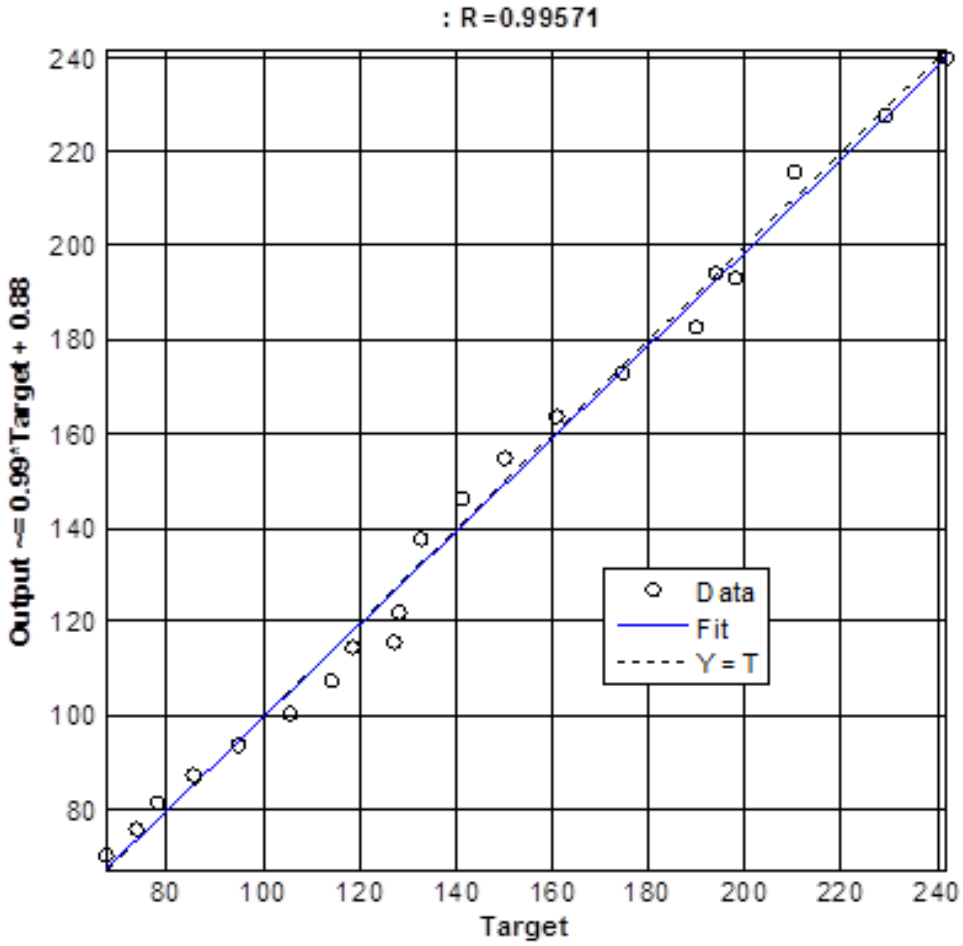

Figure 33. Neural Network Training Result

For testing the performance of the network a term which is called mean absolute percentage error (MAPE) can be defined as shown in the Equation 45, where e_i is the error, t_i is the target output. The MAPE value for this neural network is %3,65 which is a quite good value. In testing process the output of the network and target outputs are shown in the Table 22.

$$MAPE(\%) = \frac{100}{N}\sum_{i=1}^{N}\left|\frac{e_i}{t_i}\right| \qquad \text{(Eq. 45)}$$

Table 22. Test Results of the Network

Year	1995	2001	2008
Target (TWh)	85,5	126,9	198,0
Output (TWh)	87,581	119,293	192,990
Error (TWh)	-2,081	7,607	5,010
MAPE	**3,65%**		

After testing the network, the network can be used for forecasting the future values of the electrical energy demand. The forecast results are shown in the Table 23. The development of the electrical energy is shown in the Figure 34.

Table 23. Electrical Energy Demand Forecast (ANN)

Year	**Electrical Energy Demand (GWh)**	**Year**	**Electrical Energy Demand (GWh)**
2013	255.724	2019	366.571
2014	272.191	2020	387.579
2015	289.567	2021	409.278
2016	307.727	2022	431.681
2017	326.657	2023	454.336
2018	346.291		

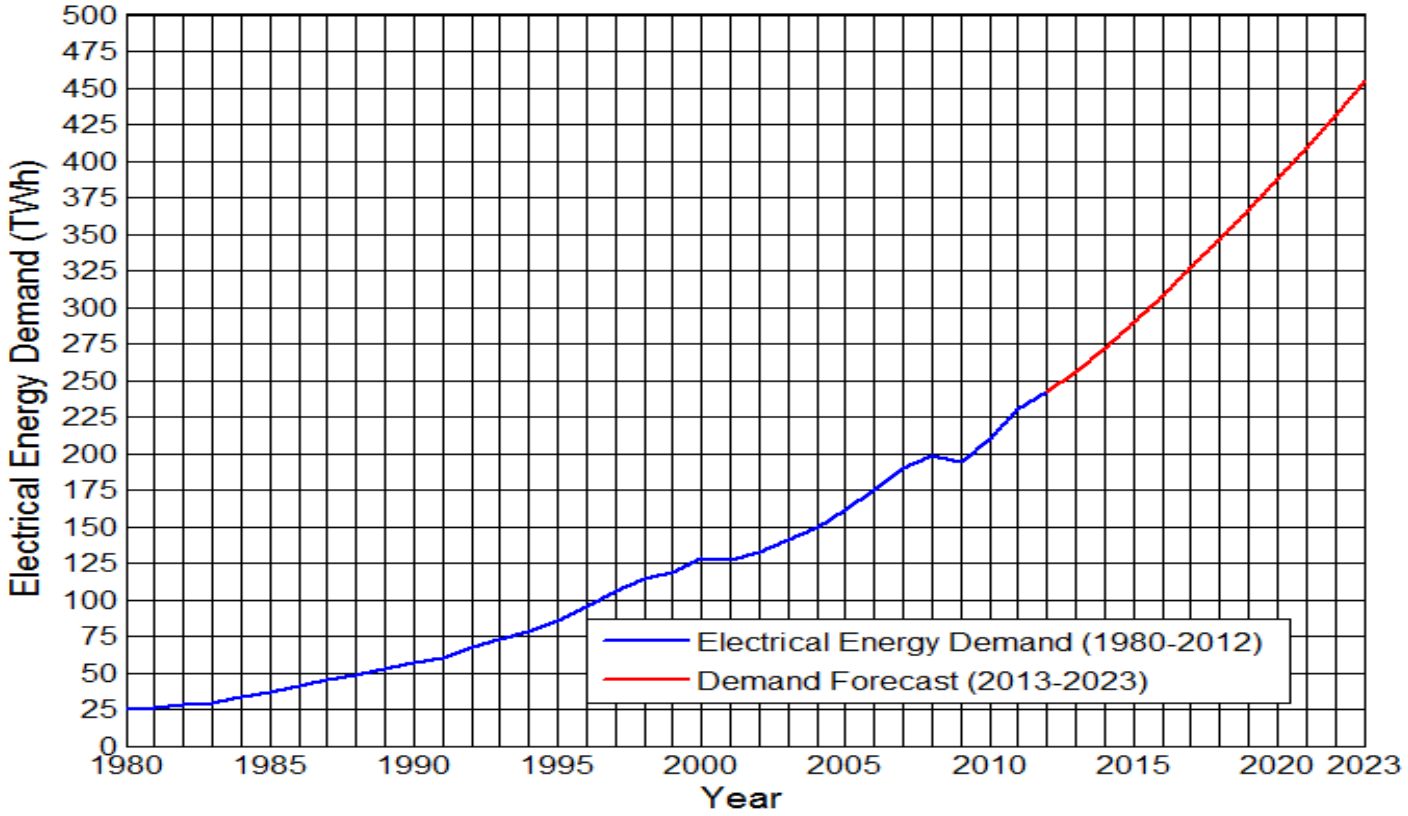

Figure 34. Electrical Energy Demand (ANN)

4.2 Peak Power Demand Forecasting by Using ANN

Peak power demand can also be forecasted with the same methodology as in the previous part. In Figure 35, Figure 36, Figure 37 the relationships between peak power demand and GDP, peak power demand and IIP, peak power demand and population are shown respectively.

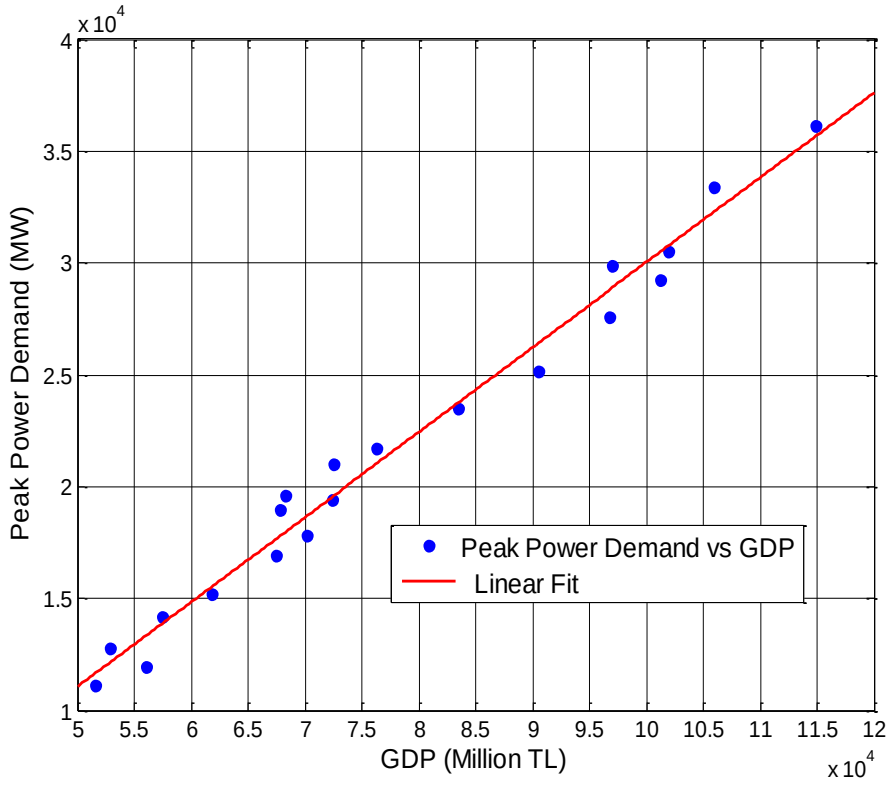

Figure 35. Peak Power Demand vs GDP

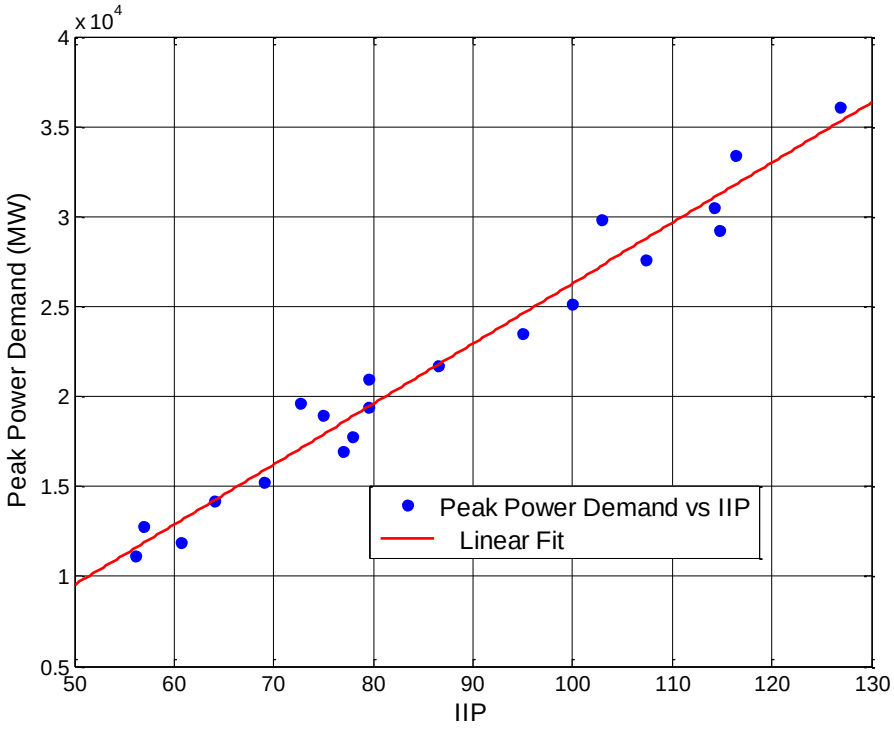

Figure 36. Peak Power Demand vs IIP

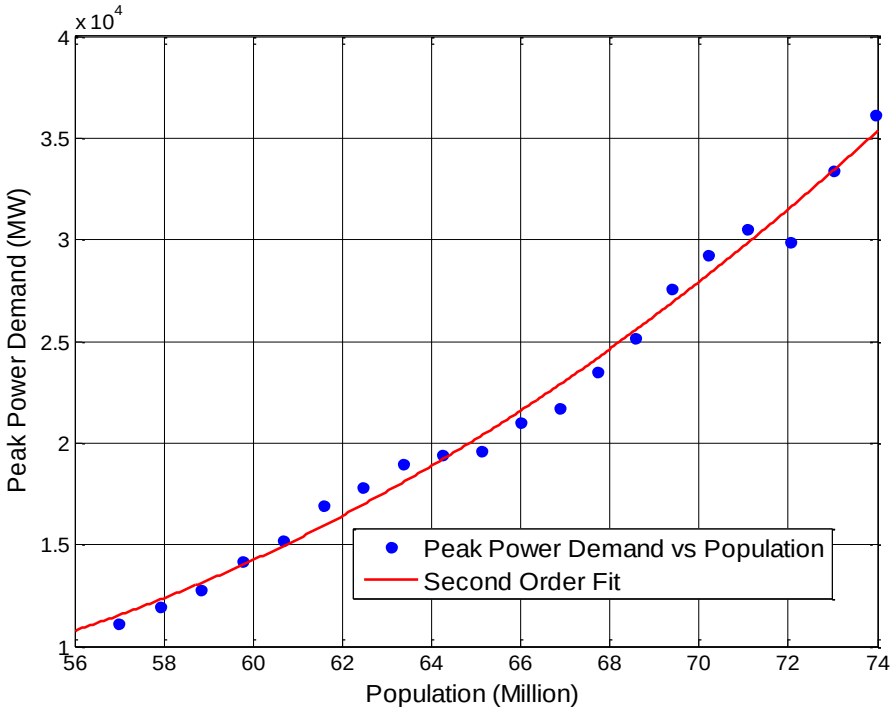

Figure 37. Peak Power Demand vs Population

For forecasting the peak power demand between 2013 and 2023 a neural network with three input layers, one hidden layer and one output layer is chosen. Data between 1992 and 2011 is used to train, validate and test the network. %70 part of the data used in the training, % 15 parts of the data is used in the validation and the remaining %15 part of the data is used in the test process. Training result of the network is shown in the Figure 38. As shown in the figure the R value is close to 1 which is a proof of good match.

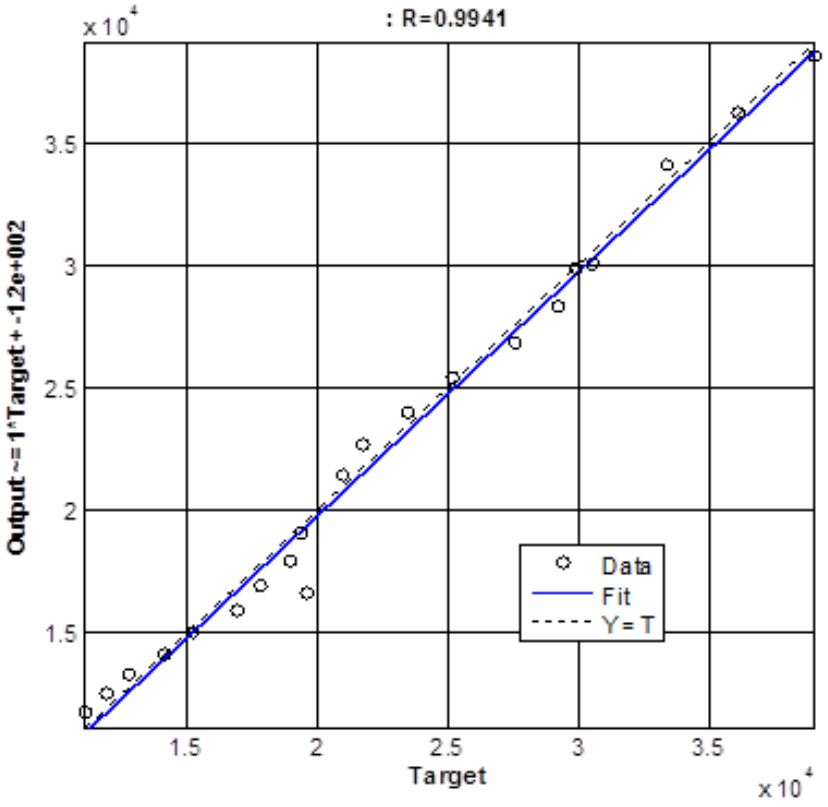

Figure 38. Neural Network Training Result

In the Table 24 the target outputs and generated outputs during test process are shown. MAPE of test procedure is %3,53. This shows that the model is successful in peak power forecasting.

Table 24. Test Results of the Network

Year	**1995**	**2001**	**2008**
Target (MW)	14.165	19.612	30.517
Output (MW)	14.083	17.836	30.224
Error (MW)	82	1.776	293
MAPE	**3,53%**		

After testing network, the network can be used for forecasting the future values of the peak power demand. Forecast results are shown in the Table 25. Development of the peak power demand is shown in the Figure 39.

Table 25. Peak Power Demand Forecast (ANN)

Year	**Peak Power Demand (MW)**	**Year**	**Peak Power Demand(MW)**
2013	41.384	2019	58.642
2014	43.871	2020	62.203
2015	46.459	2021	65.955
2016	49.273	2022	69.947
2017	52.105	2023	74.138
2018	55.396		

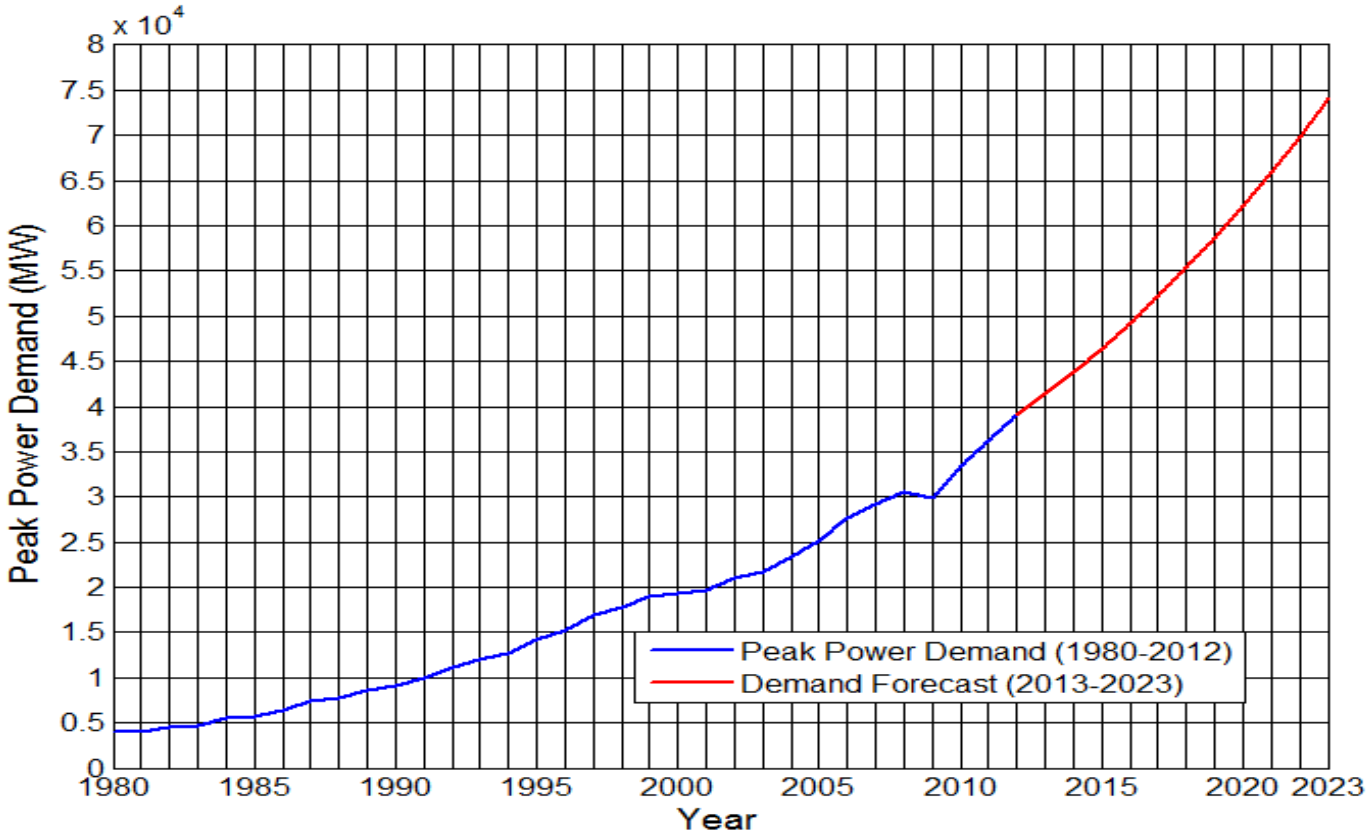

Figure 39. Peak Power Demand (ANN)

4.3 Electrical Energy Demand Forecasting Using ARIMA Modeling

In this part electrical energy demand between 2013 and 2023 will be forecasted using stochastic ARIMA modeling. Past values of electrical energy demand between 1980 and 2006 will be used in creating a model. Data between 2007 and 2012 will be used in testing the model. If test results are successful, the model will be used in forecasting electrical energy demand between 2013 and 2023.

To start with data should be turned into stationary process. If trend is first order, first order difference is enough. If there is a second order trend, data should be differenced two times. In the Figure 40, development of electrical energy demand from 1980 to 2012 is shown. As shown in the figure trend is second order, so the data should be differenced two times. In ARIMA (p,d,q) model d is the order of difference. Our model will be ARIMA(p,2,q).

The first and second order difference of electrical energy demand (∇E_t and $\nabla^2 E_t$) are shown in the Figure 41 and Figure 42 respectively.

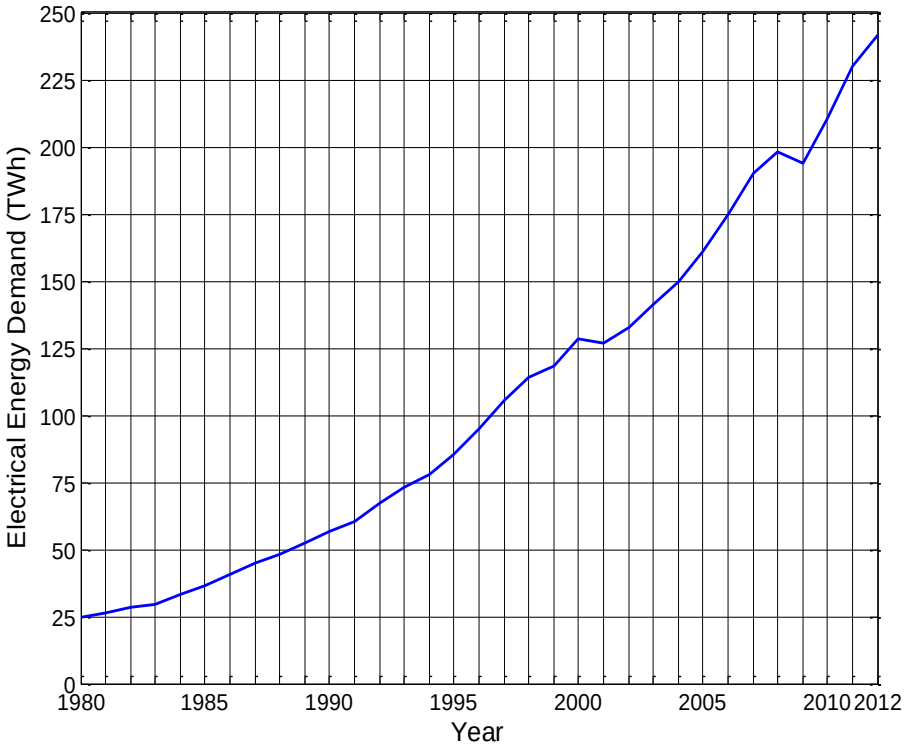

Figure 40. Electrical Energy Demand (1980-2012)

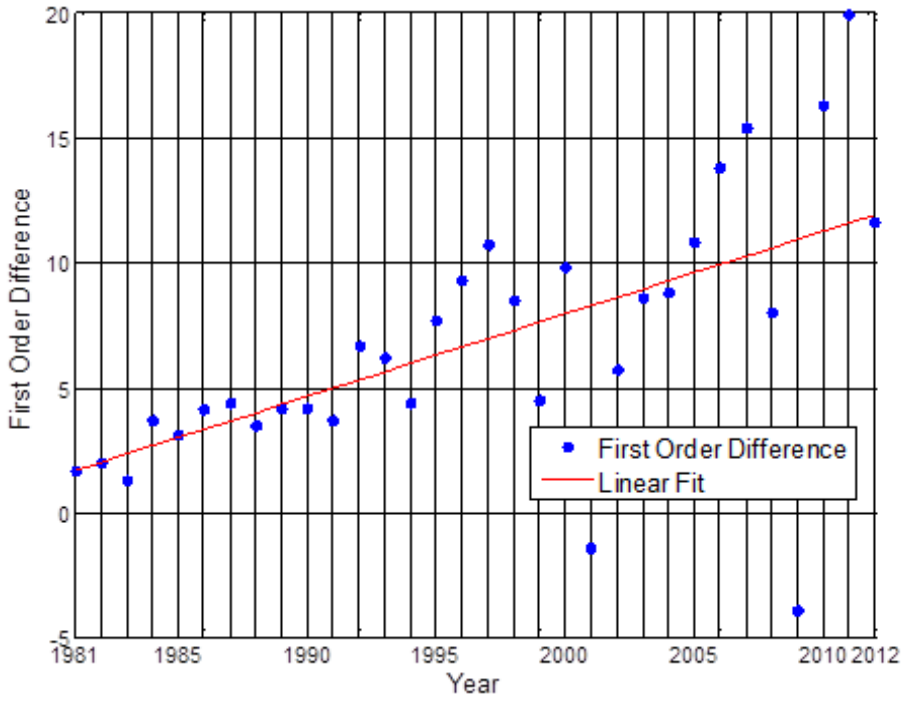

Figure 41. First Order Difference of Electrical Energy Demand

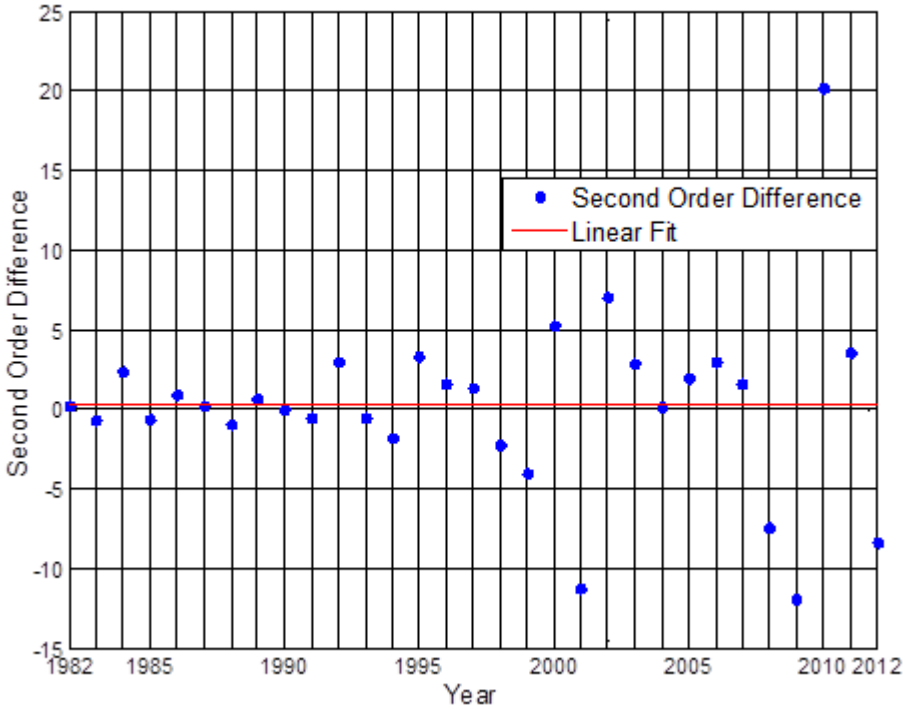

Figure 42 Second Order Difference of Electrical Energy Demand

Autocorrelation and partial autocorrelation correlogram of the $\nabla^2 E_t$ up to 20 lags are shown in Figure 43 and Figure 44 respectively.

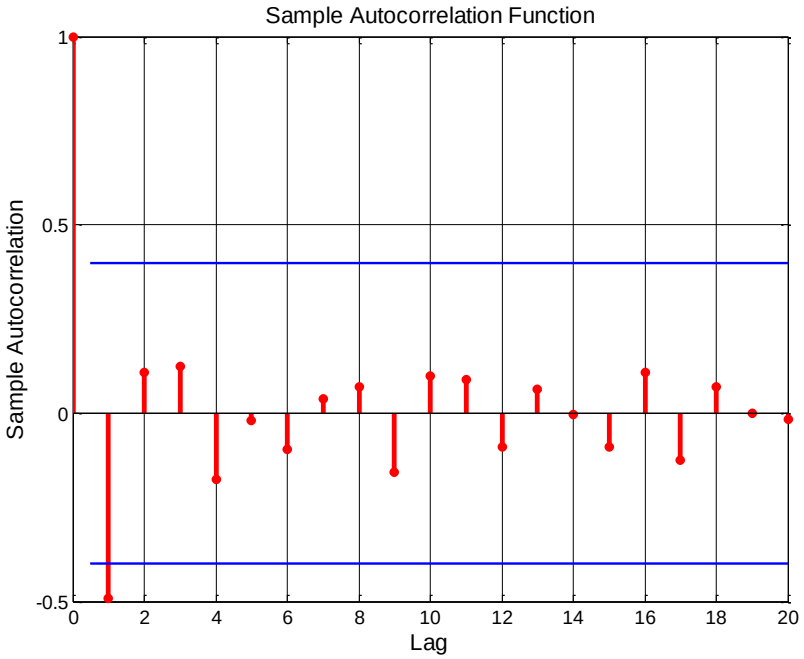

Figure 43. Autocorrelation Correlogram of $\nabla^2 E_t$

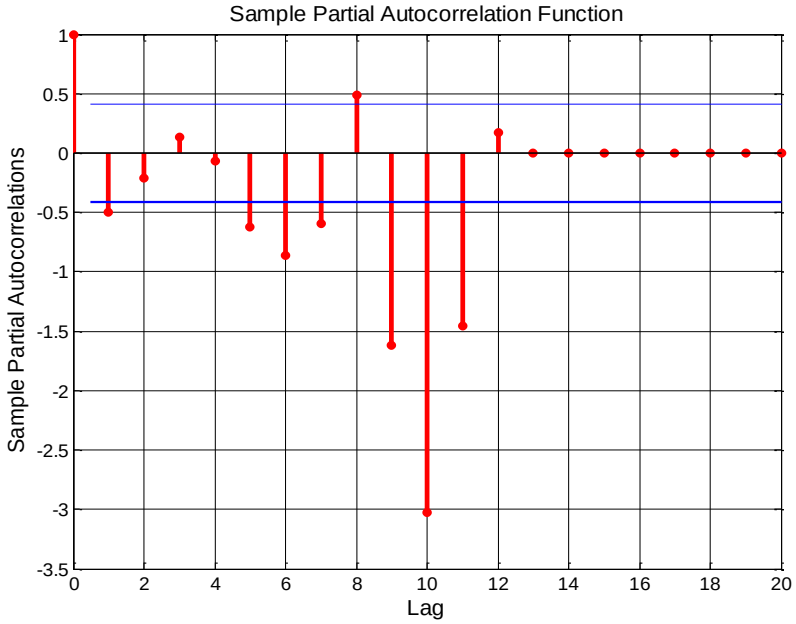

Figure 44. Partial Autocorrelation Correlogram of $\nabla^2 E_t$

From partial autocorrelation correlogram it's seen that only lag one term has statistical meaning. So ARIMA(1,2,0) model can give good results in our case. But to compare results of different models, both ARIMA (1,2,0) and ARIMA(2,2,0) models are formed. Test results of ARIMA(1,2,0) and ARIMA(2,2,0) will be compared and the better one will be used in the forecasting application. Equations of ARIMA(1,2,0) process as follows:

$$X_t = \nabla^2 E_t = E_t - 2E_{t-1} + E_{t-2} \quad \text{(Eq. 46)}$$

$$(1+\phi_1 B)X_t = \varepsilon_t + (1+\phi_1)\times 0,4840 \quad \text{(Eq. 47)}$$

$$\hat{E}_t = (2-\phi_1)E_{t-1} + (2\phi_1 - 1)E_{t-2} - \phi_1 E_{t-3} + (1+\phi_1)\times 0,4840 \quad \text{(Eq. 48)}$$

Equation 48 gives expected value of the electrical energy demand. "ϕ_1" value can be calculated by using "armax" function in MATLAB. "ϕ_1" value is found as 0,4803 and expected value of electrical energy is formulized as in Equation 49.

$$\hat{E}_t = 1,5197E_{t-1} - 0,0394E_{t-2} - 0,4803E_{t-3} + 0,2515 \quad \text{(Eq. 49)}$$

Model is tested for the electrical energy demand data between 2007 and 2012. In Table 26, observed electrical energy demands and forecasted values are shown. MAPE value for ARIMA(1,2,0) model %6,647.

Table 26. Test Results of the ARIMA(1,2,0) Model

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Target(TWh)	190	198	194,1	210,4	230,3	241,9
Forecast (TWh)	187,675	201,815	216,160	231,123	246,506	262,404
Error (TWh)	2,324	-3,815	-22,060	-20,723	-16,206	-20,504
MAPE	**% 6,647**					

Equations of ARIMA(2,2,0) process as follows:

$$X_t = \nabla^2 E_t = E_t - 2E_{t-1} + E_{t-2} \quad \text{(Eq. 50)}$$

$$(1+\phi_1 B+\phi_2 B^2) X_t = \varepsilon_t + (1+\phi_1+\phi_2)\times 0,4840 \quad \text{(Eq. 51)}$$

$$\hat{E}_t = (2-\phi_1)E_{t-1} + (2\phi_1 - \phi_2 - 1)E_{t-2} + (2\phi_2 - \phi_1)E_{t-3} - \phi_2 E_{t-4} + (1+\phi_1+\phi_2)\times 0,4840 \quad \text{(Eq. 52)}$$

Equation 52 gives the expected value of the electrical energy demand by using ARIMA(2,2,0) model. "ϕ_1" is found as 0,5593 and "ϕ_2" is found as 0,1584. Expected value of electrical energy demand can be written as in Equation 53.

$$\hat{E}_t = 1,4407E_{t-1} - 0,0398E_{t-2} - 0,2425E_{t-3} - 0,1584E_{t-4} + 0,8314 \quad \text{(Eq. 53)}$$

Model is tested for the electrical energy demand data between 2007 and 2012. In Table 27, observed electrical energy demands and forecasted values are shown. MAPE value for ARIMA(2,2,0) model is %6,069. This result is better than the results of ARIMA(1,2,0) model, so ARIMA(2,2,0) model will be used in forecasting of electrical energy demand.

Table 27. Test Results of the ARIMA(2,2,0) Model

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Target(TWh)	190	198	194,1	210,4	230,3	241,9
Forecast(TWh)	187,236	200,880	214,976	229,491	244,531	260,042
Error (TWh)	2,763	-2,880	-20,876	-19,091	-14,231	-18,142
MAPE	**% 6,069**					

In Table 28 electrical energy demand forecast by using ARIMA(2,2,0) model is shown. The development of electrical energy demand is shown in Figure 45.

Table 28. Electrical Energy Demand Forecast (ARIMA(2,2,0))

Year	Electrical Energy Demand (GWh)	Year	Electrical Energy Demand (GWh)
2013	258.403	2019	361.249
2014	274.310	2020	380.101
2015	290.605	2021	399.441
2016	307.609	2022	419.264
2017	324.987	2023	439.571
2018	342.874		

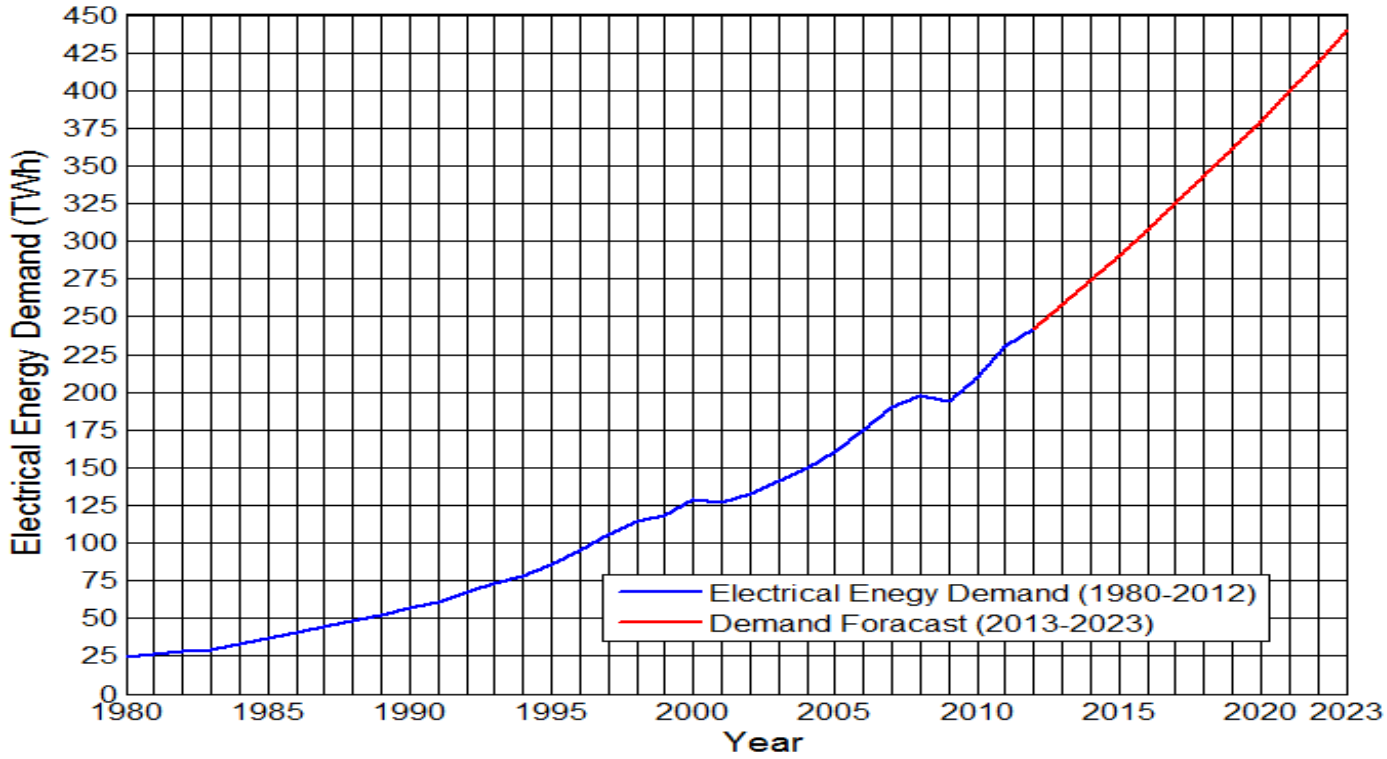

Figure 45. Electrical Energy Demand with ARIMA(2,2,0)

4.4 Peak Power Demand Forecasting Using ARIMA Modeling

In this part peak power demand between 2013 and 2023 will be forecasted using stochastic ARIMA modeling. Past values of peak power demand between 1980 and 2006 will be used in creating a model. Data between 2007 and 2012 will be used in testing the model. If test results are successful the model will be used in forecasting the peak power demand between 2013 and 2023.

To start with data should be turned into stationary process. If trend is first order, first order difference is enough. If trend is second order, data should be differenced two times. In Figure 46, development of peak power demand from 1980 to 2012 is shown. As shown in the figure, trend is second order, so the data should be differenced two times. In ARIMA (p,d,q) model d is the order of difference. Our model will be ARIMA(p,2,q).

The first and second order difference of the peak power demand (∇P and $\nabla^2 P$) are shown in the Figure 47 and Figure 48 respectively.

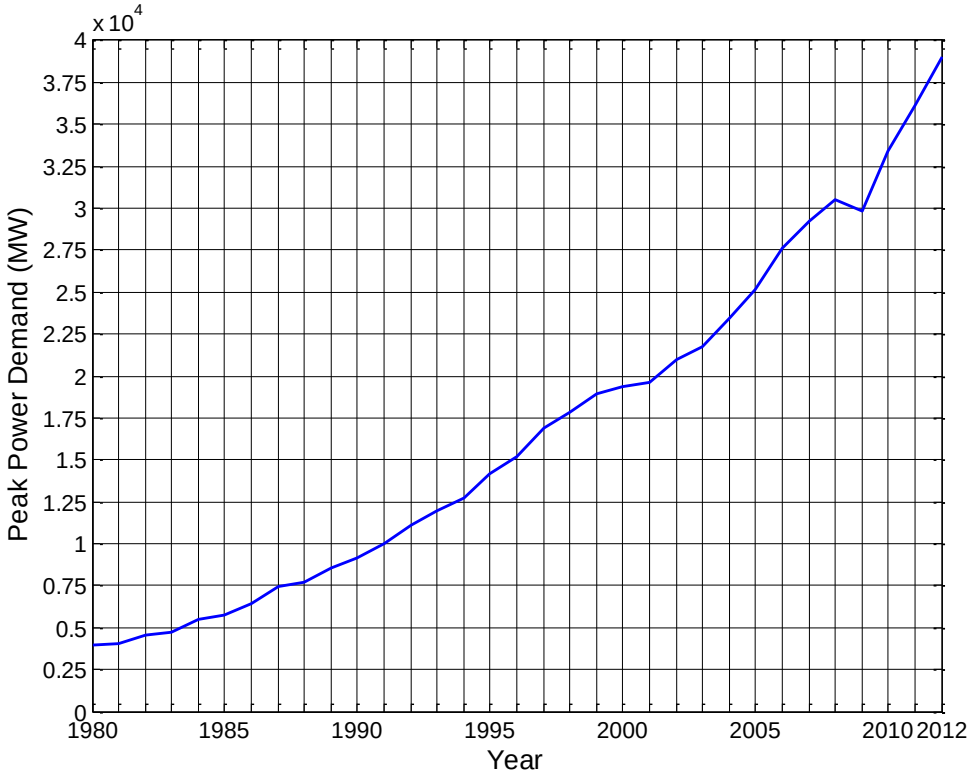

Figure 46. Peak Power Demand (1980-2011)

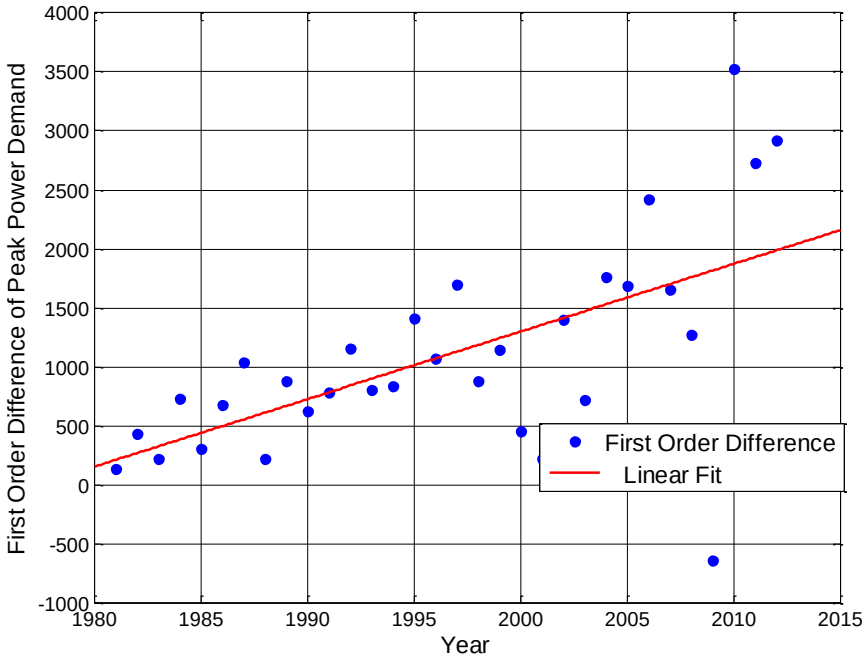

Figure 47. First Order Difference of Peak Power Demand

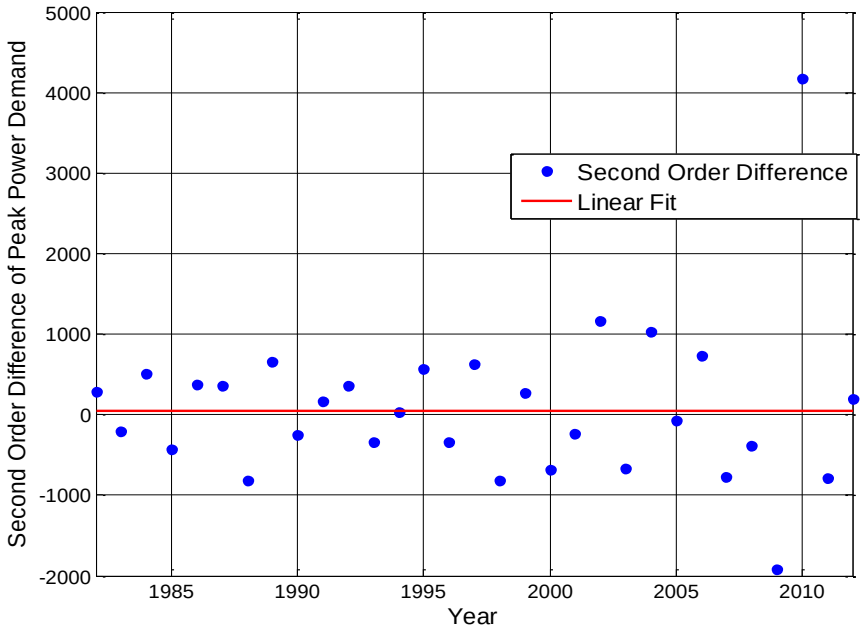

Figure 48. Second Order Difference of Peak Power Demand

Autocorrelation and partial autocorrelation correlogram of the $\nabla^2 P$ up to 20 lags are shown in Figure 49 and Figure 50 respectively.

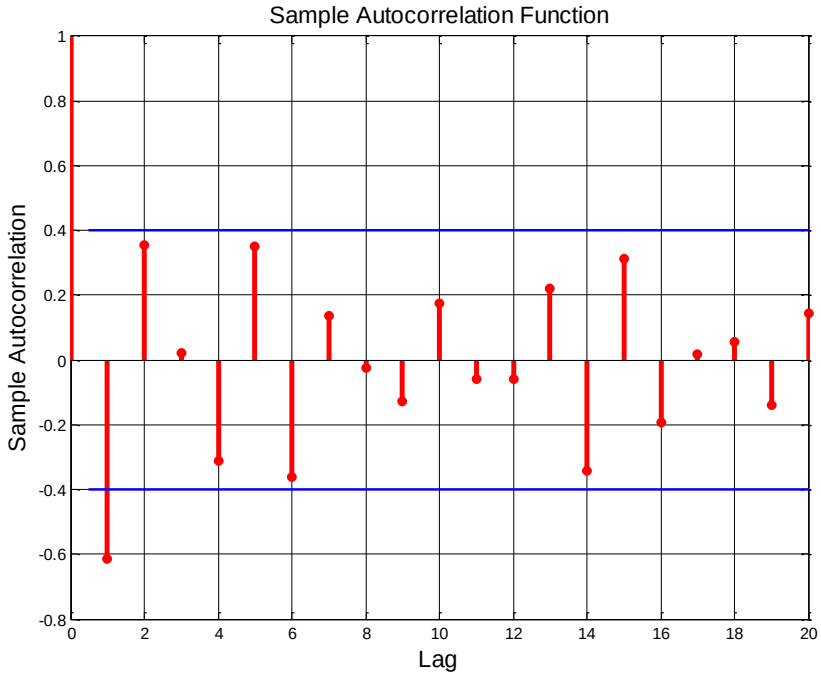

Figure 49. Autocorrelation Correlogram of $\nabla^2 P$

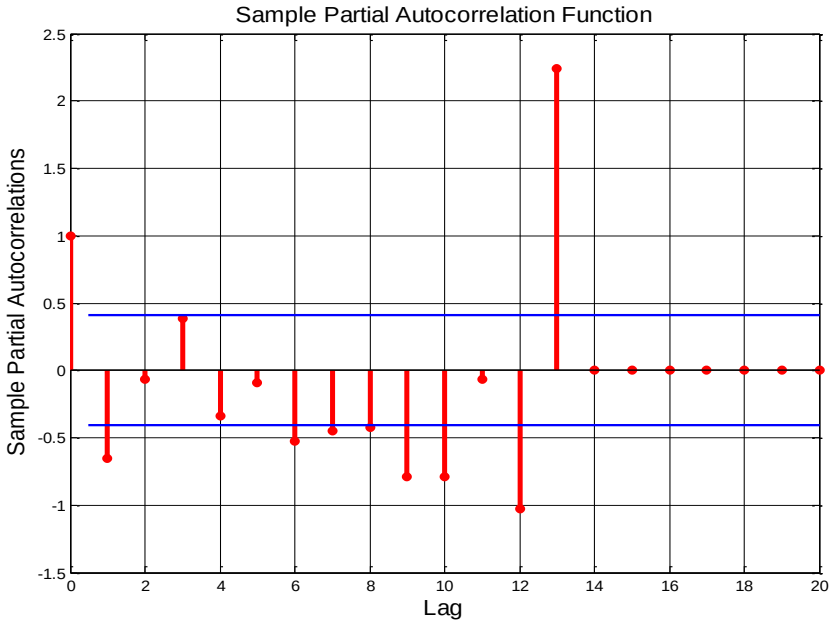

Figure 50. Partial Autocorrelation Correlogram of $\nabla^2 P$

From partial autocorrelation correlogram it's seen that only lag one term has statistical meaning. So ARIMA(1,2,0) model can give good results in our case. But to compare the results of ARIMA (1,2,0) and ARIMA(2,2,0), both of the models are formed. Results of ARIMA(1,2,0) and ARIMA(2,2,0) will be compared and the better one will be used in the forecasting application.

Equations of ARIMA(1,2,0) process as follows:

$$\hat{P}_t = (2-\phi_1)P_{t-1} + (2\phi_1 - 1)P_{t-2} - \phi_1 P_{t-3} + (1+\phi_1) \times 63,23 \quad \text{(Eq. 54)}$$

Equation 54 gives the expected value of the peak power demand. ϕ_1 value can be calculated using "armax" function in MATLAB. ϕ_1 value is found as 0,624 and expected value of peak demand is formulized as in Equation 55.

$$\hat{P}_t = 1,376P_{t-1} + 0,248P_{t-2} - 0,624P_{t-3} + 102,812 \quad \text{(Eq. 55)}$$

The model is tested for the peak power demand data between 2007 and 2011. In Table 29, observed peak power demands and forecasted values are shown. MAPE value for ARIMA(1,2,0) model %7,889.

Table 29. Test Results of the ARIMA(1,2,0) Model

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Target (MW)	29.249	30.517	29.870	33.392	36.122	39.045
Forecast (MW)	29.661	32.050	34.341	36.796	39.252	41.810
Error (MW)	-412	-1.533	-4.471	-3.404	-3.130	-2.765
MAPE	**%7,889**					

Equations of ARIMA(2,2,0) process as follows:

$$\hat{P}_t = (2-\phi_1)P_{t-1} + (2\phi_1 - \phi_2 - 1)P_{t-2} + (2\phi_2 - \phi_1)P_{t-3} - \phi_2 P_{t-4} + (1+\phi_1+\phi_2) \times 63,23 \quad \text{(Eq. 56)}$$

Equation 56 gives the expected value of the peak power demand by using ARIMA(2,2,0) model. "ϕ_1" is found as 0,6165 and "ϕ_2" is found as 0,01012. Expected value of peak demand can be written as in Equation 57.

$$\hat{P}_t = 1,3835P_{t-1} + 0,22288P_{t-2} - 0,59626P_{t-3} - 0,01012P_{t-4} + 102,85 \quad \text{(Eq. 57)}$$

Model is tested for the electrical energy demand data between 2007 and 2011. In Table 30, observed peak power demands and forecasted values are shown. MAPE value for ARIMA(2,2,0) model % 7,8996. This result is worse than the result of ARIMA(1,2,0) model, so ARIMA(1,2,0) model will be used in forecasting of electrical energy demand.

Table 30. Test Results of the ARIMA(2,2,0) Model

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Target (MW)	29.249	30.517	29.870	33.392	36.122	39.045
Forecast (MW)	29.667	32.049	34.347	36.797	39.257	41.811
Error (MW)	-418	-1.532	-4.477	-3.405	-3.135	-2.766
MAPE	**% 7,8996**					

In Table 31 peak demand forecast by using ARIMA(1,2,0) model is shown. Development of peak power demand is shown in Figure 51.

Table 31. Peak Power Forecast with ARIMA(1,2,0)

Year	**Peak Power Demand (MW)**	**Year**	**Peak Power Demand (MW)**
2013	41.950	2019	60.908
2014	44.969	2020	64.288
2015	48.020	2021	67.729
2016	51.154	2022	71.235
2017	54.338	2023	74.803
2018	57.594		

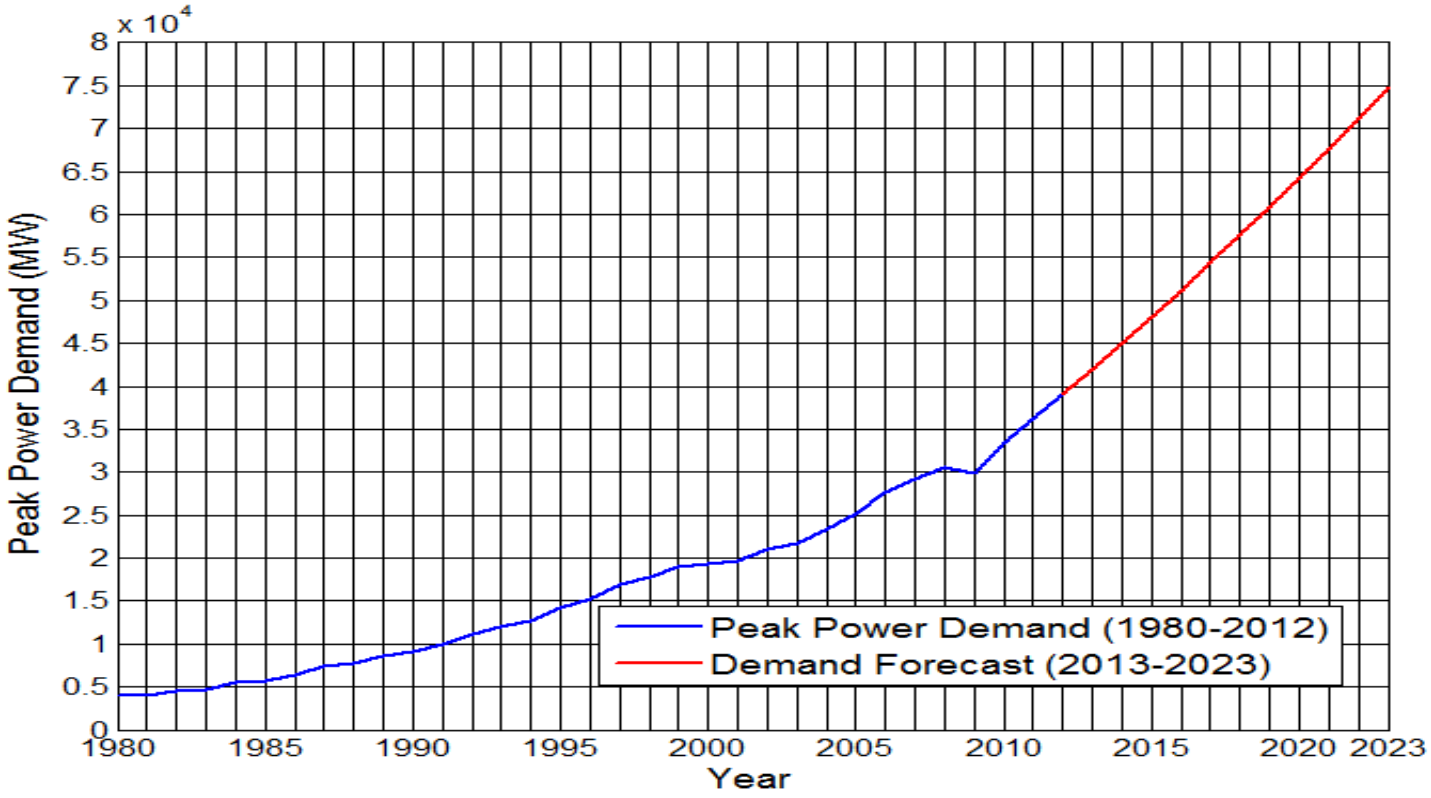

Figure 51. Peak Power Demand with ARIMA(1,2,0)

4.5 Comparison of the Results

In this part forecasting results of ANN, ARIMA modeling and MENR will be compared. In Table 32 and Figure 52 electrical energy demand forecasting results of ANN, ARIMA modeling and MENR are shown:

Table 32. Electrical Energy Demand Forecast (ANN, ARIMA and MENR)

YEAR	Electrical Energy Demand (GWh)			
	ANN	ARIMA	MENR Low Demand	MENR High Demand
2013	255.724	258.403	257.060	262.010
2014	272.191	274.310	273.900	281.850
2015	289.567	290.605	291.790	303.140
2016	307.727	307.609	310.730	325.920
2017	326.657	324.987	330.800	350.300
2018	346.291	342.874	352.010	376.350
2019	366.571	361.249	374.430	404.160
2020	387.579	380.101	398.160	433.900
2021	409.278	399.441	424.780	467.260
2022	431.681	419.264	452.390	502.304
2023	454.336	439.571	481.796	539.977

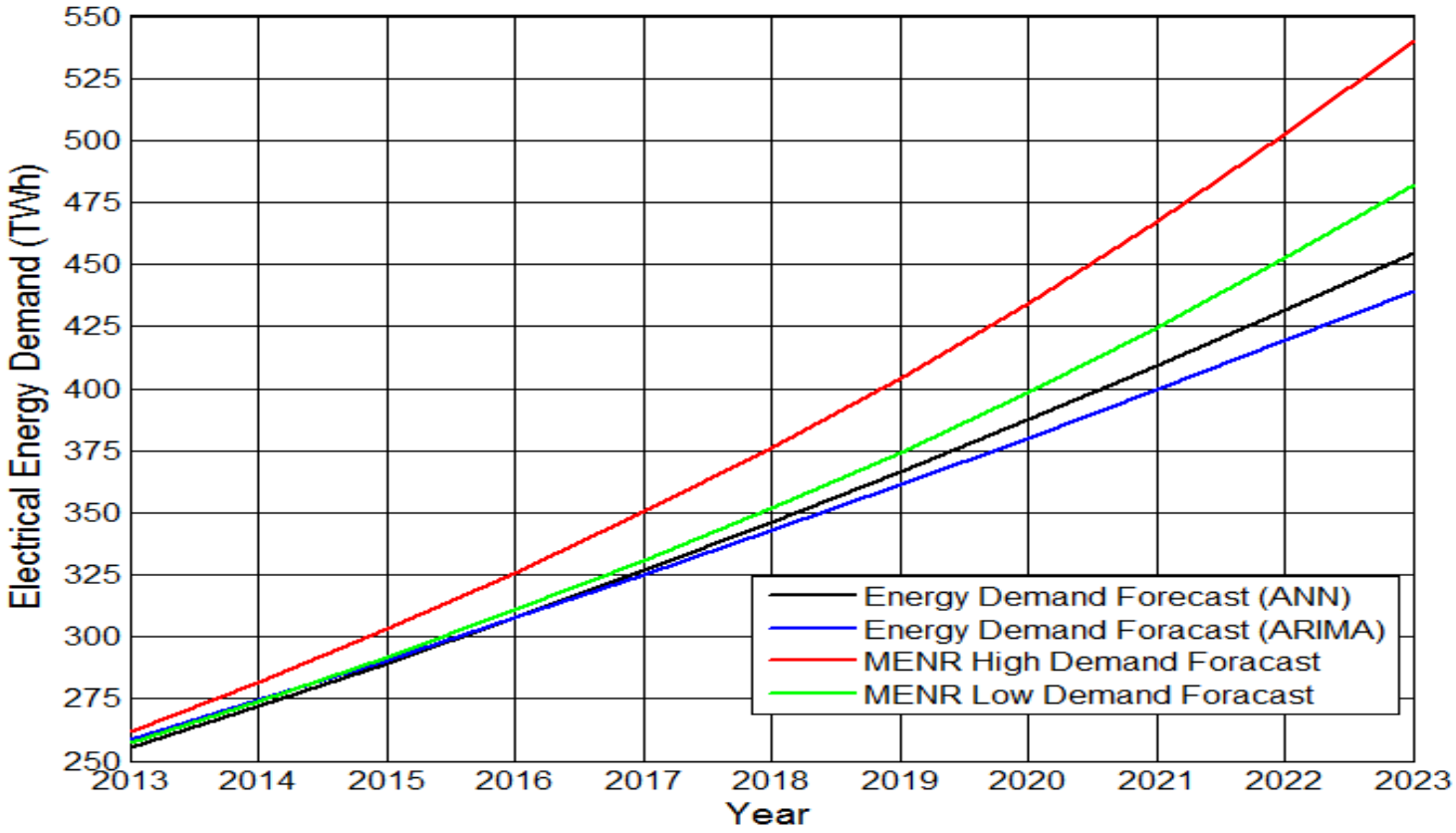

Figure 52. Energy Demand Forecast of ANN, ARIMA Model and MENR

From Table 32 and Figure 52 it's seen that results of ANN and ARIMA modeling are very close to each other. Electrical energy forecast in 2023 for ANN and ARIMA modeling has a difference of %3,26. Since two different methods give almost the same results, it can be said that electrical energy demand forecasting is successfully made. Forecast of MENR are higher than the forecasting results obtained by ANN and ARIMA modeling.

In Table 33 and Figure 53 peak power demand forecasting results of ANN, ARIMA modeling and MENR are shown. From Table 33 and Figure 53 it's seen that the results of ANN and ARIMA modeling are very close to each other. Peak power forecast in 2023 for ANN and ARIMA modeling has a difference of %0,89. Since two different methods give almost the same results, it can be said that peak power demand forecasting is successfully made. As shown in Figure 53 forecasts obtained from ANN and ARIMA modeling are between high demand and low demand forecasts made by MENR.

Table 33. Peak Power Demand Forecast (ARIMA, ANN and MENR)

YEAR	Peak Power Demand (MW)			
	ANN	ARIMA	MENR Low Demand	MENR High Demand
2013	41.384	41.950	40.130	41.000
2014	43.871	44.969	42.360	43.800
2015	46.459	48.020	44.955	46.800
2016	49.273	51.154	47.870	50.210
2017	52.105	54.338	50.965	53.965
2018	55.396	57.594	54.230	57.980
2019	58.642	60.908	57.685	62.265
2020	62.203	64.288	61.340	66.845
2021	65.955	67.729	65.440	71.985
2022	69.947	71.235	69.693	77.383
2023	74.138	74.803	74.223	83.187

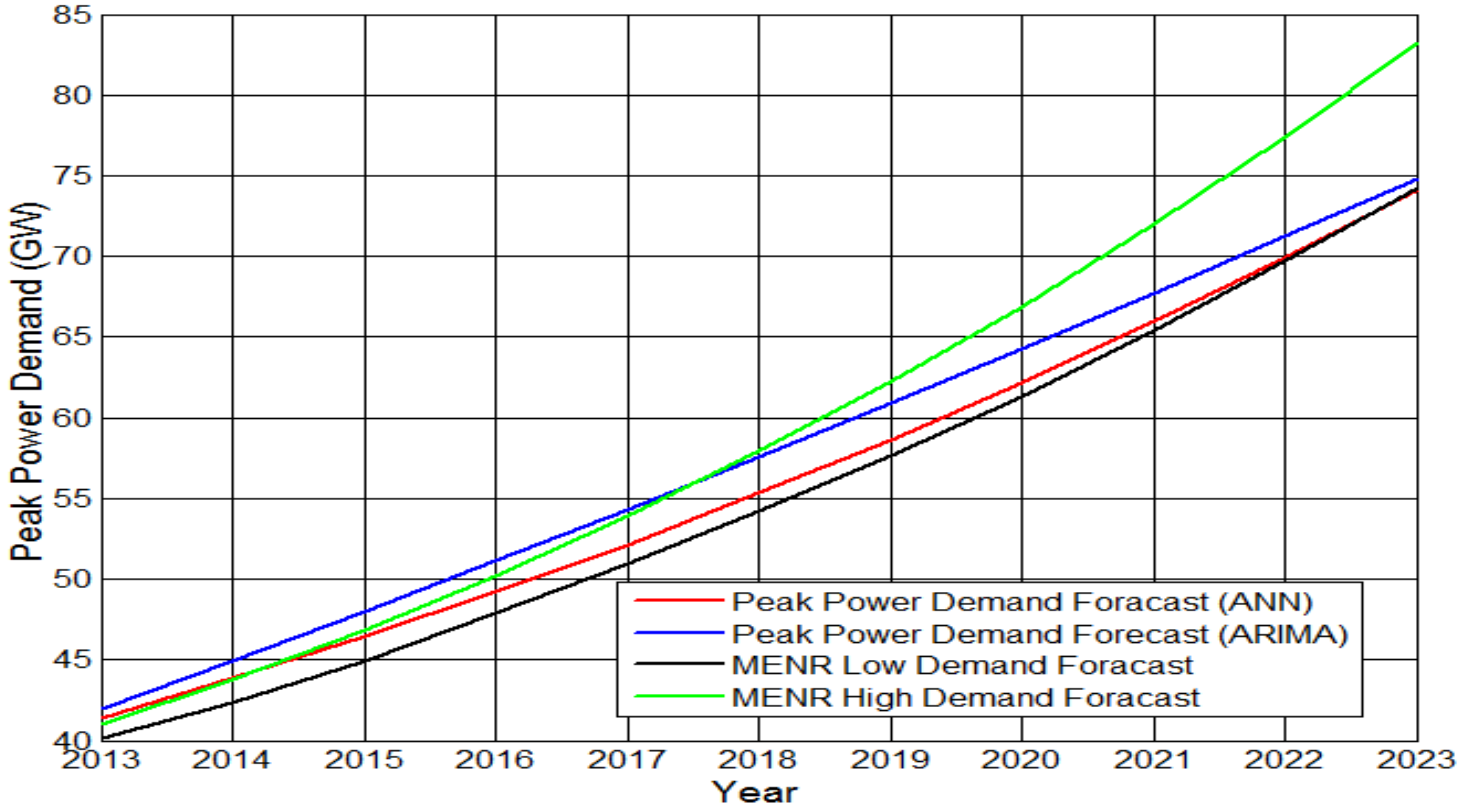

Figure 53. Peak Power Demand Forecast of ANN, ARIMA Model and MENR

4.6 Electricity Consumption by Sector

Electrical consumption by sector is an important factor which determines electricity price for different sectors. Electricity consumption of sectors shows development of different sectors and socio-demographic conditions of a community. In Table 34 net electricity consumption of Turkey between 1970 and 2010 by sector is shown [27]. In Table 35 percentages of electricity consumptions by sector are given.

Table 34. Net Electrical Energy Demand by Sector [27]

Year	Residence (GWh)	Commerce (GWh)	Government Agency (GWh)	Industry (GWh)	General Illumination (GWh)	Other (GWh)	Total (GWh)
1970	1.161,9	348,9	301,8	4.689,7	193,0	612,5	7.307,8
1975	2.359,1	659,4	495,9	8.745,3	250,6	981,4	13.491,7
1980	4.387,1	1.146,7	609,2	13.007,9	289,5	957,8	20.398,2
1985	5.634,3	1.620,5	891,5	19.607,7	407,3	1.547,3	29.708,6
1990	9.162,3	2.557,8	1.463,3	29.211,8	1.231,4	3.193,4	46.820,0
1995	14.492,5	4.195,2	3.011,6	38.007,4	3.105,9	4.581,2	67.393,8
2000	23.887,6	9.339,4	4.107,9	48.841,7	4.557,7	7.561,4	98.295,7
2005	30.935,0	18.543,8	4.662,7	62.294,2	4.143,0	9.684,1	130.262,8
2010	41.410,7	27.732,0	7.102,0	79.330,7	3.768,3	12.707,0	172.050,6

Table 35. Net Electrical Energy Demand by Sector (%)

Year	Residence (%)	Commerce (%)	Government Agency (%)	Industry (%)	General Illumination (%)	Other (%)
1970	15,9	4,8	4,1	64,2	2,6	8,4
1975	17,5	4,9	3,7	64,8	1,9	7,3
1980	21,6	5,6	3,0	63,8	1,4	4,7
1985	19,0	5,5	3,0	66,0	1,4	5,2
1990	19,6	5,5	3,1	62,4	2,6	6,8
1995	21,5	6,2	4,5	56,4	4,6	6,8
2000	24,3	9,5	4,2	49,7	4,6	7,7
2005	23,7	14,2	3,6	47,8	3,2	7,4
2010	24,1	16,1	4,1	46,1	2,2	7,4

As shown in the Table 35 from 1970 to 2010 industrial electricity consumption percentage decreases from %64,2 to %46,1. On the other hand residential consumption percentage increases from %15,9 to %24,1. Consumption in commerce increases from %4,8 to %16,1. In Turkey industrial and residential consumers are the biggest consumers. In 1970 electricity consumption of industrial sectors was almost four times more than residential consumption. But in 2010 industrial consumption is two times more than residential consumption. This shows that the importance of electricity for residential consumers and commercial consumers increases over the period 1970-2010. For determining a long term price policy for different sectors, load forecasting of different sectors is very important. In Table 36 and Figure 54 net electricity demand forecast by sector is shown.

Table 36. Net Electrical Energy Demand Forecast by Sector

Year	Residence (GWh)	Commerce (GWh)	Government Agency (GWh)	Industry (GWh)	General Illumination (GWh)	Other (GWh)	Total (GWh)
2013	49.988	36.455	8.507	110.352	4.038	12.654	221.994
2014	52.998	39.585	8.924	116.756	4.086	13.218	235.567
2015	56.111	42.824	9.350	123.248	4.133	13.258	248.924
2016	59.315	46.174	9.787	129.830	4.180	13.720	263.006
2017	62.616	49.633	10.235	136.501	4.225	13.914	277.124
2018	66.012	53.202	10.693	143.261	4.270	14.343	291.781
2019	69.502	56.882	11.161	150.110	4.313	14.641	306.609
2020	73.088	60.671	11.639	157.048	4.355	15.074	321.875
2021	76.769	64.571	12.128	164.075	4.397	15.448	337.388
2022	80.544	68.580	12.628	171.191	4.437	15.905	353.285
2023	84.415	72.700	13.137	178.396	4.476	16.342	369.466

Table 37. Net Electrical Energy Demand Forecast by Sector (%)

Year	Residence (GWh)	Commerce (GWh)	Government Agency (GWh)	Industry (GWh)	General Illumination (GWh)	Other (GWh)
2013	22,52	16,42	3,83	49,71	1,82	5,70
2014	22,50	16,80	3,79	49,56	1,73	5,61
2015	22,54	17,20	3,76	49,51	1,66	5,33
2016	22,55	17,56	3,72	49,36	1,59	5,22
2017	22,59	17,91	3,69	49,26	1,52	5,02
2018	22,62	18,23	3,66	49,10	1,46	4,92
2019	22,67	18,55	3,64	48,96	1,41	4,78
2020	22,71	18,85	3,62	48,79	1,35	4,68
2021	22,75	19,14	3,59	48,63	1,30	4,58
2022	22,80	19,41	3,57	48,46	1,26	4,50
2023	22,85	19,68	3,56	48,28	1,21	4,42

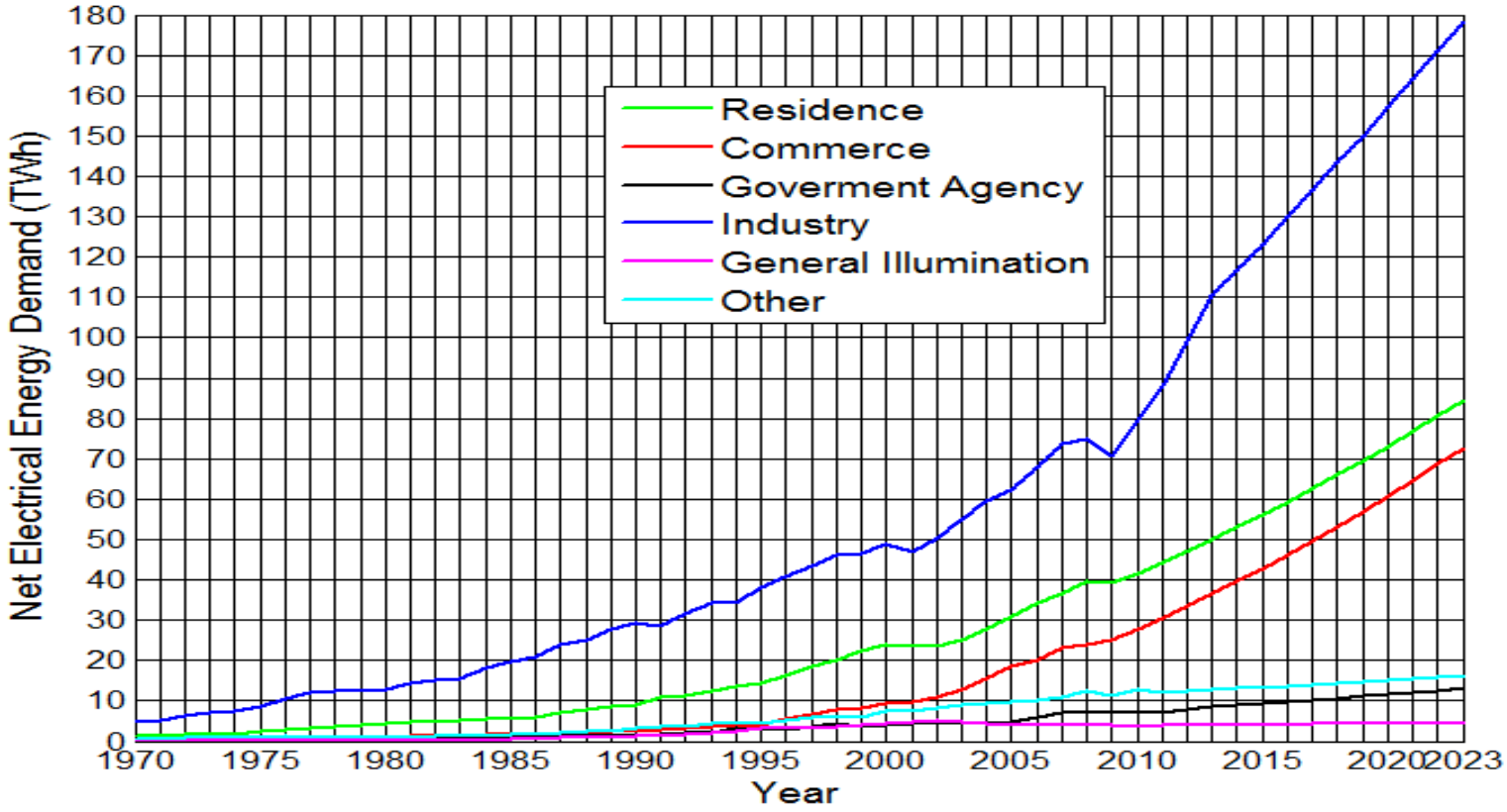

Figure 54. Net Electrical Energy Demand Forecast by Sector

4.7 Electricity Generation Capacity Projection

In this part energy and peak power production capacity of Turkey will be examined. In Appendix A, the development rates of new plants are shown. In Table 38 and Table 39 developments of energy and peak power generation capacities are shown respectively. In these tables only the plants with certain construction time are considered. In Figure 55 and Figure 56 the developments of energy and peak power production capacities are compared with demand forecast obtained from ARIMA and ANN. As shown in Figure 55 from point of reliable electrical energy production there will be deficit in Turkey starting from 2020. In Figure 56 it's seen that from point of reliable peak power production capacity there will be deficit starting from 2017. To prevent electricity deficit, plants with uncertain construction time should start to produce energy stating from 2017.

In Table 40 and Table 41 it's considered that plants with uncertain operation date will be start to produce energy in period 2017-2023. Total capacity of plants with uncertain operation date is equally distributed in period 2017-2023. In Figure 57 it's seen that from point of reliable energy production capacity there won't be any problem in Turkey but in Figure 58 it's seen that reliable peak power generation capacity is very close to peak power demand. Peak power demand exceeds, reliable peak power production capacity starting from 2020. To prevent future problems new plants should start to produce energy starting from 2020.

For a reliable system there should be % 15 security margins between forecasts and reliable production capacities. In Turkish Electrical System, reliable peak power production capacity is very close to demand on the next ten year. Reliable production capacity should be around 86.000MW in 2023.

Table 38. Development of Reliable Energy Production Capacity[10]

Year	Thermal (GWh)	Hydraulic (GWh)	Wind and Other Renewable (GWh)	Total Reliable Production (GWh)
2012	214.252	56.661	6.927	277.840
2013	217.097	59.895	7.943	284.935
2014	233.085	70.003	8.727	311.815
2015	263.477	79.281	9.029	351.787
2016	278.117	92.412	9.029	379.558
2017	278.117	93.991	9.029	381.137
2018	278.117	95.547	9.029	382.693
2019	278.117	95.547	9.029	382.693
2020	278.117	95.547	9.029	382.693
2021	278.117	95.547	9.029	382.693
2022	278.117	95.547	9.029	382.693
2023	278.117	95.547	9.029	382.693

Table 39. Development of Peak Power Production Capacity[11]

Year	Thermal (MW)	Hydraulic (MW)	Wind and Other Renewable (MW)	Total Production (MW)	Reliable Production (MW)
2012	35.029	19.620	2.423	57.072	42.063
2013	35.310	20.597	2.665	58.572	42.877
2014	36.800	23.515	3.135	63.450	45.818
2015	40.858	26.163	3.151	70.172	50.799
2016	42.435	29.957	3.151	75.543	54.115
2017	42.435	30.468	3.151	76.054	54.371
2018	42.435	30.926	3.151	76.512	54.600
2019	42.435	30.926	3.151	76.512	54.600
2020	42.435	30.926	3.151	76.512	54.600
2021	42.435	30.926	3.151	76.512	54.600
2022	42.435	30.926	3.151	76.512	54.600
2023	42.435	30.926	3.151	76.512	54.600

[10] The plants with certain construction time are considered

[11] The plants with certain construction time are considered

Table 40. Development of Reliable Energy Production Capacity[12]

Year	Thermal (GWh)	Hydraulic (GWh)	Wind and Other Renewable (GWh)	Total Reliable Production (GWh)
2012	214.252	56.661	6.927	277.840
2013	217.097	59.895	7.943	284.935
2014	233.085	70.003	8.727	311.815
2015	263.477	79.281	9.029	351.787
2016	278.117	92.412	9.029	379.558
2017	295.367	94.427	12.208	402.002
2018	312.618	96.419	15.388	424.425
2019	329.868	96.855	18.568	445.291
2020	347.118	97.291	21.747	466.156
2021	364.369	97.727	24.927	487.023
2022	381.619	98.163	28.106	507.888
2023	398.870	98.598	31.286	528.754

Table 41. Development of Peak Power Production Capacity[13]

Year	Thermal (MW)	Hydraulic (MW)	Wind and Other Renewable (MW)	Total Production (MW)	Reliable Production (MW)
2012	35.029	19.620	2.423	57.072	42.063
2013	35.310	20.597	2.665	58.572	42.877
2014	36.800	23.515	3.135	63.450	45.818
2015	40.858	26.163	3.151	70.172	50.799
2016	42.435	29.957	3.151	75.543	54.115
2017	44.712	30.599	4.091	79.402	56.768
2018	46.989	31.187	5.032	83.208	59.393
2019	49.266	31.318	5.973	86.557	61.790
2020	51.543	31.449	6.913	89.905	64.187
2021	53.819	31.579	7.854	93.252	66.583
2022	56.096	31.710	8.794	96.600	68.980
2023	58.373	31.841	9.735	99.949	71.377

[12] All licensed plants are considered

[13] All licensed plants are considered

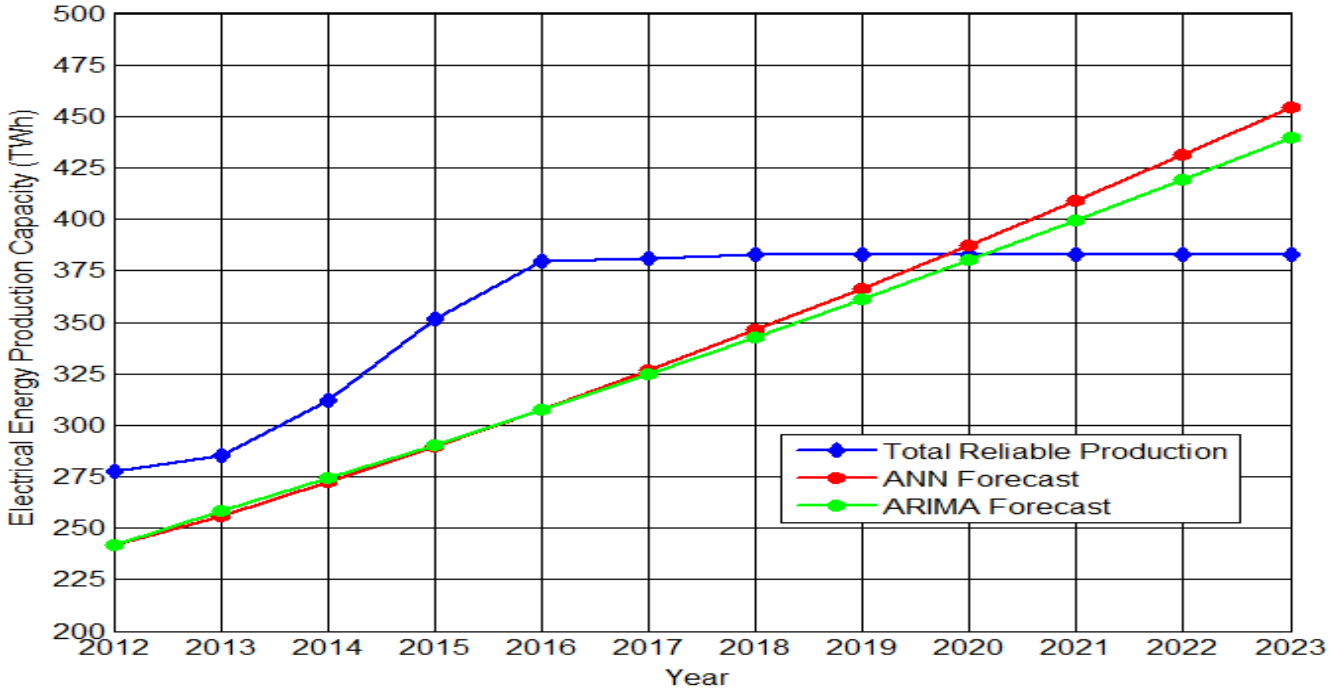

Figure 55. Electrical Energy Production Capacity vs Energy Demand Forecast[14]

[14] The plants with certain construction time are considered

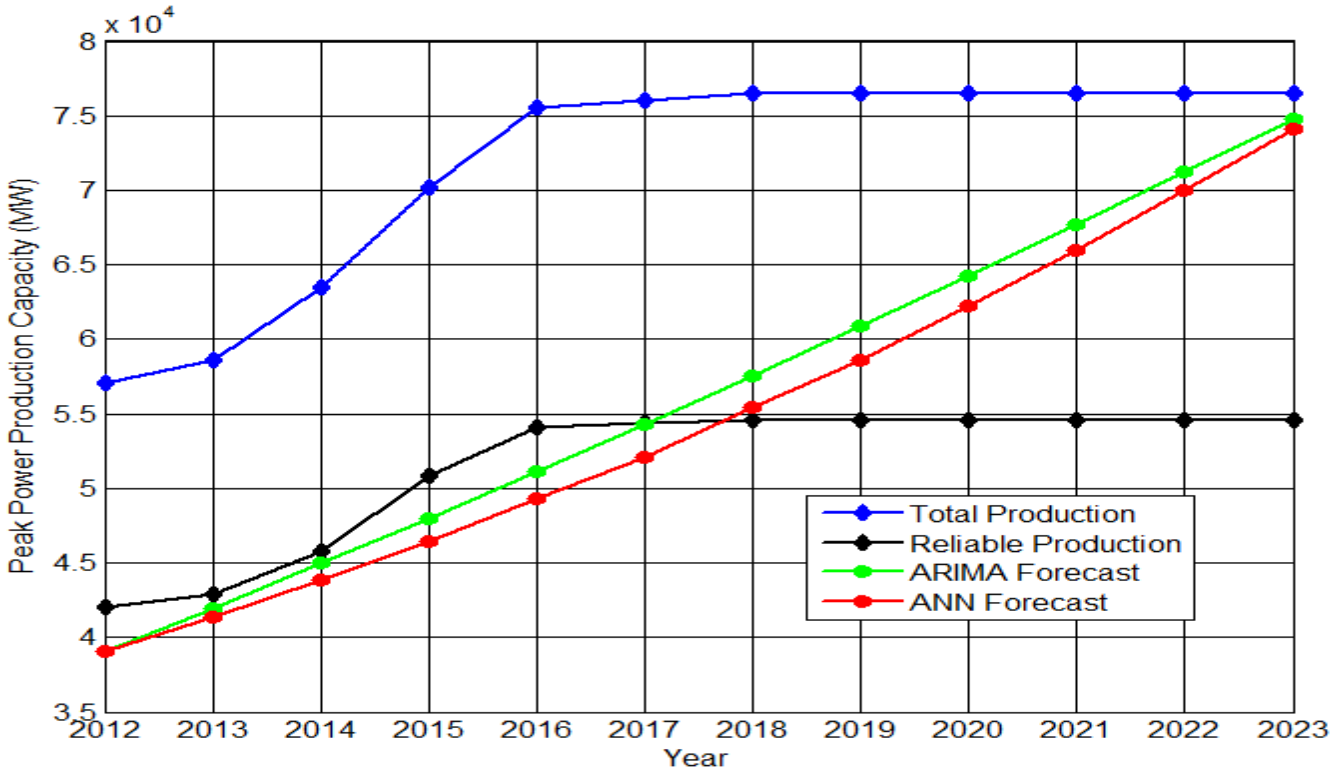

Figure 56. Peak Power Production Capacity vs Peak Power Demand Forecast[15]

[15] The plants with certain construction time are considered

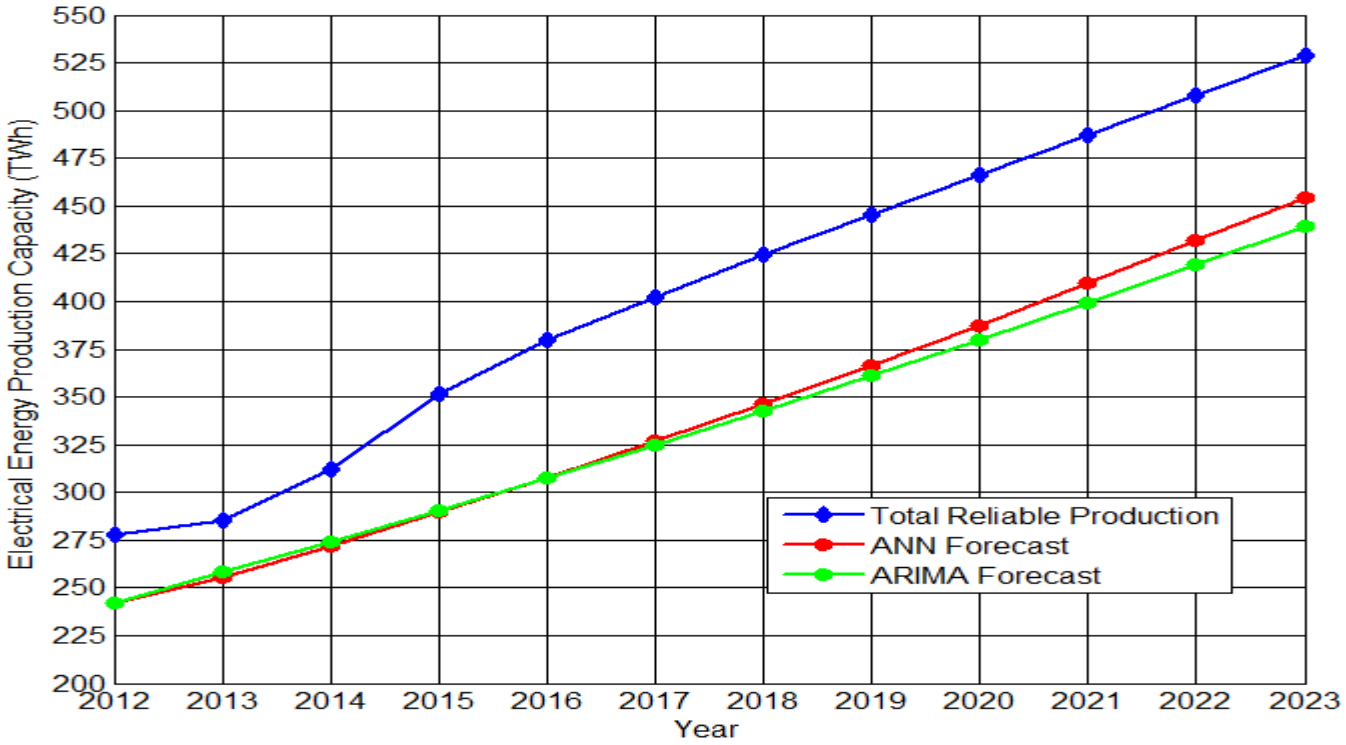

Figure 57. Electrical Energy Production Capacity vs Energy Demand Forecast[16]

[16] All licensed plants are considered

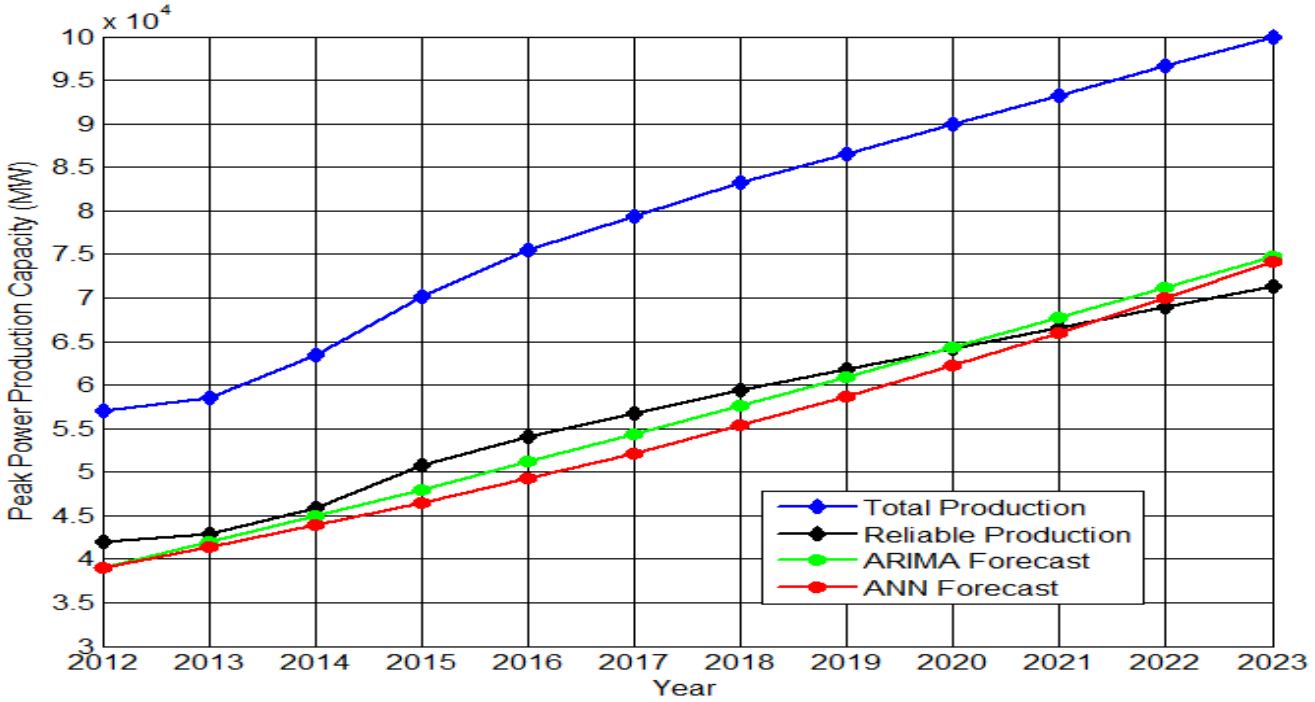

Figure 58. Peak Power Production Capacity vs Peak Power Demand Forecast[17]

[17] All licensed plants are considered

CHAPTER 5

CONCLUSION AND FUTURE WORK

In this thesis electrical energy and peak power demand forecasting study for Turkey between 2013 and 2023 is done. Then electrical energy and peak power production capacities are investigated. Results are compared to see supply demand balance of Turkey in long term. There are two fundamental methods for long term forecasting. First one is artificial neural network based method; and second one is time series method. In this thesis both artificial neural network method and time series method are used and their results are compared.

In the first part of the thesis general overview of the Turkish Electricity Market is examined. Then importance of making long term plans in electrical energy policy is discussed. Turkish Electricity Market is one of the fastest growing electricity markets in the world. To provide security of the supply in Turkey, reducing the dependency of the country to imported resources; Turkey should make long term plans in electrical energy policy. Turkey's electrical energy generation is highly dependent on natural gas. Percentage of electricity production from natural gas in Turkey is %43,2 which is two times more than world average (%21,4). Turkey imports %98 of its gas and this situation causes threats against Turkish energy security and Turkey's political independence.

In planning of electrical energy policy, the first step is forecasting electricity demand in long term. Electrical energy forecasting is very important on electrical energy investments. Overestimation of electrical energy demand causes overinvestment and construction of thermal generators to supply urgent need of electrical energy which increases the dependency of country to the imported resources. Turkey has significant amount of local energy resources and most of these resources are renewable energy resources. If Turkey supports R&D studies on energy, new job opportunities can be open for the young generation and the dependency of the country to the imported resources can be reduced.

In second part of the thesis the fundamentals of artificial neural network (ANN) is examined. ANN is an artificial intelligence based method. It simulates the operation of human brain. It learns from the examples and adjusts the synaptic coefficients according to the learning rule. ANN has some advantages and disadvantages. It can solve highly nonlinear problems which are not easy to model mathematically. But there is no guarantee for an optimum solution and the behavior of ANN cannot be explained. It does not give a closed formula for the solution; it's like a black box, takes the inputs and generates outputs.

In third part of the thesis time series method is examined. Time series method uses observed data in the past to forecast the future values. If the data is stationary AR, MA or ARMA processes can be used. If the data is nonstationary ARIMA processes should be used. Firstly non stationary data should be turned into stationary by applying difference operator. In time series method a closed formula is obtained which uses the past values to forecast the next value.

In forth part of the thesis forecasting case studies are done using ANN and ARIMA method. Forecasted electrical energy demand in 2023 by using ANN is 454,3TWh, electrical energy demand forecast by using ARIMA is 439,5TWh. Forecasting results are very close to each other and there is a difference of %3,26. Forecasted peak power demand in 2023 by using ANN is 74.138MW, and peak power demand forecast by using ARIMA is 74.803MW. There is a difference of %0,89 which is a quite low value. By comparing forecast results of two different methods, it can be said that the forecasts are successful because completely different methods give almost the same result.

In ARIMA modeling, to make forecasting statistical information such as GPD, IIP, population is not necessary. ARIMA modeling takes the past values of the data and finds the relationship between past values of the data with future values. It gives a mathematical formula which can be used in long term forecasting. In cases, when reliable statistical data such as GPD, IIP, and population does not exist; ARIMA modeling should be used for forecasting. When ANN is trained with wrong statistical data, forecasted outputs will be wrong.

ANN method is generally used in short term forecasting applications. ANN requires past statistical data. It can form nonlinear relationship between input data and output such as relationship between temperature, humidity and electrical energy demand. In these cases ANN can be used to model the nonlinear relationship between input and output. ANN is not very popular in long term forecasting application because it is not easy to access reliable statistical data to train the network. Since ANN is a black box, it gives output according to the input values; if statistical data is wrong, ANN will give incorrect outputs. In the thesis; GDP, IIP and population are used as input of ANN. For better forecasting number of factories, number of hotels can be added as input. But in Turkey's situation it is not easy to access reliable statistical data for long term forecasting (past 30 years data). This reduces usage of ANN in long term forecasting applications.

When the forecasting results are compared with forecasts made by MENR it's seen that forecasted electrical energy demand with ANN and ARIMA method is lower than electrical energy demand forecast made by MENR. It's seen that MENR uses similar increment rates for forecasting energy demand and peak power demand. On the other hand from the average increment rates of past ten years, it's seen that the average increment rate of peak power demand (%6,06) is higher than the average increment rate of electrical energy demand (%5,48). Since MENR uses similar increment rates for forecasting, MENR's electrical energy demand forecast is higher than expected.

After forecasting electrical energy and peak power demand, electrical energy forecast by sector is done. It's seen that residential and commercial usage of electricity highly increases from 1970 to 2010. As shown in the forecast results this increase will continue in 2013-2023 period. It can be said that the residential and commercial electricity price will increase in the period 2013-2023.

Finally development of electrical energy production capacity and peak power production capacity are examined. According to development rates of new plants (with certain operation time), electrical deficit from point of reliable peak power generation is expected starting from 2017. From point of reliable electrical energy generation, deficit is expected starting from 2020. To prevent possible problems in near future, licensed plants with uncertain operation dates should start to produce energy starting from 2017. If all licensed plants are considered and plants with uncertain operation dates will start to produce energy starting from 2017 there won't be any problem from point of reliable electrical energy generation but reliable peak power generation capacity is still very close to peak power demand. Peak power demand exceeds peak power generation capacity starting from 2020. To prevent possible problems, plants with uncertain construction time should start operation from 2017. New generations should be constructed to satisfy supply demand balance after 2020.

For a reliable electrical system there should be a minimum %15 security barrier between reliable production capacity and demand forecast. Every long term forecasts are inaccurate so demand can be higher than expected. Production of hydraulic and wind generators highly dependent on weather conditions. They may produce less energy than expected. Moreover there should be spare generation reserve to service when there is a fault in the system. To increase reliability of the electrical system and prevent possible blackouts during high power demand periods new generators should be constructed. In 2023 Turkey's reliable electrical energy production capacity should exceed 525TWh, and reliable peak power production capacity should exceed 86.000MW. Old plants which are not economical to operate should be renewed.

To ensure security of Turkish Electrical System and to guide the new investors, EMRA should regularly obtain and publish expected construction time of licensed plants and development rate of constructions. In the web site of EMRA there is a list of licensed plants and development rate of the constructions [28]. But there is not any information about completion time of the constructions. For new investors it is very important to know what will be the total electrical energy production capacity of Turkey in the next ten year. If the demand exceeds the production capacity, electricity price can highly increase. If the total production capacity will be much more than demand; because of the competition in the market, electricity price will decrease. The future development of supply demand curve influences on electricity price. For investors electricity price is very important because it determines the payback time of the plant. EMRA is the only institution which has power of taking actual information about the licensed plants. EMRA should publish the actual completion times of constructions for licensed plants.

As a future work, long term electrical energy price forecasting can be done. In a competitive market electrical energy price is very important. It's like a signal for new investments. In the case of electrical energy deficit, electrical energy price increases and this mechanism gives a signal for new investments. For investors, electrical energy price forecasting is very important because payback time of the plant depends on the electricity price. For electricity price forecasting ANN and ARIMA method can be used together. For ANN; natural gas price, spare supply reserve, electrical energy demand and peak power demand can be used as input.

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APPENDIX A

DEVELOPMENT RATES AND OPERATION TIMES OF NEW PLANTS [28]

Table 42. Thermal Plants

No	Company	Plant	Place	Source Type	Data of License	License Installed Power (MWm)	Average Production (kWh/year)	Capacity under Construction (MWm)	Completion Rate July 2012(%)	Completion Time
THERMAL PLANTS										
1	3S Enerji ve Maden Üretim A.Ş.	Yıldızlar Termik Santrali	Çankırı	lignite	31.05.2006	380,0	2.800.000.000	380,0	12,5	2015
2	Acarsoy Enerji Elektrik Üretim San. Ve Tic. A.Ş.	Acarsoy Denizli Doğalgaz Santrali	Denizli	natural gas	29.07.2010	129,8	1.050.000.000	129,8	*	2014
3	Adularya Enerji Elektrik üretimi ve Madencilik A.Ş.	Yunus Emre Termik Santrali	Eskişehir	coal	30.07.2008	294,2	2.100.000.000	294,2	34,2	2015
4	AGE Denizli Doğalgaz Elektrik Üretim A.Ş.	AGE DGKÇS	Denizli	natural gas	18.09.2008	209,0	1.643.792.000	113,4	*	2014
5	Ağaoğlu Enerji Üretim A.Ş.	My World Europe Ayazma Kojenerasyon Tesisi	İstanbul	natural gas	08.03.2012	36,0	280.000.000	36,0	0,5	uncertain
6	Akçansa Çimento San. Ve Tic. A.Ş.	Akçansa Çanakkale Atık Isı Enerji Santralı	Çanakkale	thermal other	06.11.2008	16,2	100.000.000	16,2	31,1 (January 2011)	2012
7	Akdeniz Kimya San. Ve Tic. A.Ş.	Akdeniz Kimya	İzmir	natural gas	08.12.2011	4,2	32.352.000	2,1	*	uncertain
8	Akfen Enerji Üretim ve Tic. A.Ş.	Mersin DGKÇ Enerji Santralı	İçel	natural gas	08.03.2012	575,8	4.816.500.000	575,8	*	uncertain
9	Akman Tekstil Tic. ve San. A.Ş.		Tekirdağ	natural gas	22.06.2004	1,5	11.826.000	1,5	*	uncertain
10	Aksa Enerji Üretim A.Ş.	Aksa Enerji Santralı	Antalya	natural gas	13.11.2007	2.091,0	6.000.000.000	969,0	9,2	2016
11	Aksa Göynük Enerji Üretim A.Ş.	Bolu-Göynük Elektrik Santralı	Bolu	lignite	15.03.2012	275,0	2.025.000.000	275,0	32,2	2015
12	Aktaş Grup Elektrik Üretim San. Ve Tic. A.Ş.	May DGKÇS	Düzce	natural gas	23.02.2012	64,0	404.859.168	64,0	*	uncertain
13	Ales Elektrik Üretim Ve Ticaret A.Ş.	Ales DKÇS	Aydın	natural gas	26.01.2011	64,5	525.000.000	64,5	52,5	2014
14	Aliağa Çakmaktepe Enerji Üretim A.Ş.		İzmir	natural gas	08.12.2005	278,2	2.165.720.000	26,2	80,8 (July 2011)	2014
15	Alkim Alkali Kimya A.Ş.	Bolluk Tesisi (Termik-Akışkan Yataklı-Kojenerasyon)	Konya	lignite	12.10.2006	2,7	7.128.000	2,2	99,0 (May 2010)	2012
16	Altınsu Tekstil San. Ve Tic. Ltd. Şti.	Altınsu Tekstil Kojenerasyon Tesisi	Bursa	natural gas	08.12.2011	1,2	9.512.000	1,2	*	uncertain
17	Anadolu Termik Santralleri A.Ş.	Gerze Enerji Santrali	Sinop	coal other	20.11.2008	1.020,0	6.500.000.000	1.020,0	0,7 (July 2011)	uncertain
18	AS Enerji Elektrik Üretim San. Ve Tic. A.Ş.	AS Çimento Enerji Üretim Santralı	Burdur	natural gas	25.04.2008	67,0	520.000.000	67,0	37,2	2013
19	Aşkale Çimento San. A.Ş.	Aşkale Çimento San.T.A.Ş. Elektrik Üretim Tesisi	Erzurum	thermal other	21.07.2011	7,5	50.000.000	7,5	*	2013
20	Atlas Enerji Üretim Sanayi A.Ş.	Atlas Termik Santrali	Hatay	coal other	23.10.2008	1.213,6	8.520.000.000	1.213,6	22,4	2015

Table 42. Thermal Plants (continued)

21	Ayas Enerji Üretim ve Ticaret A.Ş.	Ayas Enerji Santralı	Adana	coal other	30.04.2009	635,1	5.000.000.000	635,1	5,7	uncertain
22	Aytaş Alçı İnşaat Malz. Ve İnş. Maden San. Tic. A.Ş.	Aytaş Kojenerasyon Santrali	Ankara	natural gas	27.09.2007	1,7	12.800.000	1,7	*	2013
23	Bades Elektrik Üretim A.Ş.	Taha DGKÇS	Mardin	natural gas	11.08.2011	186,0	1.415.000.000	186,0	1,8	uncertain
24	Batıçim Batı Anadolu Çimento San. A.Ş.	Batıçim Atık Isı Satralı (otoprodüktör)	İzmir	thermal other	21.07.2011	9,0	51.289.700	9,0	98,4	2012
25	Batısöke Söke Çimento San. Türk A.Ş.	Batısöke Atık Isı otoprodüktör Santralı	Aydın	thermal other	21.07.2011	7,3	46.297.585	7,3	99,6	2012
26	Binatom Elektrik Üretim A.Ş.	Binatom Emet Elektrik Üretim Santrali	Kütahya	natural gas	06.10.2011	11,0	87.945.000	8,8	74,8	2014
27	Borasco Elektrik Üretim San. Ve Tic. A.Ş.	Samsun Doğalgaz Kombine Çevrim Santrali	Samsun	natural gas	25.04.2008	886,9	6.948.800.000	886,9	64,8 (July 2011)	uncertain
28	Boyar Kimya San. Ve Tic. A.Ş.	Boyar Kimya Kojenerasyon TESİSİ	Gaziantep	natural gas	03.03.2011	2,1	14.800.000	2,1	*	2014
29	Burkay Tekstil San. Tic. A.Ş.	Burkay Tekstil Kojenerasyon Santrali	Bursa	natural gas	22.12.2011	1,2	9.512.000	1,2	*	uncertain
30	Burteks Tekstil San. Ve Tic. A.Ş.		Gaziantep	natural gas	20.10.2011	4,4	24.768.000	4,4	*	uncertain
31	Can Enerji Entegre Elektrik Üretim A.Ş.	Tekirdağ Enerji Üretim Santrali	Tekirdağ	natural gas	20.05.2010	30,0	230.000.000	0,0	1,9	uncertain
32	Canan Tekstil Sanayi ve Ticaret A.Ş.	Canan I	Gaziantep	natural gas	01.07.2010	4,1	32.000.000	4,1	*	2013
33	Çalık NTF Elektrik Üretim ve Madencilik A.Ş.	Çankırı-Orta Enerji Santralı	Çankırı	lignite	27.09.2007	170,0	1.300.000.000	170,0	7,6	uncertain
34	Çatalkaya Enerji Madencilik Tarım San. Ve Tic. A.Ş.	Büyükefe DGKÇS	Aydın	natural gas	04.08.2011	145,2	1.161.050.400	145,2	0,0 (January 2012)	2015
35	Çeltik Enerji Elektrik Üretim ve Ticaret A.Ş.	Çeltik DGKÇS	Şanlıurfa	natural gas	20.10.2011	791,7	5.100.000.000	791,7	0,0	uncertain
36	Çimsa Çimento San. Ve Tic. A.Ş.	Çimsa Atıkısı Santrali	İçel	thermal other	06.07.2011	9,8	60.000.000	9,8	*	2014
37	Çine Enerji Üretim San. Ve Tic. A.Ş.	Çaycuma DGKÇS	Zonguldak	natural gas	24.05.2012	145,8	910.000.000	145,8	0,0	uncertain
38	Çobanyıldızı Elektrik Üretim A.Ş.	Çumra Termik santrali	Konya	lignite	04.08.2011	38,1	244.000.000	38,1	6,5	2013
39	Dedeli Doğalgaz Elektrik Üretim ve Ticaret A.Ş.	Çay DGKÇS	Afyon	natural gas	18.05.2011	143,0	1.115.920.000	13,0	85,0	2012
40	Dedeli Doğalgaz ve Elektrik Üretim A.Ş.	Bilecik DGKÇS	Bilecik	natural gas	04.05.2011	143,0	1.115.920.000	13,0	85,0	2012

Table 42. Thermal Plants (continued)

41	Delta Enerji Üretim ve Ticaret A.Ş.	Delta Doğalgaz Kombine Çevrim Santrali	Kırklareli	natural gas	13.03.2008	199,2	1.550.000.000	135,0	12,8	2013
42	Demirer Kablo Tesisleri San. Ve Tic. A.Ş.	Demirer Kojenerasyon Tesisi	Bilecik	natural gas	22.12.2011	2,5	17.822.000	2,5	*	uncertain
43	Derhan Tekstil Konfeksiyon San. Tic. LTd. Şti.	Derhan Tekstil Kojenerasyon Santrali	Bursa	natural gas	22.12.2011	1,2	9.512.000	1,2	*	uncertain
44	Doğaner Alçı Madencilik Enerji İth. İhr. Paz. Tic. ve San. A.Ş.	Doğaner Alçı Otop. Enerji Santralı	Ankara	natural gas	27.08.2007	1,6	11.592.000	1,6	*	uncertain
45	Durkar Halı Tekstil San. ve Tic. A.Ş.	Durkar I	Gaziantep	natural gas	22.12.2011	2,5	13.500.000	2,5	*	uncertain
46	Ege Yıldızı Doğalgaz ve Elektrik Üretim Limited Şirketi	Ege Yıldızı İzmir Çandarlı DGKÇS	İzmir	natural gas	23.02.2012	143,5	1.159.200.000	143,5	0,6	uncertain
47	Egemer Elektrik üretim A.Ş.	Erzin Doğalgaz santrali	Hatay	natural gas	07.05.2009	900,0	6.750.000.000	900,0	37,8	uncertain
48	Enerjisa Enerji Üretim A.Ş.	Tufanbeyli Termik Santrali	Adana	lignite	10.02.2004	453,0	3.375.000.000	453,0	19,2	2015
49	Enka Enerji Üretim A.Ş.	Aliağa Enerji Santralı	İzmir	coal other	06.03.2008	800,0	5.625.000.000	800,0	2,5	uncertain
50	Erpiliç Entegre Tavukçuluk Üretim Pazarlama ve Tic. Ltd.Şti.	Kojenerasyon-Erpiliç Otoprodüktör Santralı	Bolu	thermal other	09.11.2007	1,5	11.625.000	1,5	*	uncertain
51	Eti Alüminyum A.Ş.	Seydişehir Santrali	Konya	coal	27.12.2011	13,5	103.440.000	13,5	*	uncertain
52	ETİ Krom A.Ş.	Eti Krom A.Ş. Proses Isılı Kojenerasyon Santralı	Elazığ	ermal oth	15.03.2012	5,8	36.000.000	5,8	*	uncertain
53	Fener Enerji Taahhüt İnşaat ve San. Tic. Ltd. Şti.	Fener Enerji TES	Kayseri	natural gas	20.12.2011	1,2	6.900.000	1,2	*	uncertain
54	Frito Lay Gıda Sanayi ve Ticaret A.Ş.	Frito Lay Tarsus Kogenerasyon Santrali	İçel	natural gas	18.11.2009	0,7	4.800.000	0,7	95,9 (July 2011)	2012
55	Galata Enerji Üretim San. Ve Tic. A.Ş.	Şırnak Termik Santrali	Şırnak	asphaltite	19.03.2009	275,5	1.944.000.000	275,5	0,0	uncertain
56	Gaziantep OSB Elektrik Üretim A.Ş.	Goren 2	Gaziantep	natural gas	07.06.2011	50,0	276.500.000	50,0	*	2014
57	GG Doğalgaz Elektrik Üretim A.Ş.	Kombine Çevrim Santralı	Aydın	natural gas	01.11.2011	450,0	3.410.000.000	450,0	*	uncertain
58	Göçtur Tur. Yat. ve Tic. A.Ş.	Göçtur Pine Bay kojenerasyon tesisi	Aydın	natural gas	08.03.2012	0,8	4.400.000	0,8	*	uncertain
59	Gülsan Sentetik Dokuma Sanayi ve Ticaret A.Ş.	Gülsan Sentetik Kojenerasyon	Gaziantep	natural gas	31.03.2011	37,6	264.000.000	37,6	*	2014
60	Günöz Tekstil ve Kimya İşletmeleri Sanayi ve Ticaret Ltd. Şti.	Günöz Otop	Tekirdağ	natural gas	03.07.2003	1,4	11.000.000	1,4	*	uncertain

Table 42. Thermal Plants (continued)

61	Gürteks İplik San. Ve Tic. A.Ş.	Gürteks iplik Kojenerasyon Tesisi	Gaziantep	natural gas	19.08.2010	6,9	52.660.080	6,9	0,7 (September 2010)	2012
62	Gürteks İplik San. Ve Tic. A.Ş.	Gürteks sentetik kojenerasyon tesisi	Gaziantep	natural gas	27.12.2011	3,4	26.200.000	3,4	*	uncertain
63	Gürteks İplik San. Ve Tic. A.Ş.	Gürteks sentetik kojenerasyon tesisi	Gaziantep	natural gas	09.02.2012	3,4	26.200.000	3,4	*	uncertain
64	Güven Gıda San. Ve Tic. A.Ş.	Güven Gıda Kojenerasyon	Gaziantep	natural gas	21.07.2011	2,1	15.887.520	2,1	*	2013
65	Habaş Sınai ve Tıbbi Gazlar İstihsal Endüstrisi A.Ş.	Habaş Termik Santralı	İzmir	natural gas	28.04.2011	460,0	3.600.000.000	460,0	*	uncertain
66	Hakan Madencilik ve Elektrik Üretim San. Tic. A.Ş.	Hakan Kömür Santrali	Adana	coal other	19.08.2010	110,0	665.760.000	110,0	1,4 (January 2012)	uncertain
67	Hasırcı Tekstil Tic. Ve San. Ltd. Şti.	Hasırcı Kojenerasyon Tesisi	Gaziantep	natural gas	06.01.2011	2,1	16.000.000	0,0	96,4	uncertain
68	Hayat Kimya Sanayi A.Ş.	Kojenerasyon	Kocaeli	natural gas	08.09.2005	30,7	188.000.000	15,4	*	2012
69	Hema Elektrik Üretim A.Ş.	Kandilli Termik Santralı	Zonguldak	hard coal	12.10.2006	51,3	350.000.000	51,3	1,9	uncertain
70	Hema Elektrik Üretim A.Ş.	Amasra Termik Santralı	Bartın	hard coal	12.10.2006	1.116,7	7.700.000.000	1.116,7	0,0	uncertain
71	Hera Enerji Üretim A.Ş.	Uşak OSB Enerji Üretim Santrali	Uşak	natural gas	22.03.2012	46,4	337.000.000	46,4	0,1	uncertain
72	International Hospital İstanbul A.Ş.	International Hastanesi İstanbul Kojenerasyon Santrali	İstanbul	natural gas	04.09.2008	0,8	6.100.000	0,8	*	uncertain
73	Işıl Sağlık Hizmetleri A.Ş.	Medicana/Ankara Hastanesi Otop. Santralı	Ankara	natural gas	26.01.2011	0,8	6.500.000	0,8	*	2012
74	İç Anadolu natural gas Elektrik Üretim ve Ticaret A.Ş.	İç Anadolu natural gas Kombine Çevrim Enerji Santralı Projesi	Kırıkkale	natural gas	19.03.2011	432,0	3.150.000.000	432,0	5,6	uncertain
75	İÇDAŞ Elektrik Enerjisi Üretim ve Yatırım A.Ş.	İÇDAŞ Elektrik Enerjisi Üretim ve Yatırım A.Ş.	Çanakkale	coal other	12.04.2007	1.215,8	8.640.000.000	607,9	36,1	2016
76	İpeksan Elektrik Üretim A.Ş.	İpeksan Kojenerasyon Tesisi	Mardin	natural gas	01.11.2011	6,6	54.054.000	6,6	*	uncertain
77	İzdemir Enerji Elektrik Üretim A.Ş.	İzdemir Enerji	İzmir	coal other	04.06.2009	354,6	2.500.000.000	354,6	21,5	uncertain
78	İzmir Büyük Efes Otelcilik ve Turizm A.Ş.	İzmir Büyük Efes Oteli Kojenerasyon Tesisi	İzmir	natural gas	28.03.2012	1,2	9.600.000	1,2	*	uncertain
79	JTİ Tütün Ürünleri San. A.Ş.		İzmir	natural gas	18.02.2010	4,5	30.000.000	4,5	*	uncertain
80	Kanyon Enerji Üretim ve Ticaret A.Ş.	Kırşehir DGKÇS	Kırşehir	natural gas	18.01.2012	853,0	6.622.560.000	853,0	*	uncertain

Table 42. Thermal Plants (continued)

81	Kayalı Enerji Üretim A.Ş.	Osmaniye DGKÇS	Osmaniye	natural gas	17.11.2011	81,0	632.944.206	81,0	*	uncertain
82	Keskinkılıç Gıda San. Ve Tic. A.Ş.	Kojenerasyon	Aksaray	natural gas	22.06.2006	19,8	40.320.000	10,8	*	uncertain
83	Kıvanç Tekstil San. ve Tic. A.Ş.		Adana	natural gas	08.04.2005	6,2	50.300.000	2,2	1,9	uncertain
84	Kızılırmak Elektrik Üretim A.Ş.	Kırıkkale Doğalgaz Kombine Çevrim Enerji Santrali	Kırıkkale	natural gas	06.07.2011	1.260,0	9.900.000.000	1.260,0	0,3	uncertain
85	Komet Enerji San. Ve Tic. A.Ş.	Komet Enregre DGÇS	Karaman	natural gas	24.02.2011	1.108,0	8.493.880.000	1.108,0	9,6	uncertain
86	Konya Şeker Sanayi ve Ticaret A.Ş.	Çumra	Konya	lignite	12.10.2004	22,0	62.000.000	6,0	*	uncertain
87	Koruma Klor Alkali San. ve Tic. A.Ş.	Koruma Klor Alkali Otop.	Kocaeli	natural gas	13.03.2003	31,2	242.000.000	21,3	*	uncertain
88	Kurtoğlu Bakır Kurşun Sanayi A.Ş.		Tekirdağ	natural gas	03.03.2006	3,3	25.360.000	1,7	*	uncertain
89	Küçükbay Yağ ve Deterjan San. A.Ş.	Küçükbay Yağ ve Deterjan San. Otop. Tesisi	İzmir	natural gas	29.09.2011	1,7	13.000.000	1,7	96,2	2012
90	Küçüker Tekstil San. Ve Tic. A.Ş.	Küçüker Termik Kojen. Tesisi	Denizli	coal	28.04.2011	5,0	39.600.000	5,0	*	2014
91	Makyol İnş. San. Tur. Ve Tic. A.Ş.	Makyol ETM projesi Otop Santrali	İstanbul	natural gas	02.06.2011	0,6	4.500.000	0,6	*	2013
92	Marde Elektrik Üretim A.Ş.	Mardin DGKÇS	Mardin	natural gas	04.04.2012	510,0	3.825.000.000	510,0	0,4	uncertain
93	Marmara Pamuklu Mensucat Sanayi ve Ticaret A.Ş.	Kojenerasyon	Tekirdağ	natural gas	14.07.2005	78,5	424.278.000	6,5	*	2012
94	Melike İplik San. Ve Tic. A.Ş.	Melike İplik Kojenerasyon Tesisi	Gaziantep	natural gas	19.09.2011	10,0	51.300.000	10,0	*	2014
95	Mercedes-Benz Türk A.Ş.		İstanbul	natural gas	17.02.2004	10,4	36.800.000	2,1	*	uncertain
96	Mina Alçı ve Harç Madencilik San. Tic. A.Ş.	Mina Alçı Kojenerasyon Tesisi	Ankara	natural gas	10.09.2009	1,6	11.760.000	1,6	*	uncertain
97	MMK Atakaş Metalurji San. Tic. Ve Liman İşletmeciliği A.Ş.	Kojenerasyon Tesisi	Hatay	natural gas	28.01.2010	14,5	114.780.000	14,5	*	2013
98	Naksan Enerji Elektrik Üretim A.Ş..	Naksan Enerji Santrali II	Gaziantep	natural gas	20.12.2011	55,0	312.007.840	55,0	*	2012
99	Naksan Plastik San. Ve Tic. A.Ş.	Naksan kojenerasyon	Gaziantep	natural gas	24.12.2009	8,3	58.880.000	8,3	*	uncertain
100	Ne-sa İnş. Elektrik Ve Madencilik İth. İhr. Tic. Ve San. A.ş.	Nesa Otoprodüktör Tesisi	Adana	natural gas	20.10.2010	1,7	13.000.000	1,7	80,1 (July 2011)	2012

Table 42. Thermal Plants (continued)

101	Odaş Elektrik Üretim San. Tic. A.Ş.	ODAS I DGKÇS	Şanlıurfa	natural gas	14.07.2011	150,0	1.260.000.000	17,0	78,2	2014
102	Ode Yalıtım Sanayi ve Ticaret A.Ş.	Ode Yalıtım Çorlu Kojenerasyon Tesisi	Tekirdağ	natural gas	01.03.2012	2,1	14.100.000	2,1	100,0	uncertain
103	Ora İstanbul Gayrimenkul Yatırım ve Geliştirme A.Ş.	Ora İstanbul Eğlence Merkezi Otoprodüktör Enerji Üretim Santrali	İstanbul	natural gas	14.01.2010	5,4	43.000.000	5,4	80,4	2012
104	Özşah Örme Sanayii A.Ş.	Özşah kojenerasyon	İstanbul	natural gas	16.02.2006	1,7	12.672.000	1,7	*	uncertain
105	Pancar Elektrik Üretim ve Tic. A.Ş.	Pancar	İzmir	natural gas	17.03.2010	36,0	283.820.000	36,0	93,1	2012
106	Polat Elektrik Üretim İnşaat İthalat İhracat A.Ş.	Polat-1 Termik Santrali	Kütahya	lignite	04.12.2008	52,0	357.000.000	52,0	39,2	2014
107	Prokom Madencilik Otomotiv İnşaat Eleketrik Elektronik Taahhüt İth. İhr. San. Ve Tic. Ltd. Şti.	Ömrünü Tamamlamış Lastik Dönüşüm Tesisi	Erzincan	thermal other	01.03.2012	8,0	40.000.000	8,0	42,6	uncertain
108	Rasa Enerji Üretim A.Ş.	Şanlıurfa OSB Enerji Santrali	Şanlıurfa	natural gas	12.05.2011	277,3	2.025.562.500	157,3	54,7	2014
109	RWE Turcas Güney Elektrik Üretim A.Ş.	Doğalgaz Kombine çevrim Enerji Santrali	Denizli	natural gas	22.04.2009	806,6	6.167.000.000	806,6	69,7	2014
110	Sarp Elektrik Üretim A.Ş.	Şarköy DGKÇS	Tekirdağ	natural gas	09.05.2012	881,5	6.950.000.000	881,5	0,7	uncertain
111	Sayenerji Elektrik Üretim A.Ş.		Kayseri	natural gas	21.04.2005	5,9	47.250.000	0,0	*	uncertain
112	Silopi Elektrik Üretim A.Ş.	Silopi Termik Santrali	Şırnak	asphaltite	23.03.2004	413,3	2.916.000.000	275,5	23,4	2015
113	Sönmez Elektrik Üretim San. ve Tic. A.Ş.	Kojenerasyon	Uşak	natural gas	16.06.2005	72,9	293.328.000	9,0	51,5 (September 2010)	2013
114	Süzer Elektrik Üretim A.Ş.	Çatalca DGKÇS	İstanbul	natural gas	08.03.2012	82,8	643.769.280	82,8	0,0	uncertain
115	Şırnak Elektrik Üretim A.Ş.	Silopi Elektrik Santrali	Şırnak	asphaltite	01.03.2012	137,8	972.000.000	137,8	*	uncertain
116	Şireci Tekstil San. ve Tic. A.Ş.	Şireci Enerji I	Gaziantep	natural gas	01.12.2011	8,8	47.500.000	8,8	*	uncertain
117	Tam Enerji Üretim A.Ş.	Etyemez KömürTermik Santrali	Sivas	lignite	30.07.2008	103,1	650.000.000	103,1	13,8	2015
118	Tat Tekstil San.ve Tic. A.Ş.	Tat Tekstil Otoprodüktör Santrali	Gaziantep	natural gas	22.12.2011	2,1	16.000.000	2,1	*	uncertain
119	Tekno Doğalgaz Çevrim Enerji Elektrik Üretim A.Ş.	Bilecik DGÇS	Bilecik	natural gas	22.03.2012	26,3	150.000.000	26,3	93,0	uncertain
120	Temelli Doğalgaz Enerji Üretim A.Ş.	Temelli KDÇS	Ankara	natural gas	15.03.2012	195,8	1.565.360.000	195,8	*	uncertain

Table 42. Thermal Plants (continued)

121	Trakya Yenişehir Cam Sanayii A.Ş.	Trakya Cam Otoprodüktör Santrali	Bursa	thermal other	08.03.2012	6,3	37.800.000	6,3	*	uncertain
122	Turyağ Gıda San. Ve Tic. A.Ş.	Turyağ Termik Santrali	Balıkesir	coal	09.02.2012	1,6	3.500.000	1,6	*	uncertain
123	Uğur Enerji Üretim Tic. veSan. A.Ş.	Uğur Enerji Çerkezköy OSB Üretim Santrali	Tekirdağ	natural gas	25.06.2009	123,0	1.011.360.000	61,5	0,7	uncertain
124	Verbena Enerji ve Tic. A.Ş.	Verbena DGKÇS	Kırklareli	natural gas	29.09.2011	899,4	7.248.800.000	899,4	7,0	uncertain
125	Verim Plastik İhtiyaç Maddeleri Dağıtım A.Ş.	Verim Plastik Kojenerasyon/Trijenerasyon Projesi	İzmir	natural gas	10.09.2008	4,1	32.000.000	4,1	*	uncertain
126	Yeni Elektrik Üretim A.Ş.	Yeni Doğalgaz Çevrim Santrali	Kocaeli	natural gas	20.11.2008	918,4	6.844.320.000	918,4	64,1	2015
127	Zafer Tekstil San. Ve Tic. A.Ş.	Zafer Tekstil Kojen. Tesisi	Gaziantep	natural gas	06.01.2011	1,5	8.300.000	1,5	*	2013
128	Zorlu Enerji Elektrik Üretim A.Ş.		Kayseri	natural gas	07.09.2004	188,5	1.381.066.560	38,6	*	uncertain

Table 43. Hydrolytic Plants

129	2M Enerji Elektrik Üretim A.Ş.	Uzungöl II HES	Trabzon	hydraulic	20.03.2008	10,2	32.882.000	10,2	5,4 (legal issue)	2015
130	2M Enerji Elektrik Üretim A.Ş.	Öğdem Reg. ve HES	Artvin	hydraulic	02.06.2011	20,4	47.750.000	20,4	3,8 (legal issue)	2015
131	2M Enerji Üretim Anonim Şirketi	Şavşat HES	Artvin	hydraulic	23.09.2010	16,6	49.010.000	16,6	2,1 (legal issue)	2015
132	A.F.E Elektrik Üretim San. Tic. Ltd. Şti.	Akdere Reg. ve HES	Bursa	hydraulic	11.11.2011	7,7	23.160.000	7,7	0,9	2015
133	Adabağ Enerji Elektrik Üretim Sanayi ve Tic. A.Ş.	Doyran HES	Antalya	hydraulic	26.05.2006	2,4	6.980.000	2,4	6,0 (January 2011)	2015
134	Adacami Enerji El. Ür. San. ve Tic. A.Ş.	Adacami HES	Rize	hydraulic	11.11.2010	29,9	94.929.000	29,9	86,7	2012
135	Adasu Enerji A.Ş.	Adasu Regülatörü ve HES	Sakarya	hydraulic	25.04.2008	10,2	49.210.000	10,2	94,0	2012
136	Adasu Enerji A.Ş.	Ova Regülatörü ve HES	Sakarya	hydraulic	11.11.2010	10,0	52.873.000	10,0	0,5	2015
137	Ado Enerji Üretim Sanayi ve Ticaret A.Ş.	Söylemez HES	Erzurum	hydraulic	07.02.2008	36,9	247.020.000	36,9	5,5	2015
138	Ado Madencilik Sanayi ve Ticaret A.Ş.	Çayağzı HES	Antalya	hydraulic	16.03.2006	10,0	36.860.000	10,0	(legal issue)	2014
139	Ado Madencilik Sanayi ve Ticaret A.Ş.	Alakır 1 HES	Antalya	hydraulic	03.03.2011	8,7	33.110.000	8,7	1,7 (legal issue)	2015
140	Ado Madencilik Sanayi ve Ticaret A.Ş.	Alakır 2 HES	Antalya	hydraulic	03.03.2011	5,5	28.160.000	5,5	1,2 (legal issue)	2015
141	ADV Elektrik Üretim Ltd. Şti.	Fındık Reg. ve HES	Trabzon	hydraulic	23.10.2008	6,0	23.360.000	6,0	99,4	2012
142	AES-IC İçtaş Enerji Üretim ve Ticaret A. Ş.,	Yumrutepe Reg. Ve HES	Giresun	hydraulic	20.06.2007	13,7	43.720.000	13,7	18,2	2014
143	AES-IC İçtaş Enerji Üretim ve Ticaret A.Ş.	Güneyce Barajı Ve HES	Trabzon	hydraulic	09.04.2009	64,6	301.810.000	64,6	0,1	2016
144	Ağrı Enerji Üretimi A.Ş.	Yıldırım HES	Ağrı	hydraulic	07.03.2007	13,4	35.310.000	13,4	3,5	2015
145	Ağrı Enerji Üretimi A.Ş.	Şimşek HES	Ağrı	hydraulic	07.03.2007	19,4	48.360.000	19,4	2,9	2015
146	Ağrı Enerji Üretimi A.Ş.	Bulut HES	Ağrı	hydraulic	07.03.2007	27,0	65.790.000	27,0	2,9	2015
147	Ağrı Enerji Üretimi A.Ş.	Yağmur HES	Ağrı	hydraulic	07.03.2007	27,0	64.180.000	27,0	4,7	2015
148	Ahem Elektrik Üretim Limited Şirketi	Güneyyaka HES	Konya	hydraulic	21.01.2010	6,8	14.010.000	6,8	10,8	2015
149	Ahmesel Elektrik Üretim Ltd. Şti	Kirazdere reg. Ve HES	Kocaeli	hydraulic	14.04.2011	1,8	5.724.549	1,8	*	2015
150	Ahmet Hakan Elektrik Üretim Anonim Şirketi	Zala HES	Kastamonu	hydraulic	02.12.2010	5,8	18.606.778	5,8	47,8	2015

Table 43. Hydrolytic Plants (continued)

151	Ahmetli Hes Elektrik Üretim A.Ş.	Ahmetli HES	Adana	hydraulic	14.07.2011	12,3	48.058.285	12,3	8,1	2015
152	AHS Elektrik Üretim Ltd. Şti.	Hasanabdal HES	Van	hydraulic	01.12.2011	6,2	13.351.000	6,2	3,0	2015
153	AİDA Enerji San. Ve Tic. Ltd. Şti.	Alçe Reg. ve HES	Sivas	hydraulic	27.05.2010	5,4	16.060.000	5,4	22,7	2014
154	Akar Enerji San. Ve Tic. Ltd. Şti.	Gecür Reg. Ve HES	Giresun	hydraulic	16.07.2009	3,2	10.200.000	3,2	34,0	2015
155	Ak-ar Enerji Üretim A.Ş.	Düzköy reg. Ve HES	Trabzon	hydraulic	19.03.2009	5,3	19.670.000	5,3	3,8	2015
156	Akasya Elektrik Üretim Ltd. Şti.	Murat HES	Ordu	hydraulic	08.12.2011	35,5	85.917.000	35,5	8,4	2015
157	Akdenizli Elektrik Üretim A.Ş.	Bağıştaş II HES	Erzincan	hydraulic	25.12.2008	49,8	181.250.000	49,8	81,3	2013
158	Ak-el Kemah Elektrik Üretim A.Ş.	Kemah Barajı ve HES	Erzincan	hydraulic	01.04.2009	163,3	527.020.000	163,3	2,8	2016
159	Akenes Enerji Elektrik Üretim Ltd. Şti.	Doğanşar Reg ve HES	Sivas	hydraulic	22.06.2011	7,0	16.620.000	7,0	4,0	uncertain
160	Akgün Enerji Üretim ve Ticaret Anonim Şirketi	Bedirdüzü 2 HES	Erzincan	hydraulic	28.12.2011	13,1	22.652.000	13,1	1,8	uncertain
161	Akgün Enerji Üretim ve Ticaret Anonim Şirketi	Bedirdüzü 1 HES	Erzincan	hydraulic	14.02.2012	16,8	23.230.000	16,8	0,6	uncertain
162	Akhes Müşavirlik Mühendislik Enerji San. Ve Tic. Ltd. Şti.	Barış Regülatörü ve HES	Artvin	hydraulic	23.05.2008	28,4	93.760.000	28,4	14,0	2015
163	Ak-Kızılev Elektrik Üretim Ticaret A.Ş.	Kızılev Reg. ve HES	Giresun	hydraulic	19.01.2011	7,8	27.475.000	7,8	13,1	2014
164	Akkoç Elektrik Üretim Ltd. Şti.	Remsu HES	İçel	hydraulic	26.01.2012	2,0	7.100.000	2,0	*	uncertain
165	Akme Elektrik Üretim Ticaret Anonim Şirketi	Geçitli Reg. ve HES	Hakkari	hydraulic	20.10.2011	34,1	82.020.000	34,1	0,0	uncertain
166	Aköz Enerji Elektrik Üretim San. A.Ş.	Amastal Reg. ve HES	Trabzon	hydraulic	01.10.2009	11,8	34.840.000	11,8	0,0	2015
167	Aköz Enerji Elektrik Üretim San. A.Ş.	Yanbolu HES	Trabzon	hydraulic	01.10.2009	9,0	34.420.000	9,0	*	2015
168	Ak-Özlüce Elektrik Üretim Ticaret A.Ş.	Özlüce (Çoruh) HES	Erzurum	hydraulic	11.11.2010	21,7	61.005.000	21,7	49,8	2014
169	Akpınar Enerji Üretim Sanayi ve Ticaret A.Ş.	Akpınar HES	Kahramanmaraş	hydraulic	05.03.2009	9,2	36.087.000	9,2	28,0	2014
170	Aksa Enerji Üretim A.Ş.	Mansurlar Reğülatörü ve Pazarköy HES	Sakarya	hydraulic	10.02.2005	27,2	114.000.000	27,2	3,3	2016

Table 43. Hydrolytic Plants (continued)

171	Aksa Enerji Üretim A.Ş.	Yamanlı I HES	Adana	hydraulic	20.05.2010	26,3	105.000.000	26,3	1,6	2016
172	Aksa Enerji Üretim A.Ş.	İndere HES	Kayseri	hydraulic	17.01.2008	32,6	100.540.000	32,6	2,5	2016
173	Aksa Enerji Üretim A.Ş.	Efrenk HES	İçel	hydraulic	14.06.2007	21,8	77.000.000	21,8	2,1	2016
174	Aksa Enerji Üretim A.Ş.	Sansa Regülatörü ve HES	Erzincan	hydraulic	17.01.2008	92,4	326.000.000	92,4	0,4	2016
175	Aksa Enerji Üretim A.Ş.	Kor Barajı ve HES	Bitlis	hydraulic	30.10.2008	28,3	133.090.000	28,3	1,8	2016
176	Aksa Enerji Üretim A.Ş.	Kuletaşı Barajı ve HES	Gümüşhane	hydraulic	05.03.2009	32,6	85.940.000	32,6	1,6	2016
177	Aksa Enerji Üretim A.Ş.	Koru HES	Gümüşhane	hydraulic	17.06.2009	16,3	44.580.000	16,3	1,6	2016
178	Ak-Serpin Elektrik Üretim Ticaret A.Ş.	Serpin Regülatörü ve HES	Giresun	hydraulic	26.01.2011	13,4	47.520.000	13,4	11,0	2015
179	Aksiyon Elektrik Üretim ve İnşaat Anonim Şirketi	Asarcık Regülatörü ve HES	Giresun	hydraulic	03.05.2007	10,4	29.710.000	10,4	13,1 (January 2012)	2014
180	Aksuhes Düzce-Aksu Hidroelektrik Enerjiden Elektrik Üretim Santralı Ltd. Şti.	Aksu HES	Düzce	hydraulic	21.09.2006	48,3	141.370.000	48,3	75,5	2013
181	Akşar-Nazar Enerji Üretim A.Ş.	Akşar-Nazar HES	Bitlis	hydraulic	27.12.2011	40,7	113.650.000	40,7	22,3	2014
182	Akua Enerji Üretim ve Pazarlama San. ve Tic.A.Ş.	Kurtuluş HES	Gaziantep	hydraulic	25.01.2007	0,9	3.127.000	0,9	3,1	2013
183	Akua Enerji Üretim ve Pazarlama San. ve Tic.A.Ş.	Bayramlı HES	Gaziantep	hydraulic	04.02.2010	0,7	3.140.000	0,7	45,4	2013
184	Alaşar HES Enerji İnş. San. Ve Tic. Ltd. Şti.	Köprükale Reg. ve HES	Kırıkkale	hydraulic	29.07.2010	13,6	67.030.000	13,6	7,5	2015
185	Albe Enerji Elektrik Elektronik Danışmanlık Müşavirlik Petrol Madencilik Tarım Hayvancılık San. ve Tic. Ltd. Şti.	Berat HES	Antalya	hydraulic	11.03.2009	4,3	13.528.515	4,3	4,0 (September 2010)	2015
186	Albe Enerji Elektrik Elektronik Danışmanlık Müşavirlik Petrol Madencilik Tarım Hayvancılık San. Ve Tic. Ltd. Şti.	Yaprak HES	Antalya	hydraulic	19.08.2010	3,8	12.250.515	3,8	0,1 (September 2010)	2015
187	Albe Enerji Elektrik Elektronik Danışmanlık Müşavirlik Petrol Madencilik Tarım Hayvancılık Sanayi ve Ticaret A.Ş.	Yalnızardıç HES	Konya	hydraulic	04.08.2011	17,5	53.540.000	17,5	*	2016
188	Alp Elektrik Üretim A.Ş.	Düzlen HES	Antalya	hydraulic	29.01.2009	16,0	46.650.000	16,0	4,9	2015
189	Alpaslan II Enerji Üretim Sanayi ve Ticaret A.Ş.	Alpaslan II Barajı ve Hes	Muş	hydraulic	06.09.2010	208,0	714.000.000	208,0	6,1	2018
190	Alperen Elektrik Üretim Ltd. Şti.	Dağbaşı HES	İçel	hydraulic	12.05.2011	10,8	38.446.000	10,8	25,9	2014

Table 43. Hydrolytic Plants (continued)

191	Altek Alarko Elektrik Santralları Tesis, İşletme ve Ticaret A.Ş.	Karakuz Barajı ve HES	Adana	hydraulic	23.11.2006	88,5	335.910.000	88,5	8,1	2014
192	Ambarlık Elektrik Üretim Dağıtım Pazarlama Sanayi ve Ticaret Anonim Şirketi	Ambarlık HES	Rize	hydraulic	04.03.2010	9,5	40.890.000	9,5	34,2 (legal issue)	2014
193	Anadolum Elektrik Üretim Ltd. Şti.	Başköy HES	Bingöl	hydraulic	21.01.2009	38,8	139.800.000	38,8	4,0	2015
194	Anadolum Elektrik Üretim Ltd. Şti.	Karataş (Fırat) HES	Bingöl	hydraulic	21.01.2009	44,0	219.690.000	44,0	8,0	2015
195	Ant Karlıova Elektrik Enerji Üretimi Ltd. Şti.	Bingöl I Reg. ve HES	Bingöl	hydraulic	01.07.2010	8,1	17.136.000	8,1	21,8	2015
196	ARC Elektromekanik Enerji San. Ve Tic. Ltd.Şti.	Kutay Reg. Ve HES	Tokat	hydraulic	14.12.2008	8,1	24.619.000	8,1	65,5	2013
197	AR-ES Elektrik Üretim Limited Şirketi	HASANkale Reg. Ve HES	Nevşehir	hydraulic	06.11.2008	5,8	26.980.000	5,8	88,1	2013
198	Arı Su Enerji Üretim Ltd. Şti.	Akbaş HES	Denizli	hydraulic	03.08.2010	9,4	41.317.623	9,4	22,2	2015
199	Arısu Elektromekanik Müşavirlik Enerji Sanayi ve Ticaret Ltd.Şti.	Kemal Reg. Ve HES	Kastamonu	hydraulic	16.12.2008	7,6	24.730.000	7,6	7,3	2015
200	Ark Enerji Üretimi Sanayi ve Ticaret A.Ş.	Erbaa HES	Tokat	hydraulic	07.12.2006	49,0	398.560.000	49,0	*	2015
201	Arpacı Elektrik Üretim Ve Tic. Ltd. Şti.	Arpacık reg. Ve HES	Giresun	hydraulic	04.06.2009	3,9	12.520.000	3,9	11,7	2014
202	Arsan Enerji A.Ş.	Kayaköprü HES	Giresun	hydraulic	29.01.2009	40,2	132.781.000	29,6	*	2012
203	Arsan Soğukpınar Elektrik Üretim A.Ş.	Soğukpınar HES	Giresun	hydraulic	15.07.2010	9,3	28.100.000	9,3	63,5	2013
204	Arsin Enerji Elektrik Üretim A.Ş.	Kadahor Reg. Ve HES	Trabzon	hydraulic	18.08.2011	9,8	23.338.000	9,8	*	2016
205	Artıdeğer Enerji Müh. Kimya Med. Ve Gıda Mad. Sanayi Ticaret Ltd. Şti.	Suçatı Reg. Ve HES	Tokat	hydraulic	30.10.2008	15,0	43.575.514	15,0	42,6	2013
206	As Enerji Üretim Ltd. Şti.	Deliçay Reg. ve HES	Erzincan	hydraulic	04.08.2011	19,8	99.279.449	19,8	0,4	2016
207	Aslancık Elektrik Üretim A.Ş.	Aslancık Brj. Ve HES	Giresun	hydraulic	20.03.2008	120,0	418.170.000	120,0	69,2	2014
208	Assu Elektrik Enerji Üretim Ltd.Şti.	Balıklı I-II-III Hes	Artvin	hydraulic	26.10.2011	6,8	32.960.000	6,8	8,0	uncertain
209	Asya Enerji Elektrik Üretim Dağıtım San. ve Tic. A.Ş.	Güneşli II Reg. ve HES	Trabzon	hydraulic	28.02.2008	12,6	45.730.000	12,6	98,9	2012
210	Atabey Enerji Üretim San. ve Tic. A.Ş.	Uzundere II HES	Rize	hydraulic	24.07.2006	20,4	100.646.000	20,4	97,0	2013

Table 43. Hydrolytic Plants (continued)

211	Ataser Elektrik Üretim İnş. Ltd. Şti.	Çakmak II Reg. ve HES	Kahramanmaraş	hydraulic	01.02.2012	8,9	12.780.000	8,9	*	uncertain
212	Ataser Elektrik Üretim ve İnş. A.Ş.	Çakmak I Reg. ve HES	Kahramanmaraş	hydraulic	11.11.2011	19,3	30.710.000	19,3	*	uncertain
213	Ate Enerji Elektrik Üretim San. Tic. Ltd. Şti.	Çağlayan Reg. ve HES	Diyarbakır	hydraulic	11.11.2011	17,3	39.845.068	17,3	3,4	2016
214	Ati İnşaat Enerji Üretim ve Tic .Ltd. Şti.	Diyoban HES	Artvin	hydraulic	14.02.2008	7,9	25.180.000	7,9	54,1 (September 2010)	2013
215	Atlas Enerji Elektrik Üretim Sanayi A.Ş.	Saman Regülatörü ve HES	Trabzon	hydraulic	11.02.2009	29,1	66.636.000	29,1	4,8	2015
216	Atlas Enerji Elektrik Üretim Sanayi A.Ş.	Yaylabaşı Regülatörü ve HES	Trabzon	hydraulic	15.01.2009	26,0	57.537.000	26,0	4,9	2015
217	ATM Elektrik Üretim A.Ş.	ATM-I Reg. Ve ATM-I HES	Trabzon	hydraulic	31.12.2008	5,2	20.450.000	5,2	3,0	2015
218	Atya Enerji Elektrik Üretim Pazarlama San. Ve Tic. Ltd. Şti.	Merkez reg. Ve HES	Malatya	hydraulic	09.02.2011	6,2	36.120.000	6,2	22,1	2014
219	Avkal En. Elk. Ür. Ve Tic. Ltd. Şti	Kale HES	Amasya	hydraulic	10.09.2008	30,0	108.728.000	30,0	67,0	2013
220	Ay Elektrik Üretim Ltd. Şti.	Duraliler I-II-III-IV HES	Antalya	hydraulic	06.03.2008	4,0	15.650.000	4,0	7,5	2014
221	Ay Elektrik Üretim Ltd. Şti.	Gevne-Karapınar HES	Antalya	hydraulic	20.11.2008	5,6	18.775.944	5,6	7,5	2014
222	Aydınlar Enerji Üretim San. Ve Tic. Ltd. Şti.	Hanak HES	Ardahan	hydraulic	19.08.2010	7,6	9.700.000	7,6	49,3	2014
223	Ayen Enerji A.Ş.	Paşalar HES	Rize	hydraulic	13.12.2007	41,5	151.309.000	41,5	*	uncertain
224	Ayone Enerji Üretim Ltd. Şti.	Gürpınar reg. Ve HES	Rize	hydraulic	05.03.2009	24,2	100.854.616	24,2	9,31 (legal issue)	2015
225	AZC Enerji Üretim A.Ş.	Çardaklı HES	Elazığ	hydraulic	10.03.2011	15,5	30.335.000	15,5	12,7	2015
226	Aziz Enerji Üretim San. ve Tic. A.Ş.	Pamuk Reg. ve HES	Giresun	hydraulic	31.12.2008	6,1	20.366.000	6,1	10,3	2015
227	Bağkal Elektrik Üretim A.Ş.	Karayel HES	Amasya	hydraulic	07.06.2011	23,6	92.821.000	23,6	0,8	2016
228	Baren Enerji Üretim Sanayi ve Ticaret Ltd. Şti.	Kirazlık reg. Ve Hes	Siirt	hydraulic	09.10.2008	38,8	139.552.000	38,8	75,4	2013
229	Barış Enerji Üretim A.Ş.	Kaynarca Barajı ve HES	Malatya	hydraulic	29.01.2009	56,1	112.840.000	56,1	15,0	2014
230	Barış Enerji Üretim A.Ş.	Çukurkaya Reg. Ve Hes	Malatya	hydraulic	17.06.2009	8,0	41.590.000	8,0	*	2015

Table 43. Hydrolytic Plants (continued)

231	Baro Elektrik Üretim A.Ş.	Alicik I-II Reg. ve HES	Rize	hydraulic	24.02.2011	9,4	37.470.000	9,4	(legal issue)	2016
232	Başat Elektrik Üretim ve Tic. Ltd.Şti.	Armağan HES	Erzincan	hydraulic	25.12.2008	36,1	179.380.000	36,1	2,2	2015
233	Başköy Enerji Elektrik Üretim A.Ş.	Kuzey I-II HES	Ordu	hydraulic	10.01.2012	5,8	19.956.000	5,8	3,9	uncertain
234	Başönü Elektrik Üretim San. Tic. Ltd. Şti.	Başönü Reg. Ve HES	Ordu	hydraulic	23.10.2009	3,7	10.610.000	3,7	4,8 (legal issue-July 2011)	2015
235	Baten Enerji Üretimi A.Ş.	Tuzköy Hes	Nevşehir	hydraulic	14.01.2010	8,9	67.490.000	8,9	98,9	2012
236	BAV Elektrik Üretim A.Ş.	Irmak HES	Ordu	hydraulic	10.03.2011	7,0	27.808.655	7,0	31,3	2014
237	Bayburt Enerji Üretim ve Ticaret A.Ş.	Yıldırım HES	Bayburt	hydraulic	20.09.2007	7,6	23.610.000	7,6	99,1	2012
238	Bayburtlu Enerji Üretim A.Ş.	Gençosman HES	Bayburt	hydraulic	10.03.2011	6,0	19.190.000	6,0	2,8	2016
239	Baysan Elektrik Üreitm A.Ş.	Rüzgarlı I ve II HES	Rize	hydraulic	06.09.2010	10,1	38.312.000	10,1	17,5 (September 2010)	2014
240	BBD Elektrik Üretim Ticaret Ltd. Şti.	Işık HES	Artvin	hydraulic	29.09.2011	10,8	34.260.000	10,8	2,8	2016
241	Beha Elektrik Üretim San. Ve Tic. AŞ.	Esentepe Reg. Ve HES	Trabzon	hydraulic	28.12.2010	16,2	49.860.000	16,2	3,4	2015
242	Belalan Enerji Üretim ve İnşaat Anonim Şirketi	Belalan Reg. Ve Hes	Bilecik	hydraulic	29.09.2011	4,1	23.865.000	4,1	1,7	2016
243	Bereket Enerji Üretim A.Ş.	Göktaş HES	Adana	hydraulic	14.12.2006	292,5	1.117.660.000	292,5	58,2	2014
244	Bereket Enerji Üretim A.Ş.	Toros HES	Adana	hydraulic	18.01.2007	51,2	239.400.000	51,2	85,7	2012
245	Bereket Enerji Üretim A.Ş.	Mentaş HES	Adana	hydraulic	18.11.2004	51,7	78.725.000	10,0	99,9	2012
246	Beren Elektrik Üretim Ltd. Şti.	Bulgurkaya HES	Kahramanmaraş	hydraulic	26.08.2010	2,6	9.318.000	2,6	*	uncertain
247	Berke Elektrik Üretim A.Ş.	Ebru Reg. Ve HES	Kastamonu	hydraulic	14.05.2008	31,6	78.731.000	31,6	70,1	2014
248	Berke Elektrik Üretim A.Ş.	Çiğdem Reg. Ve HES	Sinop	hydraulic	06.11.2008	17,0	55.240.000	17,0	17,1	2014
249	Berrak Enerji Üretim Tic. Ve San. A.Ş.	Güvercin Reg. Ve HES	Kahramanmaraş	hydraulic	18.01.2012	16,3	49.167.000	16,3	0,7	uncertain
250	Berraksu Elektrik Üretim Ltd. Şti.	Berrak I-II HES	Trabzon	hydraulic	30.10.2008	11,0	48.050.000	11,0	*	uncertain

Table 43. Hydrolytic Plants (continued)

251	Bess Elektrik Üretim San. ve Tic. A.Ş.	Dereköy-Demirkapı HES	Rize	hydraulic	13.11.2007	111,9	395.710.000	111,9	0,6 (legal issue)	2016
252	Bey Enerji Üretim Ltd. Şti.	Tahtaköprü HES	Hatay	hydraulic	28.05.2009	4,6	5.830.000	4,6	0,0	2016
253	Beyda Enerji Üretim ve Tic. Ltd. Şti.	Yakacık Reg. ve HES	Hatay	hydraulic	15.03.2012	11,4	42.340.000	11,4	1,6	uncertain
254	Beyobası Enerji Üretimi A.Ş.	Sekiyaka II Reg. Ve HES	Muğla	hydraulic	21.01.2010	3,5	17.054.000	3,5	35,3	2014
255	BGT Mavi Enerji Elektrik üretim Dağıtım Pazarlama San. Ve Tic. A.Ş.	Sukenarı Reg. ve HES	Trabzon	hydraulic	11.11.2010	6,8	21.640.000	6,8	46,1	2014
256	Biem Enerji Üretim A.Ş.	İncebel HES	Erzurum	hydraulic	18.04.2007	7,5	19.185.000	7,5	55,9	2014
257	Bilsev Enerji Üretim ve Ticaret Anonim Şirketi	Karakurt HES	Kars	hydraulic	24.02.2011	113,4	407.892.000	113,4	3,6	2015
258	Bingöl Elektrik Enerji Üretimi Ltd. Şti.	Bingöl II Reg. ve HES	Bingöl	hydraulic	06.07.2011	17,4	37.010.000	17,4	*	2016
259	BND Elektrik Üretim Anonim Şirketi	Gelincik HES	Gümüşhane	hydraulic	20.03.2008	7,1	21.207.000	7,1	17,2	2014
260	BND Elektrik Üretim Anonim Şirketi	Üçgen HES	Osmaniye	hydraulic	17.04.2008	3,9	9.960.000	3,9	23,9	2014
261	BND Elektrik Üretim Anonim Şirketi	Üçgen 2 HES	Ordu	hydraulic	06.03.2008	11,6	39.034.000	11,6	54,3	2014
262	Bolsu Enerji Elektrik Üretim San. ve Tic. Ltd. Şti.	Çeltikdere HES	Bolu	hydraulic	13.12.2007	2,2	6.259.314	2,2	0,0	uncertain
263	Bolsu Enerji Elektrik Üretim San. ve Tic. Ltd. Şti.	Cevizlidere HES	Bolu	hydraulic	13.12.2007	3,5	10.351.817	3,5	0,0	uncertain
264	Bomonti Elektrik Müh. Müş. İnş. Tur. Ve Tic. Ltd. Şti.	Şifrin Reg. ve HES	Adıyaman	hydraulic	25.03.2010	6,9	17.386.555	6,9	95,1	2012
265	Boyabat Elektrik Üretim ve Tic. Ltd. Şti.	Boyabat HES	Samsun	hydraulic	13.11.2007	528,0	1.468.000.000	528,0	96,8	2012
266	Bozat Elektrik Üretim A.Ş.	Zekere HES	Giresun	hydraulic	27.11.2008	4,2	10.063.000	4,2	52,3	2013
267	Boztepe Enerji Üretim Pazarlama A.Ş.	Gemciler Reg. Ve HES	Adıyaman	hydraulic	19.09.2011	8,4	34.962.000	8,4	85,0	2013
268	Bozyazı Enerji Üretim ve İnşaat A.Ş.	Bozyazı Reg. ve HES	İçel	hydraulic	02.06.2011	10,0	26.850.000	10,0	9,1	2015
269	BT Bordo Elektrik Üretim Dağ. Paz. San. Ve Tic. A.Ş.	Yağmur reg. Ve HES	Trabzon	hydraulic	29.01.2009	9,2	31.507.000	9,2	92,0	2013
270	BTA Enerji Elektrik Üretim İnş.San.ve Tic.Ltd.Şti.	Balkodu II Regülatörü ve HES	Trabzon	hydraulic	15.02.2007	4,1	12.815.000	4,1	0,2	2015

Table 43. Hydrolytic Plants (continued)

271	Bucak Yenilenebilir Enerji Üretim A.Ş.	Bucakköy HES	Antalya	hydraulic	03.05.2007	10,0	44.059.000	10,0	46,9 (January 2012)	2013
272	Burgüç Bursa Güçbirliği Enerji Üretim San. ve Tic. A.Ş.	Boğazköy Barajı ve HES	Bursa	hydraulic	30.09.2010	10,6	20.040.000	10,6	34,8	2014
273	Bükor Elektrik Üretim A.Ş.	Bükor II HES	Bilecik	hydraulic	07.09.2011	8,0	35.914.000	8,0	46,1	2015
274	Can Enerji Entegre Elektrik Üretim A.Ş.	Çanakçı Regülatörü ve HES	Trabzon	hydraulic	16.03.2006	9,5	38.840.000	4,7	*	2012
275	Can Enerji Entegre Elektrik Üretim A.Ş.	Kayalık Regülatörü ve HES	Trabzon	hydraulic	25.12.2008	4,1	14.630.000	4,1	15,4	2014
276	Cese Elektrik Üretim A.Ş.	Mavi HES	Trabzon	hydraulic	04.03.2010	11,6	28.580.000	11,6	13,0 (January 2011)	2014
277	Ceyhan Enerji Üretim San. Ve Tic. A.Ş.	Berat Reg. Ve HES	Adıyaman	hydraulic	15.12.2010	4,0	20.550.000	4,0	6,9	2015
278	CG Enerji Elektrik Üretimi İnş. San. Ve Tic. Ltd. Şti.	Sema Reg. ve HES	Kırıkkale	hydraulic	26.08.2010	15,3	83.520.000	15,3	0,0	2015
279	Coşkun Elektrik Üretim Ltd.Şti.	Yeşilvadi HES	Hatay	hydraulic	14.09.2006	8,8	37.650.000	8,8	95,9	2013
280	Çağlar Enerji Yapı ve Yapı Malzemeleri Sanayi Ticaret A.Ş.	Doğan Reg. ve HES	Muş	hydraulic	25.04.2008	3,0	9.750.000	3,0	27,2	2015
281	Çağlayan Hes Enerji Üretim A.Ş.	Çağlayan HES	Trabzon	hydraulic	16.10.2008	5,2	20.830.000	5,2	98,8	2012
282	Çalık Enerji Elektrik Üretim ve Madencilik A.Ş.	Kızkayası Brj. Ve HES	Bursa	hydraulic	11.03.2009	130,0	395.610.000	130,0	4,9	2016
283	Çalık Enerji Elektrik Üretim ve Madencilik A.Ş.	Aksu (Çoruh-Anakol) Barajı ve HES	Bursa	hydraulic	05.03.2009	134,0	363.278.000	134,0	5,1	2016
284	Çamlıkaya Enerji Üretim ve Tic. A.Ş.	Ataköy HES	Trabzon	hydraulic	17.01.2008	5,0	19.200.000	5,0	24,6	2014
285	Çarşamba Enerji Elektrik Üretim A.Ş.	Çarşamba HES	Samsun	hydraulic	28.05.2009	11,8	62.768.000	0,0	99,7	2012
286	Çekerek Elektrik Üretim ve Tic. Ltd. Şti.	Çekerek Reg. Ve Hes	Yozgat	hydraulic	20.12.2011	22,6	68.016.031	22,6	4,2	2016
287	Çetin Enerji A.Ş.	Çetin Barajı ve HES	Siirt	hydraulic	04.06.2009	386,0	1.208.814.000	386,0	7,0	2016
288	Çifteköprü Elektrik Üretim Ltd. Şti.	Çifteköprü Reg. ve HES	Artvin	hydraulic	01.10.2009	8,2	31.170.000	8,2	87,7 (January 2012)	2012
289	Dağlar Enerji Elektrik Üretim A.Ş.	Kalecik HES	Artvin	hydraulic	29.01.2009	26,6	81.970.000	26,6	3,6	2015
290	Damlapınar Elektrik Üretim San. Ve Tic. A.Ş.	Manahoz HES	Trabzon	hydraulic	07.03.2007	4,7	16.839.000	4,7	69,8	2013

Table 43. Hydrolytic Plants (continued)

291	Damlapınar Elektrik Üretim San. Ve Tic. A.Ş.	Cinali HES	Trabzon	hydraulic	21.09.2006	5,9	19.085.000	5,9	(legal issue)	uncertain
292	Damlapınar Elektrik Üretim San. Ve Tic. A.Ş.	İftelan HES	Trabzon	hydraulic	19.03.2009	13,4	43.533.000	13,4	26,9	2014
293	Darenhes Elektrik Üretimi A.Ş.	Pembelik HES	Elazığ	hydraulic	22.09.2005	122,4	367.482.000	122,4	38,1	2015
294	Darenhes Elektrik Üretimi A.Ş.	Tatar HES	Tunceli	hydraulic	02.06.2005	115,8	364.252.000	115,8	70,0	2014
295	Debi Enerji Elektrik üretim Dağıtım İnş. Müh. Tic. Ltd. Şti.	Aksu Regülatörü ve HES	Isparta	hydraulic	17.01.2008	11,9	25.790.000	11,9	6,1	2016
296	Debit Elektrik Üretim Ltd.Şti.	Bora (Memi Usta) HES	Sakarya	hydraulic	09.02.2011	1,4	4.361.000	1,4	7,8	2016
297	Dedegöl Enerji Yatırım A.Ş.	Sinanhoca HES	Antalya	hydraulic	22.03.2007	57,0	274.000.000	57,0	*	uncertain
298	Değirmen Elektrik Üretim San. ve Tic. A.Ş.	Korkuteli Reg. ve HES	Antalya	hydraulic	16.07.2009	3,0	9.370.000	3,0	11,9 (legal issue)	2015
299	Demirci Enerji Yatırım Üretim İnş.ve Tic. A.Ş.	Demirci Reg.ve HES	Kastamonu	hydraulic	30.09.2010	13,1	59.068.000	13,1	32,6	2014
300	Demko Enerji Üretim ve Tic. Ltd. Şti.	Söğüt Reg. ve HES	Kars	hydraulic	12.05.2011	17,0	53.700.000	17,0	7,0	2016
301	Deniz Enerji Elektrik Üretim Paz., Dan., San. ve Tic. Ltd. Şti.	Tepehan Reg. ve HES	Malatya	hydraulic	03.03.2011	13,3	36.960.000	13,3	10,4	2016
302	Denizli Elektrik Üretim A.Ş.	Sarıkavak HES	Denizli	hydraulic	18.04.2007	3,2	25.180.151	3,2	49,1	2013
303	Derebaşı Enerji A.Ş.	Derebaşı HES	Trabzon	hydraulic	29.11.2007	11,3	33.860.000	11,3	13,4	2015
304	Dereköy Elektrik Üretim Ltd. Şti.	Dereköy HES	Antalya	hydraulic	26.01.2012	4,5	18.808.124	4,5	1,2	uncertain
305	Deremen Enerji Elektrik Üretim San. ve Tic. A.Ş.	Açma Reg. ve HES	Trabzon	hydraulic	20.11.2008	2,5	9.610.000	2,5	30,5	2014
306	Derin Enerji Üretim San. ve Tic. A.Ş.	Çamlıca II HES	Kayseri	hydraulic	09.02.2011	15,9	90.700.000	15,9	37,1	2015
307	Derya Elektrik Üretim ve Ticaret A.Ş.	Pirinçli Reg. Ve HES	Çorum	hydraulic	26.03.2009	19,5	155.200.000	19,5	97,0	2012
308	Detaş Enerji Üretim A.Ş.	Çandır I Reg. Ve HES	Antalya	hydraulic	20.12.2011	1,8	6.500.000	1,8	20,1	2016
309	Dinamik HES Enerji Yatırımları San. Ve Tic. A.Ş.	Kargı HES	Antalya	hydraulic	09.02.2011	4,5	14.810.010	4,5	35 (January 2012)	2014
310	Direnç Enerji Üretimi San. Ve Tic. A.Ş.	Selin I HES	Rize	hydraulic	27.08.2007	23,0	93.120.000	23,0	1,4 (legal issue)	2015

Table 43. Hydrolytic Plants (continued)

311	Direnç Enerji Üretimi San. Ve Tic. A.Ş.	Selin II HES	Rize	hydraulic	27.08.2007	25,0	104.290.000	25,0	0,1 (legal issue)	2015
312	Dirim Enerji Üretim San. Ve Tic. Ltd. Şti.	Çarıklı Reg. ve HES	Samsun	hydraulic	12.01.2012	18,3	88.070.000	18,3	1,3	uncertain
313	Diz-ep Elektrik Üretim A.Ş.	Bektemur HES	Amasya	hydraulic	15.10.2009	3,6	19.287.000	3,6	90,8 (January 2012)	2012
314	DNZ Elektrik Üretim A.Ş.	Büyük Menderes-Akkent HES	Denizli	hydraulic	04.06.2009	3,6	21.678.615	3,6	*	2012
315	Doğa Hes Elektrik Üretim A.Ş.	Ak Regülatörü ve HES	Van	hydraulic	06.05.2010	12,8	38.372.916	12,8	14,4 (January 2012)	2014
316	Doğal Elektrik Üretim Ticaret Sanayi A.Ş.	Cala Reg. ve HES	Artvin	hydraulic	20.05.2009	13,1	42.985.000	13,1	29,8	2014
317	Doğuş Enerji Üretim ve Ticaret A.Ş.	Artvin Barajı ve Hes	Artvin	hydraulic	04.02.2010	340,0	1.026.000.000	340,0	20,3	2015
318	Doka Enerji Sanayi İnşaat Ticaret A.Ş.	Arkun Barajı ve HES	Erzurum ve Artvin	hydraulic	10.05.2007	231,3	818.040.000	231,3	60,1	2014
319	Dumlu Enerji Elektrik Üretim San. Ve Tic. Ltd. Şti.	Dumlu HES	Erzurum	hydraulic	11.11.2010	4,1	9.174.000	4,1	67,5	2015
320	Durucasu Elektrik Üretim Ltd. Şti.	Duru Reg. ve HES	Amasya	hydraulic	05.03.2009	9,0	45.070.000	4,2	25,1 (January 2012)	2014
321	Durusu Enerji Üretim Ltd. Şti.	Duru HES	Bingöl	hydraulic	19.01.2011	69,3	178.147.000	69,3	35,3	uncertain
322	Ebara Elektromekanik Enerji San. Ve Tic. Ltd. Şti.	Cüneyt Reg. Ve HES	Artvin	hydraulic	10.04.2008	60,7	189.020.000	60,7	(legal issue)	uncertain
323	EBD Enerji Üretim ve Ticaret A.Ş.	Köroğlu (Kotanlı) HES	Ardahan	hydraulic	28.02.2008	44,1	191.460.000	44,1	6,3	2015
324	EBD Enerji Üretim ve Ticaret A.Ş.	Serap HES	Kars	hydraulic	16.12.2008	30,0	74.453.000	30,0	69,1	2013
325	Efe Enerji Elektrik Üretim Pazarlama Danışmanlık San. Ve Tic. Ltd.Şti.	Bayraktar Reg. Ve HES	Trabzon	hydraulic	07.06.2011	1,4	8.150.000	1,4	8,9	2015
326	Efe Enerji Elektrik Üretim Pazarlama Danışmanlık San. Ve Tic. Ltd.Şti.	Erem HES	Osmaniye	hydraulic	25.06.2009	3,5	12.420.000	3,5	68,4	2013
327	Egeli Enerji Yatırım Üretim İnşaat ve Ticaret Lts. Şti.	Yayla Reg.ve HES	Artvin	hydraulic	30.10.2008	5,3	22.259.000	5,3	84,9	2012
328	Egemen Elektrik Üretim Tic. Ve San. Ltd. Şti.	Saran HES	İçel	hydraulic	26.02.2009	17,8	67.023.000	17,8	17,6	2014
329	Egenda Ege Enerji Üretim A.Ş.	Manavgat II HES	Antalya	hydraulic	27.12.2007	26,8	77.840.000	26,8	7,1	2015
330	Egenda Ege Enerji Üretim A.Ş.	Eğlence-1 HES	Adana	hydraulic	27.12.2007	40,2	122.743.771	40,2	88,3	2013

Table 43. Hydrolytic Plants (continued)

331	Egenda Ege Enerji Üretim A.Ş.	Eğlence-2 HES	Adana	hydraulic	27.12.2007	30,1	91.996.043	30,1	86,2	2013
332	Eğin Enerji Üretim Ağaçlandırma Tarım ve Hayvancılık İnşaat Turizm Madencilik San. Ve Tic. Ltd. Şti.	Demir Reg. ve HES	Erzincan	hydraulic	04.05.2011	4,2	8.100.000	4,2	8,8	2015
333	Ekinciler Bölgesi Enerji Üretim Pazarlama San. Ve Tic. Ltd. Şti.	Ekinciler Reg. ve HES	Gümüşhane	hydraulic	12.05.2011	1,0	3.480.000	1,0	1,6	2015
334	Ekol Elektrik Üretim Dağıtım Sanayi ve Ticaret A.Ş.	Burgular (Gebeş) HES	Antalya	hydraulic	04.12.2008	7,6	54.550.000	7,6	9,6	2015
335	Ekotel enerji Üretimi İletişim Elektronik Elektrikli Cihaz ve San. Tic. Paz. Ltd. Şti.	Kayabaşı Reg. ve HES	Malatya	hydraulic	17.02.2011	1,9	10.080.000	1,9	*	uncertain
336	Elda Elektrik Üretim Ltd.Şti.	skale Reg. Ve HES	Artvin	hydraulic	22.03.2012	10,8	27.757.000	10,8	*	uncertain
337	Elen Enerji Üretimi San.Tic.A.Ş	Doğançay HES	Sakarya	hydraulic	10.05.2007	31,5	171.682.000	31,5	53,7	2013
338	Elhes Elektrik Üretim Ltd. Şti	Gökçeköy Reg. Ve HES	Erzincan	hydraulic	30.10.2008	6,2	31.080.000	6,2	24,4	2014
339	Elif Grup Enerji Elektrik Üretim Limited Şirketi	Yazılı I II III HES	İçel	hydraulic	06.09.2010	7,4	28.390.361	7,4	3,6	2015
340	Elite Elektrik Üretimi ve Elektronik Makine Sanayi Tic. Ltd. Şti.	Han HES	Karabük	hydraulic	12.04.2007	6,1	16.210.000	6,1	27,2	2015
341	Emirhan HES Enerji Yatırım Üretim İnşaat ve Ticaret A.Ş.	Poyrazlı Reg. ve HES	Sivas	hydraulic	15.03.2012	2,0	7.687.000	2,0	3,0	2016
342	Emsat Elektrik Malzemeleri Pazarlama İmalat Taahhüt San. ve Tic.Ltd.Şti.	Merekler Reg. ve Algölü HES	Ardahan	hydraulic	19.03.2009	12,5	42.835.000	12,5	95,6	2012
343	Enbatı Elektrik Üretim Sanayi ve Tic. A.Ş.	Pirinçlik reg ve HES	Karabük	hydraulic	29.01.2009	23,9	76.850.000	23,9	76,2	2013
344	Enerji 2023 İnşaat Elektrik Üretim Tic. A.Ş.	Delice 1 HES	Tokat	hydraulic	23.11.2011	6,4	19.874.000	6,4	*	uncertain
345	Enerjisa Enerji Üretim A.Ş.	Kandil Enerji Projesi HES	Kahramanmaraş	hydraulic	09.03.2006	211,5	588.999.000	211,5	72,5	2014
346	Enerjisa Enerji Üretim A.Ş.	Sarıgüzel HES	Kahramanmaraş	hydraulic	09.03.2006	104,6	311.763.000	104,6	78,8	2014
347	Enerjisa Enerji Üretim A.Ş.	Dağdelen HES	Kahramanmaraş	hydraulic	09.03.2006	8,9	23.540.000	8,9	47,6	2014
348	Enerjisa Enerji Üretim A.Ş.	Köprü Barajı ve HES	Adana	hydraulic	06.07.2006	158,1	383.880.000	158,1	93,3	2013
349	Enerjisa Enerji Üretim A.Ş.	Kuşaklı Barajı ve HES	Adana	hydraulic	06.07.2006	20,5	47.705.000	20,5	55,5	2014
350	Enerjisa Enerji Üretim A.Ş.	Kavşak Bendi ve HES	Adana	hydraulic	06.12.2007	185,5	741.030.000	185,5	71,0	2014

Table 43. Hydrolytic Plants (continued)

351	Enerjisa Enerji Üretim A.Ş.	Yamanlı II Reg. Ve HES	Adana	hydraulic	22.06.2006	88,9	301.610.000	88,9	43,8	2014
352	Enerjisa Enerji Üretim A.Ş.	Çambaşı Barajı ve HES	Trabzon	hydraulic	25.04.2008	45,0	200.510.000	45,0	63,9	2014
353	Enerjisa Enerji Üretim A.Ş.	Doğançay Hes	Adana	hydraulic	27.11.2008	32,5	176.590.000	32,5	14,0	2015
354	Enerka Kalecik Elektrik Üretim ve Pazarlama A.Ş.	Kalecik HES	Ankara	hydraulic	01.02.2007	11,8	84.767.713	11,8	58,3	2014
355	Enersu Enerji Elektrik Üretim Petrol Maden İnşaat San. ve Tic. Ltd. Şti.	Hisar HES	Elazığ	hydraulic	23.02.2012	5,0	11.960.000	5,0	*	uncertain
356	Enser Enerji Elektrik İnşaat Maden San. Ve Tic. Ltd. Şti.	Uzunköy Reg. ve HES	Adıyaman	hydraulic	29.07.2010	3,3	9.200.000	3,3	*	2015
357	Ensu Elektrik Enerji Üretim Ltd. Şti.	Çiğdem reg. Ve HES	Giresun	hydraulic	27.11.2008	14,9	39.750.000	14,9	40,0	2014
358	Entek Enerji Teknolojileri San. ve Tic.Ltd.Şti.	Cindere HES	Denizli	hydraulic	11.01.2007	29,3	88.120.000	10,8	*	uncertain
359	Entek Enerji Teknolojileri San. ve Tic.Ltd.Şti.	Boztepe HES	Ordu	hydraulic	07.08.2008	18,5	48.200.000	18,5	66,0	2013
360	Erarı Elektromekanik Enerji San. Ve Tic. Ltd. Şti.	Damla Reg. Ve HES	Artvin	hydraulic	17.04.2008	56,0	182.313.000	56,0	3,2 (legal issue)	2016
361	Erenler Enerji Üretim ve Ticaret A.Ş.	Değirmen Regülatörü ve HES	Antalya	hydraulic	04.04.2007	7,7	19.807.644	7,7	76,5	2013
362	Eres Enerji Üretimi San. Tic. A.Ş.	Erikoğlu-Keserali HES	Muğla	hydraulic	01.10.2009	1,7	8.880.000	1,7	23,0	2014
363	Eriç Enerji Üretim ve Tic. A.Ş.	Eriç Barajı ve Hes	Erzincan	hydraulic	03.08.2010	188,7	702.720.000	188,7	2,5	2016
364	Er-kur Seydioğlu Elektrik Üretim A.Ş.	Seydioğlu HES	Trabzon	hydraulic	06.08.2007	2,3	11.240.000	2,3	46,1	2013
365	ErNaNur Elektrik Üretim Dağıtım Su Ürünleri İnş. Tarım Tic. Ltd. Şti.	Çaygözü HES	Muğla	hydraulic	25.03.2008	0,3	2.210.000	0,3	21,7	2014
366	Ersoy Enerji Ticaret ve Sanayi A.Ş.	Karapur HES	Kahramanmaraş	hydraulic	07.02.2008	9,2	33.590.000	9,2	0,2	2016
367	Ersoy Enerji Ticaret ve Sanayi A.Ş.	Çatalkaya HES	Kahramanmaraş	hydraulic	16.07.2009	18,1	52.100.000	18,1	0,2	2016
368	Etken Elektrik Üretim Ltd. Şti.	Oylat I HES	Bursa	hydraulic	13.03.2008	1,9	7.730.000	1,9	58,6	2014
369	Etken Elektrik Üretim Ltd. Şti.	Köroğlu HES	Osmaniye	hydraulic	25.12.2008	5,8	19.109.000	5,8	31,0	2014
370	Etki Elektrik Üretim A.Ş.	Demirdöven Reg. Ve HES	Artvin	hydraulic	18.07.2012	9,2	33.350.000	9,2	5,0	2015

Table 43. Hydrolytic Plants (continued)

371	Etki Elektrik Üretim A.Ş.	Kışla Reg. Ve HES	Artvin	hydraulic	21.06.2012	11,2	30.381.000	11,2	0,0	2015
372	September Elektromekanik Enerji San. Tic. Ltd. Şti.	Mert Reg. Ve HES	Erzurum	hydraulic	19.03.2009	10,8	29.520.000	10,8	50,7	2014
373	Eymir Enerji Elektrik Üretim Ltd.Şti.	Dicle-Şahaban HES	Diyarbakır	hydraulic	11.08.2011	26,3	110.851.000	26,3	0,8	2016
374	Eyner Enerji Üretim ve Ticaret Limited Şirketi	Taşlıkaya HES	Artvin	hydraulic	07.05.2009	22,6	92.668.000	22,6	3,4	2016
375	Ey-Tur Elektrik Enerji Üretim ve Tic. Ltd.Şti.	Yağmur Reg. Ve HES	Kars	hydraulic	10.04.2008	30,7	87.376.000	30,7	21,9	2015
376	Falanj Enerji Elektrik Üretim A.Ş.	Telli I Regülatörü ve HES	Giresun	hydraulic	03.05.2007	9,1	31.350.000	9,1	86,9 (January 2012)	2012
377	Fatih Enerji Elektrik Üretim Paz. Dan. San. Ve Tic. Ltd. Şti.	Aksu HES	Malatya	hydraulic	04.05.2011	6,0	21.283.000	6,0	56,6	2014
378	Fem Enerji Üretim Ltd. Şti.	Paşalı Reg. Ve Hes	Giresun	hydraulic	01.12.2011	7,2	23.257.000	7,2	3,0	2016
379	Fernas Enerji A.Ş.	Garzan Brj. Ve HES	Batman	hydraulic	01.05.2008	37,8	158.400.000	37,8	99,3	2012
380	Fernas Enerji A.Ş.	Şirvan Barajı ve HES	Siirt	hydraulic	15.01.2009	18,2	44.880.000	18,2	15,8	2014
381	Fırat Elektrik Üretim ve Tic. A.Ş.	Akıncı HES	Tokat	hydraulic	28.03.2012	102,3	410.770.000	102,3	14,3	2015
382	Ga Elektrik Enerjisi Üretim Satış San. Ve Tic. Ltd. şti.	Umutlu HES	Amasya	hydraulic	30.10.2008	23,6	86.050.000	23,6	8,3	2015
383	GAE Enerji Üretim Ticaret ve Sanayi A.Ş.	Derya HES	Gümüşhane	hydraulic	15.01.2009	28,3	88.740.000	28,3	1,7	2015
384	Gelenek Elektrik Üretim A.Ş.	Değirmendere HES	Denizli	hydraulic	17.07.2008	1,4	6.933.791	1,4	14,3	2014
385	General Enerji Üretim A.Ş.	General Reg. ve HES	Ordu	hydraulic	29.07.2010	5,8	15.600.000	5,8	38,6	2013
386	Getiri Enerji Üretim Sanayi ve Tic. Ltd. Şti.	Piro Reg. Ve HES	Ordu	hydraulic	07.05.2009	4,0	16.110.000	4,0	14,9	2014
387	Getiri Enerji Üretim Sanayi ve Tic. Ltd. Şti.	Tokmadin Regülatörü ve HES	Giresun	hydraulic	29.09.2011	3,6	10.157.000	3,6	7,7	2015
388	Getiri Enerji Üretim Sanayi ve Tic. Ltd. Şti.	Kızılçam Regülatörü ve HES	Kastamonu	hydraulic	03.05.2012	1,4	6.103.000	1,4	0,0	uncertain
389	Gimak Enerji Üretim Ltd. Şti.	Bayır Reg. Ve HES	Ankara	hydraulic	13.03.2008	5,3	15.610.000	5,3	14,7	2014
390	Gizem Elektrik Üretim Ltd.Şti.	Bahar Reg. Ve HES	Ordu	hydraulic	18.05.2011	12,4	38.230.000	12,4	5,6	2016

Table 43. Hydrolytic Plants (continued)

391	GMT Enerji Elektrik Üretim A.Ş.	STS-1 Reg. ve HES	Kayseri	hydraulic	01.12.2011	8,0	36.460.000	8,0	0,3	uncertain
392	Gökbel Enerji Elektrik Üretim A.Ş.	Gökbel I-II HES	Isparta	hydraulic	06.09.2010	24,1	75.720.000	24,1	53,6	2013
393	Gökçay Enerji Elektrik Üretim San. Ve Tic. Ltd. Şti.	Derinçay HES	Giresun	hydraulic	09.02.2012	6,4	22.835.000	6,4	0,8	uncertain
394	Gökçeköy Elektrik Üretim Ltd. Şti.	Ziyaret HES	Erzincan	hydraulic	26.01.2012	3,8	15.480.000	3,8	2,8	uncertain
395	Göksu Enerji Üretim A.Ş.	Ayranlı Hes	Sivas	hydraulic	15.12.2010	18,4	79.915.000	18,4	53,3	2013
396	Gözel Elektrik Ür. A.Ş.	Güngör Reg. Ve Hes	Erzurum	hydraulic	19.08.2010	2,2	10.518.000	2,2	0,0	2016
397	Grup Elektrik Üretim A.Ş.	Şerefli Reg. ve HES	Adıyaman	hydraulic	04.05.2011	4,1	14.362.000	4,1	0,0	uncertain
398	Güfen Enerji Elektrik Üretim Pazarlama San. Tic. Ltd. Şti.	Gökboyun reg ve hes	Osmaniye	hydraulic	09.07.2009	5,5	17.370.000	5,5	42,5	2014
399	Gülkar Enerji Üretim ve Ticaret A.Ş.	Düzenli HES	Artvin	hydraulic	28.11.2005	5,1	30.547.000	5,1	45,7 (legal issue)	uncertain
400	Gümüşsan Enerji Elektronik Elektrik İnş. Taah. San. ve Tic. Ltd. Şti.	Ilıca HES	Van	hydraulic	25.12.2008	9,0	29.050.000	9,0	86,7	2014
401	Gün Enerji Üretim Sanayi İthalat İhracat ve Tic. Ltd. Şti.	Batlama Reg. Ve Hes	Giresun	hydraulic	08.07.2009	2,1	12.370.000	2,1	12,1	2014
402	Gün-taş enerji el. Üretim A.Ş.	Dereiçi reg. Ve hes	Trabzon	hydraulic	04.05.2011	4,3	12.300.000	4,3	50 (January 2012)	2013
403	Gürgen Enerji Üretim ve Dağıtım A.Ş.	Gürgen Reg. Ve HES	Rize	hydraulic	29.09.2011	2,4	9.664.962	2,4	*	uncertain
404	Gürle Enerji Elektrik Üretim İnş. Eğitim Dan. San Tic. Ltd Şti.	Taraklı Gürleyik HES	Sakarya	hydraulic	29.07.2010	0,5	2.720.000	0,5	4,4	2015
405	Gürleyen Enerji Üretim Pazarlama A.Ş.	Alatay HES	Ordu	hydraulic	19.09.2011	13,9	52.772.092	13,9	(legal issue)	2016
406	H.H.K. Enerji Elektrik Üretim Anonim Şirketi	Çalıkobası reg. Ve HES	Giresun	hydraulic	14.06.2012	17,9	46.400.000	17,9	0,0	uncertain
407	Has Enerji Elektrik Üretim A.Ş.	İkizkavak HES	Artvin	hydraulic	02.06.2011	22,4	82.180.000	22,4	3,8	2016
408	HATKO Enerji Elektrik Üretim ve Ticaret A.Ş.	Karakeçili I	Tokat	hydraulic	15.03.2012	6,8	25.220.000	6,8	*	uncertain
409	Hayatsu Enerji Üretim Turizm İnşaat Sanayi ve Ticaret Ltd. Şti.	ayat I-II Reg. Ve He	Antalya	hydraulic	26.05.2011	7,3	30.150.000	7,3	*	uncertain
410	Heda Elektrik Üretim Ltd. Şti.	Çamlı HES	Trabzon	hydraulic	07.05.2009	5,0	18.895.000	5,0	9,2	2015

Table 43. Hydrolytic Plants (continued)

411	Hes Enerji Üretimi San. Tic. A.Ş.	Yunuslar I-II Hes	Kastamonu	hydraulic	09.06.2010	8,1	25.010.000	8,1	11,7	2015
412	Hetaş Hacısalihoğlu Enerji Ticaret A.Ş.	Köprüyanı Reg. Ve HES	Trabzon	hydraulic	20.06.2007	10,4	35.770.000	10,4	27,2	2014
413	Hetaş Hacısalihoğlu Enerji Ticaret A.Ş.	Tonya I-II Regülatörü ve HES	Trabzon	hydraulic	07.03.2007	2,6	10.510.000	2,6	95,8	2012
414	HGM Enerji İnşaat Nakliyat Gıda Gübre Yem San. ve Tic.Ltd.Şti.	Karanlıkdere HES	Malatya	hydraulic	25.06.2009	7,2	28.000.000	7,2	6,6	2015
415	HHK Enerji Elektrik Üretim Ltd. Şti.	Memülü reg. Ve HES	Giresun	hydraulic	06.06.2012	3,9	9.410.000	3,9	0,0	uncertain
416	Hidaş Elektrik Üretim Hidroelektrik Santralleri A.Ş.	Tımarlı Regülatörü ve HES	Çankırı	hydraulic	30.10.2007	7,4	58.020.000	7,4	74,8	2013
417	Hidro D Hidroelektrik Enerji Üretim A.Ş.	Çobanlı HES	Sivas	hydraulic	22.11.2007	20,1	53.136.000	20,1	82,3	2013
418	Hidro Lider Elektrik Üretim ve Tic. Ltd. Şti.	Çayırözü reg. Ve HES	Erzurum	hydraulic	12.04.2012	10,6	23.300.000	10,6	0,6	uncertain
419	Hidrolik Enerji Müh. Müş. İnş. El. Üretim ve San. Ltd Şti.	Akpınar Reg. ve HES	Düzce	hydraulic	13.10.2010	8,2	39.540.000	8,2	2,3	2015
420	Hilal Enerji Üretim Sanayi ve Ticaret A.Ş.	Arı Reg. Ve HES	Rize	hydraulic	16.12.2008	38,0	145.820.000	38,0	21,7	2015
421	Hira Enerji Üretim ve Ticaret Ltd. Şti.	Mor-1 Reg. Ve HES	Ordu	hydraulic	25.12.2008	11,3	42.330.000	11,3	6,7	2016
422	Hoşdere Enerji Elektrik Üretim ve Ticaret A.Ş.	Sena HES	Kars	hydraulic	23.06.2010	19,3	60.410.000	19,3	69,1	2014
423	Ilgar Elektrik Üretim Ltd. Şti.	Ergenekon Reg. Ve HES	Gümüşhane	hydraulic	21.04.2011	6,2	20.520.000	6,2	1,4	2016
424	Irmak Enerji Üretim San. ve Tic. A.Ş.	Eren Barajı, Reg ve HES	Karabük/Kastamonu	hydraulic	25.12.2008	37,0	141.898.552	37,0	20,9	2015
425	İBA Elektrik Üretim Ltd. Şti.	İncir Reg. Ve HES	Siirt	hydraulic	06.11.2008	125,8	487.516.000	125,8	6,4	2015
426	İdil İki Enerji San ve Tic A.Ş.	Olur HES	Erzurum	hydraulic	06.09.2007	65,2	170.430.000	65,2	1,6	2016
427	İdil İki Enerji San ve Tic A.Ş.	Kozbükü HES	Ordu	hydraulic	25.04.2008	67,8	238.582.000	67,8	1,6	2016
428	İdol Elektrik Üretim Ltd. Şti.	Acısu Reg. ve HES	Gümüşhane	hydraulic	12.05.2011	14,6	31.450.000	14,6	2,8	2016
429	İdol Enerji Üretim Dağıtım Pazarlama San. Ve Tic. A.Ş.	Güzeloluk HES	Gümüşhane	hydraulic	21.04.2010	14,0	32.070.000	14,0	51,1	2014
430	İklimya Elektrik Üretim Anonim Şirket	Hawa HES	Erzurum	hydraulic	31.12.2007	7,5	22.925.000	7,5	74,4	2012

Table 43. Hydrolytic Plants (continued)

431	İklimya Elektrik Üretim Anonim Şirketi	Tuana HES	Erzurum	hydraulic	31.12.2007	4,6	11.406.000	4,6	6,6	2014
432	İlcan Elektrik Üretim Limited Şirketi	Yazyurdu reg. Ve HES	Erzurum	hydraulic	21.04.2011	15,5	40.515.000	15,5	19,6 (January 2012)	2015
433	İlci Enerji Elektrik Üretim Sanayi ve Tic. A.Ş.	Kaynarca Regülatörü ve HES	Bingöl	hydraulic	12.01.2012	12,7	29.670.000	12,7	7,3	uncertain
434	İlen Enerji Üretim Sanayi ve Ticaret A.Ş	Akçakoyun HES	Osmaniye	hydraulic	20.11.2008	7,0	15.550.000	7,0	23,6	2014
435	İlk Elektrik Enerji Üretimi San. Tic.A.Ş.	Ayancık HES	Sinop	hydraulic	02.11.2006	17,6	64.710.000	17,6	95,0 (January 2012)	2012
436	İrem Enerji Üretim ve Ticaret Ltd. Şti.	Zümrüt I-II-III-IV HES	Erzurum	hydraulic	06.11.2008	25,1	64.527.000	25,1	2,9	2016
437	Üretim San.	İkiler Hes	Bolu	hydraulic	03.03.2011	3,7	11.380.000	3,7	26,5	2014
438	İs-Tur İnşaat ve Beton Elemanları San. Turizm ve Tic. Ltd. Şti.	Moran Reg. ve HES	Giresun	hydraulic	10.04.2008	8,6	22.730.000	8,6	13,1 (January 2012)	2015
439	İyon Enerji Üretimi Sanayi ve Ticaret A.Ş.	Koçlu HES	Giresun	hydraulic	08.06.2007	46,2	171.700.000	46,2	12,2	2016
440	İyon Enerji Üretimi Sanayi ve Ticaret A.Ş.	Kayalar HES	Rize	hydraulic	11.01.2007	39,2	155.760.000	39,2	0,3 (legal issue)	2016
441	Kaçkar Enerji Elektrik Üretim A.Ş.	Çiğdemli Reğülatörü ve HES	Rize	hydraulic	29.03.2007	4,7	19.826.000	4,7	34,7 (legal issue-January 2012)	2016
442	Kaçkar Enerji Elektrik Üretim A.Ş.	Ayvasıl Reğülatörü ve HES	Rize	hydraulic	31.08.2006	4,6	11.188.000	4,6	93,6 (January 2012)	2012
443	Kadoğlu Enerji Elektrik Üretim Anonim Şirketi	Kale HES	Kars	hydraulic	08.12.2010	17,8	61.892.000	17,8	40,2	2014
444	Kais Elektrik Üretim Anonim Şirketi	Değirmen Reg. ve HES	Trabzon	hydraulic	26.08.2010	13,0	26.850.000	13,0	*	uncertain
445	Kalehan Enerji Üretim ve Ticaret A.Ş.	Kaleköy Barajı ve HES	Bingöl	hydraulic	06.09.2007	300,0	1.292.630.000	300,0	15,0	2016
446	Kalehan Enerji Üretim ve Ticaret A.Ş.	Beyhanı Barajı ve HES ile Palu Reg. Ve HES	Elazığ	hydraulic	06.09.2007	310,0	1.434.740.000	310,0	48,0	2016
447	Kalkavan Enerji Elektrik Üretim Ltd.Şti.	Akça Regülatörü ve HES	Trabzon	hydraulic	30.10.2008	4,8	11.014.000	4,8	6,1	2014
448	Kam Enerji Üretim Ticaret ve Sanayi A.Ş.	Torlar Regülatörü ve HES	Kahramanmaraş	hydraulic	11.11.2009	15,0	34.380.000	15,0	87,6	2014
449	Kandil Elektrik Üretim Tic. Ve San. Ltd. Şti.	Kandil Reg. Ve HES	Adıyaman	hydraulic	21.04.2011	16,3	62.707.000	16,3	10,0	2015
450	Kanyon Yenilenebilir Enerji Üretim San. ve Tic.A.Ş.	Çenger Regülatörü ve HES	Antalya	hydraulic	17.05.2007	9,2	32.290.000	9,2	41,0	2013

Table 43. Hydrolytic Plants (continued)

451	Karabük Enerji Elektik Üretim A.Ş.	Suçatı HES	Karabük	hydraulic	25.06.2009	44,3	109.700.000	44,3	13,1	2015
452	Karaca HES Enerji Üretim A.Ş.	Karataş I HES	Denizli	hydraulic	03.03.2011	7,7	26.009.000	7,7	3,5 (January 2012)	2015
453	Karaköy Elektrik Üretim ve Ticaret Ltd.Şti.	Karaköy HES	Ankara	hydraulic	19.08.2010	4,5	10.655.000	4,5	93,8	2012
454	Kargı Enerji Üretim ve Ticaret A.Ş.	Kargı Barajı ve HES	Ankara	hydraulic	11.05.2010	100,0	254.484.000	100,0	8,2	2016
455	Kargı Kızılırmak Enerji A.Ş. eski unvan:Akel Elektrik Üretim San. Tic. A.Ş.	Kargı (Kızılırmak) HES	Çorum	hydraulic	29.11.2007	66,6	452.130.000	66,6	26,1	2014
456	Karhes Karadeniz Hidroelektrik Enerjiden Elektrik Üretim Santralı Ltd. Şti.	Çırakdamı HES	Giresun	hydraulic	14.09.2004	58,7	140.000.000	58,7	98,9	2012
457	Karhes Karadeniz Hidroelektrik Enerjiden Elektrik Üretim Santralı Ltd. Şti.	Dereli HES	Giresun	hydraulic	06.12.2004	58,8	157.500.000	58,8	92,3	2012
458	Kavraz Enerji Elektrik Üretim Tic. Ltd. Şti.	Muzaffer HES	Gümüşhane	hydraulic	08.03.2012	4,6	11.544.000	4,6	3,2	uncertain
459	Kayayıldız Elektrik üretim İnş. Ve San. Ltd. Şti.	Burma HES	Sivas	hydraulic	16.07.2009	18,2	53.420.000	18,2	4,5	2016
460	Kayen Beta Enerji Elektrik Üretim Sanayi ve Ticaret A.Ş.	Büyükbahçe HES	Erzurum	hydraulic	22.06.2006	12,1	33.080.000	12,1	80 (legal issue)	2013
461	Kayen Heta Enerji Elektrik Üretim Sanayi ve Ticaret A.Ş.	Bağbaşı HES	Erzurum	hydraulic	09.06.2010	13,5	48.110.000	13,5	80(legal issue)	2013
462	Kayen Omikron Enerji Elektrik Üretim Sanayi ve Ticaret A.Ş.	Serhat Reg. Ve HES	Giresun	hydraulic	04.05.2011	9,1	24.840.000	9,1	1 (legal issue)	2017
463	Kazandere Yenilenebilir Enerji Üretim ve Tic. A.Ş.	Kazandere Reg. Ve HES	Antalya	hydraulic	05.03.2009	0,4	830.000	0,4	17,0	2014
464	Kıy Enerji A.Ş.	Kıy Reg ve HES	Adana	hydraulic	11.02.2009	24,6	72.294.000	24,6	53,5	2014
465	Kıyı Enerji Elektrik Üretim A.Ş.	Erik Reg. Ve HES	Artvin	hydraulic	24.12.2009	15,6	41.273.000	15,6	2,3	uncertain
466	Konur Elektrik Üertim A.Ş.	Gemköprü Reg. ve HES	Malatya	hydraulic	30.10.2008	2,0	12.000.000	2,0	28,1	2016
467	Köprübaşı Enerji Elektrik Üretim A.Ş.	Köprübaşı Reg. Ve HES	Gümüşhane	hydraulic	05.03.2009	16,5	45.351.000	16,5	62,6	2014
468	Köprübaşı Petrol Ürünleri Elektrik Üretim Taşımacılık ve İnşaat A.Ş.	Eğerci Reg. Ve HES	Zonguldak	hydraulic	04.12.2008	1,4	6.120.000	1,4	43,3	2014
469	Köprübaşı Petrol Ürünleri Elektrik Üretim Taşımacılık ve İnşaat A.Ş.	Yayla I-II Hes	Bolu	hydraulic	02.06.2011	1,4	5.177.000	1,4	5,1	2015
470	KRC Hes Enerji Üretim ve Ticaret A.Ş.	Yön HES	Denizli	hydraulic	19.08.2010	11,6	35.558.000	11,6	4,9 (January 2012)	2015

Table 43. Hydrolytic Plants (continued)

471	Kurtal Elektrik Üretim Dağ. Paz. San. Ve tic. Ltd. Şti.	Çiçekli I-II reg. Ve HES	Artvin	hydraulic	14.06.2012	7,0	21.908.000	7,0	0,0	uncertain
472	Kurtsuyu Enerji Elektrik Üretim ve Tic.Ltd.Şti.	Daran HES	Karaman	hydraulic	23.05.2008	54,6	189.077.000	54,6	75,1	2012
473	Kutup Enerji Elektrik Üretim A.Ş.	Bayra HES	Iğdır	hydraulic	12.05.2011	9,4	51.319.000	9,4	6,8	uncertain
474	Kuyuma Elektrik Üretim Ltd.Şti.	Kuyma HES	Samsun	hydraulic	04.02.2010	9,4	27.600.000	9,4	2,9	2016
475	Kuzeykaya Elektrik Üretim Ltd. Şti.	Güneykaya Reg. ve HES	Ağrı	hydraulic	17.06.2009	16,0	39.532.225	16,0	2,2 (January 2012)	2016
476	Kübra Enerji Üretim ve Tic. Ltd. Şti.	Kübra HES	Erzurum	hydraulic	20.11.2008	36,1	98.830.000	36,1	2,9	2016
477	Küçük Enerji Üretim ve Tic. Ltd. Şti.	prübaşı Reg. Ve HE	Trabzon	hydraulic	12.04.2012	8,2	28.401.000	8,2	0,4	uncertain
478	Laleli Enerji Elektrik Üretim A.Ş.	Laleli Barajı ve HES	Bayburt	hydraulic	09.02.2011	104,8	256.700.000	104,8	1,4	2017
479	Lega Elektrik Üretim A.Ş.	Taç Reg. Ve HES	Erzurum	hydraulic	25.06.2009	7,4	19.240.000	7,4	8,3	2015
480	Limak Yatırım, Enerji Üretim Dağıtım İşletme Hizmetleri ve İnşaat A.Ş.	Uzunçayır Barajı ve HES	Tunceli	hydraulic	26.08.2010	84,0	322.000.000	56,0	*	uncertain
481	Limit Enerji Üretim A.Ş.	Nizir HES	Şırnak	hydraulic	02.12.2010	4,5	15.716.000	4,5	*	uncertain
482	Lns Enerji Üretim San. Ve Tic. A.Ş.	Bayram Barajı ve HES	Artvin	hydraulic	20.10.2011	94,1	270.000.000	94,1	0,0	2016
483	M. Çağlar Enerji Elk. ÜR. Ve Paz. İnş. Taah. San. Ve Tic. Ltd. Şti.	Çağlar 1 Reg. Ve Hes	Ankara	hydraulic	11.08.2011	3,1	15.340.000	3,1	2,1	2016
484	MAI Elektrik Üretim Anonim Şirketi	Koyunhamza Reg. Ve HES	Giresun	hydraulic	08.01.2009	0,9	4.790.000	0,9	11,0 (January 2012)	2015
485	Maraton Enerji ve Elektrik Sistemleri ve Tic. A.Ş.	Maraton HES	Isparta	hydraulic	21.01.2009	3,8	10.594.041	3,8	10,2	2015
486	Martı Elektrik Üretim Ltd. Şti.	Çay Reg. ve HES	Giresun	hydraulic	16.03.2011	11,2	39.864.000	11,2	16,9	2016
487	Mastar Elektrik Üretim Ticaret ve Sanayi A.Ş.	Suçatı HES	Malatya	hydraulic	14.09.2006	3,5	17.950.000	3,5	0,7 (January 2012)	2016
488	Maya Enerji Üretim Ltd. Şti.	Metin (Kayser Barajı) HES	Diyarbakır	hydraulic	11.11.2010	53,8	139.870.000	53,8	*	uncertain
489	MCK Elektrik Üretim Ltd. Şti.	Devecikonağı HES	Bursa	hydraulic	26.03.2009	10,6	24.510.000	10,6	92,1	2012
490	MCK Elektrik Üretim Ltd. Şti.	Gündoğdu Reg ve HES	Bursa	hydraulic	26.03.2009	7,2	19.879.000	7,2	6,7 (September 2010)	2014

Table 43. Hydrolytic Plants (continued)

491	MED Enerji A.Ş.	Akkaya Regülatörü ve HES	Kastamonu	hydraulic	05.03.2009	4,6	14.405.648	4,6	70,1	2014
492	MED Enerji A.Ş.	Beşpınar Regülatörü ve HES	Samsun	hydraulic	26.05.2011	5,4	14.375.914	5,4	0,4	2016
493	Melet Enerji Elektrik Üretim ve Ticaret A.Ş.	Ordu HES	Ordu	hydraulic	16.07.2009	29,2	145.770.000	29,2	47,3	2014
494	Melikom Elektrik Üretim A.Ş.	Melikom Reg. ve HES	Rize	hydraulic	28.05.2009	11,7	49.041.000	11,7	12,1	uncertain
495	Mem Enerji Elektrik Üretim Sanayi ve Ticaret A.Ş.	Yamanlı III HES	Adana	hydraulic	06.11.2008	57,3	205.260.000	29,5	98,1	2012
496	Menerji Elektrik Üretim Dağıtım Paz.San. Ve Tic Ltd Şti	Yüce Reg. Ve HES	Giresun	hydraulic	06.11.2008	11,0	26.175.000	11,0	99,2	2012
497	Meral Elektrik Üretim Anonim Şirketi'ne	Esendurak HES	Erzurum	hydraulic	17.06.2009	9,5	42.421.000	9,5	99,7	2012
498	Mercan Enerji Üretim Ticaret ve Sanayi A.Ş.	Tagar HES	Tunceli	hydraulic	24.07.2006	3,5	23.600.000	3,5	2 (January 2012)	2016
499	Mercan Enerji Üretim Ticaret ve Sanayi A.Ş.	Gökçe HES	Bingöl	hydraulic	18.04.2007	6,7	25.790.000	6,7	5,1 (January 2012)	2016
500	Mertler Enerji Üretim Pazarlama A.Ş.	Saray HES	Rize	hydraulic	07.09.2011	15,5	46.890.000	15,5	19,6	2014
501	Methal Enerji Üretim San. Ve Tic. Ltd. şti	Kılıçlı-I	Adana	hydraulic	03.12.2009	2,7	9.853.044	2,7	12,4 (January 2012)	2015
502	Methal Enerji Üretim San. Ve Tic. Ltd. şti	Kılıçlı-II	Adana	hydraulic	03.12.2009	2,4	9.494.004	2,4	8,7 (January 2012)	2015
503	Moği Elektrik Enerji Üretim Ltd. Şti.	Soğuksu HES	Artvin	hydraulic	28.06.2012	8,4	24.408.000	8,4	0,1	uncertain
504	Moği Elektrik Enerji Üretim Ltd. Şti.	Meşeli HES	ARTVİN	hydraulic	28.06.2012	6,6	20.145.000	6,6	0,1	uncertain
505	Mon Elektrik Üretim A.Ş.	Ege HES 2- 3- 4	Denizli	hydraulic	08.06.2009	3,8	21.313.279	3,8	37,8	2014
506	Mor Elektrik Üretim A.Ş.	Mor-2 Reg. Ve HES	Gümüşhane	hydraulic	10.09.2008	6,8	19.969.000	6,8	78,9	2014
507	Mor Elektrik Üretim A.Ş.	Ağkolu HES	Ordu	hydraulic	04.12.2008	4,5	17.830.000	4,5	45,3 (January 2011)	2013
508	Mum Enerji San. Ve Tic. A.Ş.	Van Başkale Sarıtaş HES	Van	hydraulic	21.04.2011	8,0	47.000.000	8,0	2,8	2016
509	Murat HES Enerji Elektrik Üretim ve Tic. Ltd. Şti.	Murat HES	Adıyaman	hydraulic	29.01.2009	38,8	189.190.000	38,8	95,2	2012
510	Murat Kaan Elektrik Üretim A.Ş.	Kuzkaya HES	Kastamonu	hydraulic	12.05.2011	6,7	22.517.785	6,7	3,0	2016

Table 43. Hydrolytic Plants (continued)

511	Mut Elektrik Üretim Sanayi ve Ticaret Ltd.Şti.	Dinç Reg. Ve HES	İçel	hydraulic	17.02.2011	2,2	11.440.000	2,2	99,6	2012
512	Muy En. El. Üretim San. Ve Tic. A.Ş.	Çoraklı HES	Adana	hydraulic	26.08.2010	2,7	11.996.000	2,7	29,2	2014
513	Name Enerji Elektrik Üretim San. ve Tic. A.Ş.	Barca HES	Giresun	hydraulic	12.05.2011	7,3	28.650.000	7,3	2,3	2016
514	Narlıca Yenilenebilir Enerji Elektrik Üretim San. Ve Tic. A.Ş.	Narlıca I-II-III Reg. ve HES	Antalya	hydraulic	15.12.2010	17,4	26.650.000	17,4	3,2	2015
515	Nata Enerji Elektrik Üretim Ticaret Ltd. Şti.	Nata Reg. Ve HES	Gümüşhane	hydraulic	20.11.2008	6,0	21.291.000	6,0	12,8	2015
516	Nek Elektrik Üretim A.Ş.	Yanıkköprü HES	Erzurum	hydraulic	28.02.2008	13,0	42.826.000	13,0	37,2 (January 2012)	2014
517	Niksar Enerji Üretim Ltd. Şti.	Çileklitepe HES	Giresun	hydraulic	19.09.2011	23,6	70.650.000	23,6	10,3	2016
518	Nilsu Enerji Müh. Müş. İnş. San. ve Tic. Ltd. Şti.	Derecik Reg. Ve HES	Artvin	hydraulic	15.03.2012	2,9	11.984.000	2,9	0,5	uncertain
519	Nisan Elektromekanik Enerji Sanayi ve Ticaret A.Ş.	Ege Reg. Ve HES	Kastamonu	hydraulic	06.03.2008	31,2	91.852.000	31,2	0,0	2016
520	NİSAN Elektromekanik Enerji Sanayi ve Ticaret Ltd. Şti.	Yaprak HES	Amasya	hydraulic	20.11.2008	23,4	67.663.000	23,4	88,9	2013
521	NİSAN Elektromekanik Enerji Sanayi ve Ticaret Ltd. Şti.	Umut Reg. Ve HES	Ordu	hydraulic	01.05.2008	44,1	124.894.000	31,4	70,5	2014
522	Nisan Enerji Üretim San. Tic. A.Ş.	Yahyabey HES	Kayseri	hydraulic	11.11.2011	0,4	1.646.000	0,4	5,4	2016
523	NK Elektrik Üretim ve Ticaret Ltd. Şti.	Sude HES	Adana	hydraulic	01.05.2008	6,2	24.180.000	6,2	32,6	2014
524	NK Elektrik Üretim ve Ticaret Ltd. Şti.	Damla HES	Adana	hydraulic	01.05.2008	6,2	24.180.000	6,2	32,6	2014
525	NKD Elektrik Enerji Üretim Ltd. Şti.	Çilehane Reg. Ve HES	Tokat	hydraulic	06.07.2011	7,5	22.000.000	7,5	10,0 (January 2012)	2015
526	NKS Elektrik Üretim Limited Şirketi	Arslanca Reg. ve HES	Trabzon	hydraulic	18.08.2011	2,4	9.320.000	2,4	6,1	2016
527	Nur-en Enerji Üretim San. Ve Tic. A.Ş.	Umutlu Reg. ve HES	Kahramanmaraş	hydraulic	18.08.2011	9,4	40.687.000	9,4	*	2016
528	Nur-Tek Elektrik Santralları Tesis, İşletme ve Ticaret A.Ş.	Tortum II Reg. ve HES	Erzurum	hydraulic	02.04.2008	19,6	65.000.000	19,6	18,2	2014
529	Nuve Elektrik Üretim A.Ş.	Bitlis HES	Bitlis	hydraulic	05.02.2009	54,5	186.339.000	54,5	24,7	2014
530	January Grup Elektrik Üretim A.Ş.	January HES	Gümüşhane	hydraulic	15.03.2012	4,2	12.020.000	4,2	1,7	uncertain

Table 43. Hydrolytic Plants (continued)

531	Okkayası Elektrik Üretim ve İnş. Ltd. Şti.	Okkayası Reg. ve HES	Kahramanmaraş	hydraulic	17.06.2010	23,4	56.830.000	23,4	1,9	2015
532	Olca Elektrik Üretim ve Ticaret Ltd. Şti.	Akıncı Reg. ve HES	Kayseri	hydraulic	03.09.2009	10,8	68.170.000	10,8	46,0	2014
533	Omega Enerji ve Yatırım A.Ş.	Susuz Reg. ve HES	Artvin	hydraulic	19.09.2011	7,3	21.460.000	7,3	0,4	2016
534	Onk Elektrik Üretim San. Ve Tic. A.Ş.	Pervari Reg. ve HES	Van	hydraulic	26.02.2009	223,2	721.940.000	223,2	6,9	2017
535	Onur Elektrik Enerjisi Üretim San. Ve Tic. A.Ş.	Şimşirli HES	Rize	hydraulic	12.01.2012	3,7	18.820.000	3,7	0,4	2015
536	Oren Enerji Elektrik Üretim A.Ş.	Bağıştaş I HES	Erzincan	hydraulic	14.02.2008	145,0	422.430.000	145,0	30,7	2015
537	Ortaçağ Enerji Üretim A.Ş.	Ortaçağ Reg. ve HES	Trabzon	hydraulic	02.06.2011	8,3	32.230.000	8,3	32,5	2014
538	Ortaköy Elektrik Üretim Ltd. Şti.	Yeni Hayat HES	Erzurum	hydraulic	04.05.2011	10,2	61.892.000	10,2	0,4	2016
539	Ortu Elektrik Üretim ve Tic. Ltd. Şti.	Karaağaç Reg. ve HES	Rize	hydraulic	11.02.2009	1,3	6.380.000	1,3	1,7 (Mayıs 2010)	2016
540	Ortur Elektrik Üretim ve Ticaret Ltd Şti	Düzhanlar Regülatörü ve HES	Artvin	hydraulic	17.06.2009	9,7	42.590.000	9,7	6,5	2015
541	Orya Enerji Anonim Şirketi	Cide HES	Kastamonu	hydraulic	31.12.2008	21,5	69.511.000	21,5	(legal issue)	uncertain
542	Orya Enerji Anonim Şirketi	Darıca II HES	Ordu	hydraulic	26.01.2011	75,0	244.580.000	75,0	8,1	2017
543	Önem Elektrik Üretim Ltd. Şti.	Öner HES	Adana	hydraulic	26.01.2012	4,4	14.160.000	4,4	1,3	uncertain
544	Övünç Enerji ve Elektrik Üretim A.Ş.	Çermikler HES	Sivas	hydraulic	29.01.2009	25,8	80.651.000	25,8	74,2	2014
545	Özal Enerji Elektrik Üretim Paz. San. ve Tic. Ltd. Şti.	Bayraktar HES	Erzurum	hydraulic	02.06.2011	15,7	51.282.000	15,7	5,2	2016
546	Özbey Enerji Üretim A.Ş. (Eski ÜnvanıÖzbey Enerji İnş. Taah. Kuy. Tur. San. Tic. Ltd. Şti.)	Ak HES	Muş	hydraulic	24.08.2011	19,0	70.940.000	19,0	0,7	2016
547	Özdoğan Enerji A.Ş.	Ayvalı (Çoruh) HES	Erzurum	hydraulic	20.03.2008	130,3	318.160.000	130,3	28,0	2016
548	Özenir Elektrik Üretim Dağıtım San. Ve Tic. A.Ş.	Kırıkdağ HES	Hakkari	hydraulic	25.04.2008	18,7	61.918.000	16,9	95,2	2013
549	Özgür Elektrik Üretim A.Ş.	Manavgat I Regülatörü ve HES	Antalya	hydraulic	07.09.2006	26,0	67.840.000	26,0	7,7 (January 2012)	2014
550	Özgür Elektrik Üretim A.Ş.	Damlapınar Regülatörü ve HES	Antalya	hydraulic	11.01.2007	40,2	112.100.000	40,2	17,7 (January 2011)	2014

Table 43. Hydrolytic Plants (continued)

551	Özkal Enerji Elektrik Üretim A.Ş.	Kaynar HES	Sivas	hydraulic	26.01.2011	18,0	42.420.000	18,0	4,1	2016
552	Öztek Enerji üretim San. ve Tic. A.Ş.	Ulus I Reg. Ve HES	Bartın	hydraulic	27.11.2008	4,3	21.200.000	4,3	14,0 (January 2011)	2015
553	Öztek Enerji üretim San. ve Tic. A.Ş.	Ulus II Reg. Ve HES	Bartın	hydraulic	27.11.2008	3,8	18.680.000	3,8	14 ,0 (January 2011)	2015
554	Özyakut Enerji Üretim A.Ş.	Köprüler Gem HES	Van	hydraulic	06.10.2011	3,0	14.000.000	3,0	6,3	2014
555	Pak Enerji Üretimi Sanayi ve Ticaret A.Ş.	Demirciler HES	Denizli	hydraulic	17.12.2007	9,8	34.530.000	5,8	97,8	2012
556	Pak Enerji Üretimi Sanayi ve Ticaret A.Ş.	Kavakçalı HES	Muğla	hydraulic	18.02.2009	9,3	39.021.000	9,3	55,9	2014
557	Pak Enerji Üretimi Sanayi ve Ticaret A.Ş.	Gelinkaya Reg. Ve HES	Erzurum	hydraulic	17.03.2010	7,3	25.800.000	7,3	74,7	2014
558	Park Elektrik Üretim Madencilik Sanayi ve Ticaret Anonim Şirketi	Tarihler HES	Siirt	hydraulic	07.05.2009	49,9	169.010.000	49,9	2,4	2016
559	Peker Elektrik Üretim A.Ş.	Ağabey HES	Kars	hydraulic	03.03.2011	14,6	68.050.000	14,6	3,9	2016
560	Peker Enerji A.Ş.	Adıgüzel II HES	Denizli	hydraulic	18.04.2012	31,0	71.180.000	31,0	0,6	uncertain
561	Pelin Enerji Yatırım Üretim ve Tic. Ltd. Şti.	Kayabeyi Barajı ve Akıncı HES	Ardahan	hydraulic	17.01.2008	81,5	287.301.000	81,5	28,4	2014
562	Pervari Elektrik Üretim San. Ve Tic. A.Ş.	Pervari Baraj ve HES	Siirt	hydraulic	26.02.2009	249,8	842.310.000	249,8	8,3	2018
563	Prestij Enerji Üretim Sanayi ve Ticaret A.Ş.	Koçak Regülatörü ve HES	Giresun	hydraulic	14.06.2007	25,3	68.804.000	25,3	98,3	2012
564	Proen Enerji ve MadencilikSanayi ve Tic. A.Ş.	Vanazit HES	Giresun	hydraulic	14.12.2006	3,6	14.270.000	3,6	29,4	2015
565	Proen Enerji ve MadencilikSanayi ve Tic. A.Ş.	Büyük Regülatörü ve HES	Giresun	hydraulic	10.04.2008	3,9	14.210.000	3,9	4,4	2016
566	Rak İnşaat Turizm Demir San. Ve Tic. Ltd. Şti	Samatlar HES	Kastamonu	hydraulic	28.04.2011	6,0	20.322.501	6,0	7,6	2016
567	Redaş Elektrik Üretim Dağ.Paz.San. ve Tic. A.Ş.	Ambarlık HES	Rize	hydraulic	14.12.2006	9,5	40.890.000	9,5	*	uncertain
568	Redaş Elektrik Üretim Dağ.Paz.San. ve Tic. A.Ş.	Çaykara Reg. ve HES	Trabzon	hydraulic	31.12.2007	27,1	108.290.000	27,1	93,6	2012
569	RİNERJİ Rize Elektrik Üretim A.Ş.	Cuniş Regülatörü ve HES	Trabzon	hydraulic	01.03.2007	8,8	29.261.000	5,9	*	2012
570	Rize İpekyolu Enerji Üretim ve Dağ. A.Ş.	Tepe HES	Rize	hydraulic	15.02.2007	15,0	45.900.000	15,0	(legal issue)	uncertain

Table 43. Hydrolytic Plants (continued)

571	Saf Enerji Elektrik Üretim Sanayi ve Ticaret Anonim Şirketi	Kaleköy HES	Adıyaman	hydraulic	26.03.2009	2,0	8.720.000	2,0	11,8 (January 2012)	2015
572	Saf Enerji Elektrik Üretim Sanayi ve Ticaret Anonim Şirketi	Saf I HES	Bingöl	hydraulic	11.03.2009	19,3	39.250.000	19,3	52,0 (January 2012)	2014
573	Saf Enerji Elektrik Üretim Sanayi ve Ticaret Anonim Şirketi	Saf II HES	Bingöl	hydraulic	11.03.2009	29,7	68.140.000	29,7	2,5 (January 2012)	2016
574	Saf Enerji Elektrik Üretim Sanayi ve Ticaret Anonim Şirketi	Saf III HES	Bingöl	hydraulic	11.03.2009	23,6	60.930.000	23,6	2,3 (January 2012)	2016
575	Saren Elektrik Üretim Ltd. Şti.	Enersis HES	Erzurum	hydraulic	01.10.2009	14,6	35.258.000	14,6	2,1 (legal issue)	2016
576	Sason Elektrik Üretim Ticaret ve San. Ltd. Şti.	Güneşlik Regülatörü ve HES	Batman	hydraulic	01.12.2011	9,9	29.960.000	9,9	*	uncertain
577	Sebil Enerji Elektrik Üretim Sanayi ve Ticaret Anonim Şirketi'ne	Sebil Reg. Ve HES	İçel	hydraulic	27.11.2008	25,2	75.028.000	25,2	18,6	2015
578	Seçenek Enerji Üretim San. ve Tic.Ltd.Şti.	Kanyon Reg. Ve HES	Antalya	hydraulic	06.11.2008	24,2	51.950.000	24,2	4,5	2016
579	SEDAŞ Elektrik Üretim San. Ve Tic. A.Ş.	Ayvadere HES	Trabzon	hydraulic	04.12.2008	9,0	35.300.000	9,0	2,5	2016
580	SEDAŞ Elektrik Üretim San. Ve Tic. A.Ş.	Enes I Reg. Ve HES	Tokat	hydraulic	11.08.2011	2,2	7.340.000	2,2	5,9	2016
581	SEDAŞ Elektrik Üretim San. Ve Tic. A.Ş.	Enes II Reg. Ve HES	Tokat	hydraulic	11.08.2011	1,6	7.340.000	1,6	5,9	2016
582	Serman Yenilenebilir Enerji Üretim San. Ve Tic. A.Ş.	Cerle HES	Antalya	hydraulic	30.09.2010	3,6	12.165.000	3,6	22,5	2014
583	Siirt Elektrik Üretim San.Ve Tic.A.Ş.	Kezer Reg. ve HES	Siirt	hydraulic	04.05.2011	16,5	14.110.000	16,5	*	2016
584	Silen Elektrik Üretim ve Ticaret Ltd. Şti.	Çengelli Reg. ve Kışla HES	Erzurum	hydraulic	12.09.2007	5,0	22.360.000	5,0	8,1	2015
585	Silen Elektrik Üretim ve Ticaret Ltd. Şti.	Oltu HES	Erzurum	hydraulic	12.09.2007	3,8	11.050.000	3,8	8,6	2015
586	Simyıldız Elektrik üretim İnş. Ve San. Ltd. Şti.	Sincan HES	Sivas	hydraulic	06.11.2008	6,1	34.500.000	6,1	15,9	2016
587	STY Enerji Elektrik Üretim A.Ş.	Turhan HES	Rize	hydraulic	17.08.2006	9,4	48.380.000	9,4	3,2 (January 2012)	2016
588	Suarı Müşavirlik Mühendislik Enerji San. Ve Tic. Ltd. Şti.	Atilla 1 ve 2 HES Projesi	Ordu	hydraulic	18.02.2009	10,8	59.430.000	10,8	37,7	2014
589	Suata Enerji Müt. Müş. San. ve Tic. Ltd.Şti.	Burçak I-II Reg. ve HES	Giresun	hydraulic	13.11.2007	72,5	223.870.000	72,5	*	2013
590	Su-En Enerji Elektrik Üretim A.Ş.	Söğütlü Regülatörü ve Hes	Kahramanmaraş	hydraulic	26.01.2012	18,9	30.010.000	18,9	*	uncertain

Table 43. Hydrolytic Plants (continued)

591	Sukom Enerji El. Üretim ve Tic. Ltd. Şti.	Merek reg. Ve HES	Giresun	hydraulic	06.01.2011	9,5	26.650.000	9,5	17,8	2016
592	Sunel Enerji Üretim A.Ş.	Hunut I II III HES	Erzurum	hydraulic	11.03.2009	20,9	68.572.000	20,9	12,3	2014
593	Suveri Elektrik Üretim İnş. San. Ve Tic. A.Ş.	Dereli HES	Ankara	hydraulic	28.06.2012	2,4	4.355.655	2,4	18,0	2014
594	Sürmenek Elektrik üretim ve Tic. Ltd. Şti.	Sürmenek HES	Ankara	hydraulic	28.12.2010	4,3	11.863.912	4,3	8,1	2015
595	Şaraksel Elektrik Üretim A.Ş.	Dikmen Regülatörü ve HES	Rize	hydraulic	06.01.2007	10,5	46.568.000	10,5	2,4 (legal issue)	uncertain
596	Şekerpınar Enerji Üretim San. ve Tic. Ltd. Şti.	Sofular Reg. ve HES	Malatya	hydraulic	29.11.2007	4,0	15.893.000	4,0	27,7	2014
597	Şengün Elektrik Endüstri Sanayi ve Ticaret A.Ş.	Çanakçı II-III HES	Giresun	hydraulic	23.05.2008	12,6	48.000.000	12,6	88,8	2013
598	Şirikçioğlu Elektrik Üretim A.Ş.	Bizna Bendi ve HES	Adıyaman	hydraulic	20.11.2008	23,0	81.808.000	23,0	12,6	2015
599	T.M. Enerji Üretim Elektrik ve Ticaret A.Ş.	Şimşir Reg. Ve HES	Karabük	hydraulic	15.01.2009	4,9	18.826.000	4,9	19,3 (legal issue)	2014
600	Taçyıldız Enerji Sanayi ve Ticaret A.Ş.	Kasımlar HES	Isparta	hydraulic	15.12.2010	81,2	268.410.000	81,2	0,2	2017
601	Taşköprü HES Enerji Yatırım Üretim İnşaat ve Ticaret A.Ş.	Taşköprü Reg. Ve HES	Artvin	hydraulic	15.08.2012	17,1	56.773.000	17,1	11,2	2015
602	Taştan Enerji Üretim San. Ve Tic. A.Ş.	Taştan Reg. Ve HES	Giresun	hydraulic	04.06.2009	5,6	18.950.000	5,6	*	uncertain
603	Taşyatak Enerji Üretim ve Tic.Ltd.Şti.	Taşyatak HES	Sakarya	hydraulic	01.02.2007	12,7	46.660.000	12,7	12,4	2015
604	Tek Su Müş. En. Müh. San. Ve Tic. Ltd. Şti.	Uğurlu Regülatörü ve Hes	Ordu	hydraulic	19.03.2009	9,9	24.232.000	9,9	27,3	2015
605	Tekatan Enerji Elektrik Üretim Paz. San. Ve Tic. Ltd. Şti.	Tekatan HES	Ordu	hydraulic	24.03.2011	2,1	6.830.000	2,1	5,9	2016
606	Tek-En Enerji Üretim Ltd. Şti.	Göksu Reg. ve HES	Bolu	hydraulic	29.09.2011	17,4	62.410.000	17,4	*	2017
607	Tekhes Müşavirlik Mühendislik Enerji San. Ve Tic. Ltd. Şti.	Emir Regülatörü ve HES	Artvin	hydraulic	06.11.2008	21,5	67.960.000	21,5	6,3	2016
608	Tekkale Elektrik Üretim Tic. San. A.Ş.	Tekkale I-II HES	Artvin	hydraulic	03.03.2011	19,8	61.380.000	19,8	4,2 (January 2012)	2016
609	Tektuğ Elektrik Üretim Anonim Şirketi	Sırımtaş HES	Adıyaman	hydraulic	01.04.2009	27,9	73.530.000	27,9	62,6	2014
610	Tektuğ Elektrik Üretim Anonim Şirketi	Höçgören HES	Osmaniye	hydraulic	29.07.2010	12,5	42.550.000	12,5	44,2	2014

Table 43. Hydrolytic Plants (continued)

611	July Elektrik Üretim Ltd.Şti.	Onur Reg. Ve HES	Tokat	hydraulic	14.12.2008	20,8	42.848.000	20,8	22,2	2014
612	Temsa Elektrik Üretim Ltd. Şti.	Gözede 2 HES	Bursa	hydraulic	28.07.2011	4,2	8.840.000	4,2	36,8	2014
613	Tenet Elektrik Üretim ve Dış Ticaret Ltd. Şti.	Göktepe Reg. Ve HES	Giresun	hydraulic	11.03.2009	16,1	54.120.000	16,1	*	uncertain
614	TG Enerji Yatırım Üretim ve Ticaret Ltd. Şti.	Angutlu HES	Giresun	hydraulic	06.03.2008	21,7	79.310.000	21,7	45,7	2014
615	TIRSAN Enerji Elektrik Üretim Şirketi	Yakınca HES	Giresun	hydraulic	29.01.2009	11,9	33.649.000	11,9	28,9	2014
616	TIRSAN Enerji Elektrik Üretim Şirketi	Değirmen Regülatörü ve HES	Giresun	hydraulic	04.08.2011	27,9	77.000.000	27,9	2,5	2016
617	Tim Enerji Üretim A.Ş.	Haydar I-II Reg. Ve HES	Erzincan	hydraulic	19.01.2011	15,6	41.704.000	15,6	6,2	2016
618	Timse Elektrik Üretim Ltd. Şti.	Güneş HES	Düzce	hydraulic	16.07.2009	4,0	11.820.000	4,0	*	2013
619	TLOS Yenilenebilir Enerji Üretim San. ve Tic. A.Ş.	Geriz HES	Burdur	hydraulic	19.08.2010	1,9	5.146.000	1,9	6,0	2015
620	Trabzon Ballıca Elektrik Üretim A.Ş.	Ballıca Reg. Ve HES	Trabzon	hydraulic	15.09.2011	14,2	44.945.000	14,2	1,1	uncertain
621	Trabzon Enerji Üretim ve Ticaret A.Ş.	Üçhanlar HES	Trabzon	hydraulic	17.08.2007	10,0	41.340.000	10,0	66,8	2013
622	Trabzon Enerji Üretim ve Ticaret A.Ş.	Kemerçayır HES	Trabzon	hydraulic	17.08.2007	12,0	52.650.000	12,0	70,9	2013
623	Tufan Enerji ve Petrol ürünleri San. Tic. A.Ş.	Fahret-Özen HES	Sivas	hydraulic	16.03.2011	3,8	7.498.000	3,8	0,5 (January 2012)	2016
624	Tufan Enerji ve Petrol ürünleri San. Tic. A.Ş.	Ekinözü I-II HES	Sivas	hydraulic	16.03.2011	9,2	25.913.000	9,2	0,5	2016
625	Turhal Enerji Üretim Elektrik ve Tic. Ltd. Şti	Osmancık HES	Amasya	hydraulic	17.06.2009	13,8	47.030.000	13,8	61,4	2015
626	Tuyat Elektrik Üretim A.Ş.	Tuzlaköy-Serge Reg. ve HES	Erzurum	hydraulic	29.05.2008	17,3	49.230.000	9,9	92,1	2013
627	Tüfekçikonak Hidro Enerji Elektrik Üretim A.Ş.	Tüfekçikonağı HES	Bursa	hydraulic	19.08.2010	5,4	14.693.000	5,4	3,6	2016
628	Türkerler Enerji Yatırım Üretim İnşaat ve Ticaret Ltd. Şti.	Kanat Reg. ve Hes	Giresun	hydraulic	13.10.2010	13,9	46.000.000	13,9	7,6	2015
629	Türkoğlu Elektrik Üretim ve Ticaret Ltd. Şti.	Nebioğlu reg. Ve HES	Rize	hydraulic	02.09.2010	2,4	10.290.000	2,4	2,9 (July 2011)	2015
630	Ustaoğlu Elektrik Üretim Ltd. Şti.	Arısu Reg. Ve HES	Trabzon	hydraulic	25.12.2008	3,3	13.700.000	3,3	83,5	2013

Table 43. Hydrolytic Plants (continued)

631	Uzaş Madencilik, Çimento, Laçı, İnşaat, Ticaret ve Sanayi A.Ş.	Bilaloğlu Reg. ve Hes	Bingöl	hydraulic	11.03.2009	7,0	32.300.000	7,0	18,8	2014
632	Üçharmanlar Enerji Üretim Ltd. Şti.	Üçharmanlar HES	Trabzon	hydraulic	27.05.2010	17,4	49.160.000	17,4	82,9	2013
633	Üner Enerji El. Ür. San. Ve Tic. A.Ş.	Haymeana I-II HES	Kütahya	hydraulic	15.12.2009	12,2	40.046.000	12,2	8,5	2014
634	Ünsa Madencilik Turizm Enerji Seramik Orman Ürünleri Elektrik Üretim Sanayi ve Ticaret A.Ş.	Kayaboğazı Barajı ve HES	Kütahya	hydraulic	04.06.2009	1,3	6.829.000	1,3	4,1	2015
635	Van Elektrik Üretim Sanayi ve Ticaret A.Ş.	Çayaşan Reg. Ve HES	Erzurum	hydraulic	11.11.2010	17,0	84.400.000	17,0	4,5	2016
636	Varto Elektrik Üretim Ltd. Şti.	Kamer HES	Muş	hydraulic	01.12.2011	2,1	6.300.000	2,1	*	2016
637	Vasfi Enerji Elektrik Üretim Paz. San. Ve Tic. Ltd. Şti.	Sölperen HES	Erzincan	hydraulic	26.06.2008	5,7	15.240.000	5,7	17,8	2014
638	Vatan Elektrik Üretim San. ve Tic. A.Ş.	Rıza Reg. ve HES	Ordu	hydraulic	29.05.2008	9,4	30.377.000	9,4	47,3	2013
639	Vira Enerji Üretim ve Ticaret Ltd. Şti	Tuğra HES	Giresun	hydraulic	20.11.2008	23,6	69.780.000	23,6	46,8	2013
640	Yade Elektrik Üretim Ticaret Ltd. Şti	Umut HES	Erzincan	hydraulic	25.06.2009	11,1	41.148.000	11,1	2,1	2016
641	Yade Elektrik Üretim Ticaret Ltd. Şti	Poyraz I-II reg ve HES	Erzincan	hydraulic	08.07.2009	14,2	49.660.000	14,2	2,2	2016
642	Yağmur Enerji Üretim ve Sanayi A.Ş.	Namnam	Muğla	hydraulic	11.02.2009	1,6	6.332.000	1,6	17,8 (January 2012)	2014
643	Yapısan Elektrik Üretim A.Ş.	Bucakkışla HES	Karaman	hydraulic	18.08.2011	34,5	151.000.000	34,5	15,0	2016
644	YCK İnşaat Enerji Üretim Turizm Kozmetik Medikal Madencilik San. ve Dış Tic. A.Ş.	Aladağ Reg. Ve HES	Bolu	hydraulic	12.05.2011	5,9	13.090.000	5,9	*	2016
645	Yek Enerji Üretim A.Ş.	Aybige Reg ve HES	Kastamonu	hydraulic	29.09.2011	6,5	20.065.930	6,5	2,7	2016
646	Yeni Doruk Enerji Elektrik Üretim A.Ş.	Doruk Reg. Ve HES	Giresun	hydraulic	09.10.2008	30,6	80.680.000	30,6	58,1	2014
647	Yenigün Enerji Üretim A.Ş.	Çakırkoç (Posof I) HES	Ardahan	hydraulic	15.01.2009	4,1	14.761.000	4,1	4,2	2014
648	Yeşilırmak Elektrik Enerji Üretim A.Ş.	Yeşilırmak I Reg. ve HES	Tokat	hydraulic	09.02.2011	8,0	24.190.000	8,0	90,7	2013
649	Yeşilırmak II Elektrik Enerji Üretim Ltd. Şti.	Yeşilırmak II Reg. ve HES	Tokat	hydraulic	21.06.2012	6,2	31.430.000	6,2	6,0	2016
650	Yeşilköy Elektrik Üretim ve Tic. Ltd. Şti.	Yeşilköy Reg. ve HES	Rize	hydraulic	01.10.2009	3,1	12.829.000	3,1	9,7	2014

Table 43. Hydrolytic Plants (continued)

651	Yeşilyurt Grup Enerji Üretim Tic. Ve San. A.Ş.	Araklı IV Reg. ve HES	Trabzon	hydraulic	24.05.2012	9,2	19.000.000	9,2	24,5	uncertain
652	Yıldırım Enerji Elektrik Üretim Ltd. Şti.	Yıldırım HES	Kars	hydraulic	29.11.2007	0,6	2.496.896	0,6	11,9	2014
653	Yıldırım Enerji Üretim San. ve Tic. A.Ş.	Değirmendere HES	Artvin	hydraulic	31.12.2007	4,1	14.568.000	4,1	9,7	2015
654	Yurt Enerji Üretim Sanayi ve Ticaret A.Ş.	Gökböget Reg. Ve Hes	Isparta	hydraulic	15.09.2011	3,3	11.550.000	3,3	3,3	2016
655	Yüceyurt Enerji Üretim Tic. Ve San. A.Ş.	Araklı I Reg. Ve Hes	Trabzon	hydraulic	17.06.2010	15,4	25.082.577	4,9	92,4	2013
656	Yüceyurt Enerji Üretim Tic. Ve San. A.Ş.	Araklı III Reg. Ve Hes	Trabzon	hydraulic	24.02.2011	0,7	3.460.000	0,7	62,3	2014
657	Zeki Enerji Üretim Dağ. Paz. San. ve Tic. A.Ş.	Çatak Reg. Ve HES	Rize	hydraulic	26.03.2009	10,4	42.530.000	10,4	(legal issue)	2016
658	Zeynep Enerji Üretim San. ve Tic. A.Ş.	Avanos Regülatörü ve Cemel HES	Nevşehir	hydraulic	09.02.2011	21,6	73.950.000	21,6	45,7	2015
659	Zeyve Enerji Üretim Sanayi İthalat İhracat ve Ticaret Limited Şirketi	Zeyve HES	Karaman	hydraulic	11.11.2011	4,2	14.180.000	4,2	22,2	2014
660	Zincirli Elektrik Üretimi ve Ticaret A.Ş.	Zincirli HES	Antalya	hydraulic	12.05.2011	9,8	65.970.000	9,8	0,5	2016
661	k Enerji Üreti	Sami Soydam-Sandalcık Barajı ve HES	Denizli	hydraulic	07.06.2012	127,8	372.900.000	127,8	4,9	2015
662	Zümrüt Enerji Sağ. Ve Gıda. San. Dış Tic. A.Ş.	Deliktaş Reg. Ve HES	Bitlis	hydraulic	06.11.2008	5,3	24.200.000	5,3	14,9	2014

Table 44. Other Renewable Plants

663	ABH Elektrik Üretim Tarım Hayvancılık İnşaat Ticaret Anonim Şirketi	Alibeyhüyüğü	Konya	wind	16.03.2011	3,0	5.800.000	3,0	4,1	uncertain
664	ABK Çeşme R.E.S Enerji, Elekrik Üretim Anonim Şirketi	Çeşme	İzmir	wind	11.03.2010	16,0	58.561.200	16,0	0,4	uncertain
665	ABK Enerji Elektrik Üretim Anonim Şirketi	Çatalbük	Aydın	wind	11.11.2011	25,0	87.600.000	25,0	0,4	uncertain
666	Açar Enerji Yat. Ür. Ve Tic. A.Ş.	Türkeli	Sinop	wind	06.01.2011	30,0	108.000.000	30,0	3,0	uncertain
667	Ado Enerji Üretim Sanayi ve Ticaret A.Ş.	Akyurt	Tokat	wind	27.12.2011	12,8	42.608.000	12,8	3,0	uncertain
668	Ado Enerji Üretim Sanayi ve Ticaret A.Ş.	Konakpınar	Sivas	wind	19.09.2011	12,0	36.792.000	12,0	6,0	uncertain
669	Ado Enerji Üretim Sanayi Ve Ticaret Anonim Şirketi	Ziyarettepe	Kayseri	wind	22.06.2011	10,0	26.280.000	10,0	8,0	uncertain
670	Ahsen Enerji Üretim Tic. Ve San. A.Ş.	Akdağ	Konya	wind	10.01.2012	23,0	75.000.000	23,0	1,8	uncertain
671	Airres Elektrik Üretim San. Ve Tic. A.Ş.	Airres-4	Kırklareli	wind	28.03.2012	55,0	216.810.000	55,0	0,0	uncertain
672	Akdeniz Elektrik Üretim A.Ş.	Mersin	İçel	wind	05.07.2007	42,0	150.000.000	42,0	33,1	uncertain
673	Akış Enerji Yatırım Üretim ve Tic. A.Ş.	Söke	Aydın	wind	21.07.2011	104,0	383.000.000	104,0	1,2	uncertain
674	Aksa Enerji Üretim A.Ş.	Atik	Hatay	wind	13.03.2008	30,0	98.128.500	30,0	30,0	2013
675	Aktepe Enerji A.Ş.	Seferihisar	İzmir	wind	25.12.2008	17,5	47.400.000	17,5	1,8	uncertain
676	Akyelres Elektrik Üretim Sanayi ve Tic. A.Ş.	Akyel-1	Karaman	wind	04.04.2012	40,0	161.184.000	40,0	0,0	uncertain
677	Aladağ Rüzgar Enerji Üretim Sanayi ve Tic. A.Ş.	Kuyulukoyak	Konya	wind	27.12.2011	16,0	57.465.600	16,0	*	2015
678	Alanoba Elektrik Üretim A.Ş.	Ilbır	Muğla	wind	26.10.2011	50,0	162.060.000	50,0	0,2	uncertain
679	Alenka Enerji Üretim ve Yatırım Ltd. Şti.	Yurttepe	Hatay	wind	04.04.2007	13,5	41.891.700	13,5	22,7	2013
680	Alenka Enerji Üretim ve Yatırım Ltd. Şti.	Kıblekayası	Hatay	wind	04.04.2007	15,0	39.969.000	15,0	34,2	2013

Table 44. Other Renewable Plants (continued)

681	Alenka Enerji Üretim ve Yatırım Ltd. Şti.	Sırakayalar	Tekirdağ	wind	04.04.2007	12,0	33.216.900	12,0	29,1	2013
682	Alenka Enerji Üretim ve Yatırım Ltd. Şti.	Kıyıköy	Kırklareli	wind	04.04.2007	27,0	100.066.000	27,0	34,3	2013
683	Alentek Enerji A.Ş.	Susurluk RES	Balıkesir	wind	24.07.2008	60,0	112.227.600	0,0	0,2	uncertain
684	Alres Enerji Üretim A.Ş.	Alres Jeotermal Enerji Santrali	Aydın	geothermal	28.12.2010	9,5	70.737.000	9,5	20,4	2014
685	AL-YEL Elektrik Üretim A.Ş.	Geycek RES	Kırşehir	wind	14.05.2008	150,0	487.500.000	150,0	0,4	uncertain
686	Are Elektrik Üretim Ticaret Ve Sanayi Limited Şirketi	Kurtkaya	Kayseri	wind	15.09.2011	45,0	173.616.678	45,0	0,0	uncertain
687	Arı En Enerji Üretim ve Tic. A.Ş.	Gazi	İstanbul	wind	16.03.2011	5,0	19.552.605	5,0	3,1	uncertain
688	Arı En Enerji Üretim ve Tic. A.Ş.	Sakarbayır	İstanbul	wind	16.03.2011	3,0	10.499.916	3,0	3,1	uncertain
689	Arnaz Res Rüzgar Enerjisinden Elektrik Üretim Santralı LTD. Şti	Uşak RES	Uşak	wind	05.07.2011	54,0	210.000.000	54,0	32,8	2013
690	Arova Res Rüzgar Enerjisinden Elektrik Üretim Santralı LTD. Şti	Yalova RES	Yalova	wind	05.07.2011	54,0	155.000.000	54,0	13,5	uncertain
691	Ayen Enerji A.Ş.	Korkmaz	İzmir	wind	29.05.2008	25,2	83.005.300	25,2	62,3	2013
692	Ayen Enerji A.Ş.	Mordoğan	İzmir	wind	29.05.2008	31,5	99.409.200	31,5	73,3	2013
693	Ayen Enerji A.Ş.	Akbük	Muğla	wind	12.01.2012	20,0	68.153.000	20,0	0,5	uncertain
694	Elektrik Üretin	Yeniköy	Çanakkale	wind	06.06.2012	15,0	52.500.000	15,0	0,1	uncertain
695	Aysu Enerji San. Ve Tic. A.Ş.	Karadere	Kırklareli	wind	11.11.2011	15,0	51.840.000	15,0	7,3	uncertain
696	Babadağ Elektrik Üretim San. Ve Tic.A.Ş.	Kırkağaç	Manisa	wind	05.01.2012	45,0	193.500.000	45,0	*	uncertain
697	Babadağ Elektrik Üretim San. Ve Tic.A.Ş.	Marmara	Balıkesir	wind	11.11.2011	10,0	40.000.000	10,0	0,4	uncertain
698	Bağlar Elektrik Üretim A.Ş.	Bağlar RES	Konya	wind	21.06.2012	100,0	300.000.000	100,0	0,0	uncertain
699	Bahar Enerji Elektrik üretim San. Ve Tic. Ltd. Şti.	G Res	Çanakkale	wind	09.02.2012	5,0	17.500.000	5,0	*	uncertain
700	Bak Enerji Üretimi A.Ş.	Yahyalı	Kayseri	wind	07.09.2011	82,5	296.277.696	82,5	0,3	uncertain

Table 44. Other Renewable Plants (continued)

701	Balabanlı Rüzgar Enerjisinden Elektrik Üretim Ltd. Şti.	Balabanlı	Tekirdağ	wind	31.03.2011	50,0	153.333.000	50,0	0,8	uncertain
702	Balıkesir Rüzgar Enerjisinden Elektrik Üretim Santralı Ltd. Şti.	Alibey Adası	Balıkesir	wind	11.09.2003	30,0	106.456.000	30,0	26,9 (July 2011)	2014
703	Bali Rüzgar Elektrik Üretim San. Ve Tic. A.Ş.	Çakıl	İstanbul	wind	18.01.2012	52,5	204.160.000	52,5	*	uncertain
704	Baltepe Enerji A.Ş.	Ovacık	İzmir	wind	25.12.2008	20,0	55.000.000	20,0	1,1	uncertain
705	Bares Elektrik Üretim A.Ş.	Balıkesir	Balıkesir	wind	18.04.2007	143,0	549.200.000	98,8	28,4	2014
706	Barkan Enerji Yat. Üretim Tic. A.Ş.	Şapdağı	Balıkesir	wind	09.02.2012	55,0	192.500.000	55,0	0,9	uncertain
707	Barkan Enerji Yat. Üretim Tic. A.Ş.	Tire	İzmir	wind	08.12.2011	50,0	180.000.000	50,0	0,9	uncertain
708	Bay Temiz Enerji Elektrik Üretim İnş. San ve tic. A.Ş.	Kartaldağı	Eskişehir	wind	26.10.2011	39,0	122.990.400	39,0	0,5	uncertain
709	Bereketli Elektrik Enerji Üretim ve Tic. A.Ş.	Bereketli	Tokat	wind	16.03.2011	30,0	99.864.000	30,0	2,6	uncertain
710	Bergres Elektrik Üretim A.Ş.	Bergres	İzmir	wind	09.02.2012	70,0	245.200.000	70,0	0,1	uncertain
711	Beşiktepe Üretim ve Ticaret Ltd. Şti.	Kıyıköy	Tekirdağ	wind	28.03.2012	44,0	173.500.000	44,0	*	uncertain
712	Betim Enerji Yat. Üretim ve Tic. A.Ş.	Ömerli	İstanbul	wind	18.01.2012	100,0	377.000.000	100,0	0,0	uncertain
713	Bora Rüzgar Elektrik Üretim San. Ve Tic. A.Ş.	Çanta	İstanbul	wind	18.08.2011	47,5	159.750.000	47,5	11,1	uncertain
714	Borares Enerji Elektrik Üretim A.Ş.	Karova	Muğla	wind	18.08.2011	30,0	122.500.000	30,0	0,1	uncertain
715	Briza Rüzgar Elektrik Üretim San. Ve Tic. A.Ş.	Kavaklı	Balıkesir	wind	09.02.2012	50,0	172.200.000	50,0	1,3	uncertain
716	Can Enerji Entegre Elektrik Üretim A.Ş.	Metristepe RES	Bilecik	wind	17.01.2008	39,0	85.000.000	39,0	74,8	2012
717	Cankurtaran Enerji Üretim Dağıtım Ltd. Şti.	Cankurtaran	Denizli	wind	06.07.2011	10,0	30.600.000	10,0	*	uncertain
718	Çalık Rüzgar Enerjisi Elektrik Üretim Ltd. Şti.	Demircili	İzmir	wind	29.05.2008	40,0	107.360.000	40,0	2,2	uncertain
719	Çalık Rüzgar Enerjisi Elektrik Üretim Ltd. Şti.	Sarpıncık	İzmir	wind	29.05.2008	32,0	109.840.000	32,0	2,2	uncertain
720	Çanres Rüzgar Enerji Üretimi San. Ve Tic.A.Ş.	Sadıllı	Edirne	wind	14.02.2012	38,5	115.500.000	38,5	14,6	uncertain

Table 44. Other Renewable Plants (continued)

721	Çapar Elektrik Üretim Limited Şirketi	Yılmaz	İzmir	wind	11.11.2011	12,5	50.086.970	12,5	1,3	uncertain
722	Çayönü Elektrik Enerji Üretim ve Tic. A.Ş.	Çayönü	Kayseri	wind	31.03.2011	35,0	125.706.000	35,0	0,0	uncertain
723	Çekim Enerji Yat. Üretim Tic. A.Ş.	Kalfaköy	Balıkesir	wind	12.01.2012	10,0	39.400.000	10,0	*	uncertain
724	Çekim Enerji Yat. Üretim Tic. A.Ş.	Bozüyük	Bilecik	wind	18.08.2011	90,0	323.000.000	90,0	0,6	uncertain
725	Çelikler Jeotermal Elektrik Üretim A.Ş.	Çelikler Sultanhisar Jeotermal Elektrik Üretim Tesisi	Aydın	geothermal	26.05.2011	9,9	82.387.800	9,9	*	uncertain
726	Çelikler Jeotermal Elektrik Üretim A.Ş.	Çelikler Pamukören Jeotermal Elektrik Üretim Tesisi	Aydın	geothermal	26.05.2011	30,0	249.660.000	30,0	*	uncertain
727	Deniz Elektrik Üretim Ltd. Şti.	Sebenoba	Hatay	wind	04.06.2004	60,0	100.000.000	30,0	66,7	2012
728	Denizhan Enerji Yatırım Üretim ve Ticaret Anonim Şirketi	Mahmut Şevket Paşa-2	Kocaeli	wind	11.11.2011	100,0	377.000.000	100,0	0,0	uncertain
729	Derbent Enerji Üretim Paz. İth. Ve İhr. A.Ş.	Üçpınar	Çanakkale	wind	29.09.2011	99,0	342.254.600	99,0	1,4	uncertain
730	Derin Enerji Üretim Sanayi ve Ticaret Limited Şirketi	ypazarı biogas Tes	Ankara	biogas	11.11.2011	0,6	4.826.892	0,6	*	uncertain
731	Derton Elektrik Üretim A.Ş.	Gerede-Yeniçağa RES	Bolu	wind	27.12.2011	60,0	199.728.000	60,0	0,0	uncertain
732	Doğal Enerji Elektrik Üretim A.Ş.	Samurlu	İzmir	wind	06.12.2007	30,0	105.000.000	18,0	47,0	2014
733	Doğal Enerji Elektrik Üretim A.Ş.	Kozbeyli	İzmir	wind	07.12.2007	30,0	105.000.000	30,0	44,8	uncertain
734	Doğal Enerji Elektrik Üretim A.Ş.	Sayalar	Manisa	wind	13.04.2004	54,2	103.047.059	20,0	7,3	uncertain
735	Eber Elektrik Üretim A.Ş.	Eber	Afyon	wind	01.02.2011	36,0	94.608.000	36,0	*	uncertain
736	Edincik Enerji Üretim A.Ş.	Edincik RES	Balıkesir	wind	08.03.2012	30,0	125.000.000	30,0	1,9	uncertain
737	Efil Enerji Üretim Tic. Ve San. A.Ş.	Kartaldağı	Gaziantep	wind	04.05.2011	63,0	198.600.000	63,0	*	uncertain
738	Egenda Ege Enerji Üretim A.Ş.	Germiyan	İzmir	wind	29.05.2008	10,8	37.834.100	10,8	*	uncertain
739	Egenda Ege Enerji Üretim A.Ş.	Urla	İzmir	wind	29.05.2008	13,0	52.468.900	13,0	*	uncertain
740	Egenda Ege Enerji Üretim A.Ş.	Alaçatı	İzmir	wind	29.05.2008	16,0	49.911.487	16,0	*	uncertain

Table 44. Other Renewable Plants (continued)

741	Egenda Ege Enerji Üretim A.Ş.	Mordoğan	İzmir	wind	29.05.2008	13,8	53.897.400	13,8	*	uncertain
742	Egener Elektrik üretim ve Makine San. Ve Tic. A.Ş.	Karabel	İzmir	wind	23.02.2012	3,0	11.826.000	3,0	0,6	uncertain
743	Ekim Elektrik Müh. Müş. İnş. Tur. Ve Tic. Ltd. Şti.	Havza	Samsun	wind	11.11.2011	48,0	155.577.600	48,0	0,0	uncertain
744	Ekim Grup Elektrik Üretim Ltd. Şti.	Ekim Grup biogas	Konya	biogas	14.02.2012	1,2	9.936.000	1,2	90,4	uncertain
745	Ekolojik Enerji Ltd. Şti.	Kemerburgaz Çöp	İstanbul	landfill gas	05.10.2004	6,5	40.000.000	5,5	*	uncertain
746	Ekolojik Enerji Ltd. Şti.	Katı Atık Bertaraf Tesisi	Tekirdağ	biomass	24.09.2008	0,8	4.233.000	0,8	*	uncertain
747	Eksel Elektrik Üretim San. Ve Tic. Ltd. Şti	Alares	Uşak	wind	14.07.2011	10,0	41.600.000	10,0	0,6	uncertain
748	Eksim Enerji A.Ş.	Hasanbeyli	Osmaniye	wind	11.11.2011	50,0	216.813.700	50,0	1,5	uncertain
749	Ekşi Enerji Üretim Ltd. Şti	Arapkir	Malatya	wind	05.07.2011	10,0	27.000.000	10,0	1,6	uncertain
750	Elfa Elektrik Üretim A.Ş.	Umurlar	Balıkesir	wind	21.04.2011	10,0	30.660.000	10,0	1,9	uncertain
751	Elmadağ Elektrik Enerji Üretim ve Tic. A.Ş.	Elmadağ	Ankara	wind	27.12.2011	72,0	264.902.000	72,0	0,1	uncertain
752	Elmalı Enerji Limited Şirketi	Elmalı	İçel	wind	29.09.2011	9,0	31.536.000	9,0	2,2	uncertain
753	Eni Enerji İnş. Taah. Tic. Ve San. A.Ş.	Maslaktepe	Çanakkale	wind	15.03.2012	20,0	70.000.000	20,0	0,8	uncertain
754	Ertan Enerji Elektrik Üretim Anonim Şirketi	Ertan	İstanbul	wind	01.12.2011	3,0	10.000.000	3,0	*	uncertain
755	Esenköy Elektrik Enerji Üretim ve Tic. A.Ş.	Esenköy	Kastamonu	wind	21.07.2011	10,0	35.040.000	10,0	0,4	uncertain
756	Esin Rüzgar Enerji Üretim Sanayi ve Tic. A.Ş.	Çamınbaşı	Antalya	wind	01.12.2011	27,0	94.608.000	27,0	*	uncertain
757	Esinti Enerji Üretim Tic. Ve San. A.Ş.	Kınık	Manisa	wind	08.03.2012	50,0	162.500.000	50,0	1,2	uncertain
758	Esit Enerji A.Ş.	Ada 2	Balıkesir	wind	01.11.2011	3,2	11.360.000	3,2	*	uncertain
759	Eskoda Enerji Üretim Paz. İth. Ve İhr. A.Ş.	Koru	Çanakkale	wind	22.12.2011	50,0	182.632.300	50,0	0,1	uncertain
760	ES-YEL Elektrik Üretim Ltd. Şti.	Ardıçlı RES	Konya	wind	24.07.2008	50,0	162.500.000	50,0	4,7	uncertain

Table 44. Other Renewable Plants (continued)

761	Evrencik Rüzgar Enerjisinden Elektrik Üretim Ltd. Şti.	Evrencik	Kırklareli	wind	09.02.2012	120,0	367.920.000	120,0	0,0	uncertain
762	Fuatres Elektrik Üretim A.Ş.	Fuatres	İzmir	wind	23.02.2012	30,0	105.000.000	30,0	0,5	uncertain
763	Galata Wind Enerji Limited Şirketi	Şah RES	Balıkesir	wind	10.04.2008	105,0	325.500.000	105,0	39,3	uncertain
764	Garet Enerji Üretim ve Ticaret A.Ş.	Gökres-2	Manisa	wind	09.02.2012	35,0	122.640.000	35,0	0,8	uncertain
765	Geres Elektrik Üretim A.Ş.	Geres	Manisa	wind	09.02.2012	27,0	106.396.875	27,0	0,3	uncertain
766	Gökova Elektrik Üretim ve Ticaret Ltd. Şti	Alapınar	Muğla	wind	01.12.2011	0,8	2.474.800	0,8	*	uncertain
767	Göl Marmara Enerji Yat. Üretim ve Tic. A.Ş.	Gölmarmara	Manisa	wind	16.03.2011	45,0	166.000.000	45,0	0,8	uncertain
768	Gölyaka Enerji Yatırım Üretim ve Ticaret Anonim Şirketi	Gölyaka	Sakarya	wind	16.03.2011	15,0	54.000.000	15,0	1,0	uncertain
769	GRC Enerji Elektrik Üretim San. Ve Tic. A.Ş.	Emres	İzmir	wind	07.06.2011	2,0	6.500.000	2,0	1,8 (January 2012)	uncertain
770	GRC Yenilenebilir Enerji Üretimi Sanayi ve Ticaret Limited Şirketi	Çataltepe	İstanbul	wind	28.12.2011	4,0	7.000.000	4,0	1,8	uncertain
771	Gümüşköy Jeotermal Enerji Üretim A.Ş.	Gümüşköy JES	Aydın	geothermal	24.02.2011	15,0	118.260.000	15,0	26,2	uncertain
772	Günce Enerji Yat. Üretim ve Tic. A.Ş.	Sandıklı	Afyon	wind	24.03.2011	12,0	43.000.000	12,0	2,2	uncertain
773	Gündoğdu Rüzgar Enerji Üretim Sanayi ve Tic. A.Ş.	Demirözü	Sivas	wind	20.10.2011	37,0	136.130.400	37,0	*	uncertain
774	Güral Porselen Tur. Ve Vitrifiye San. A.Ş.	Germiyan RES	İzmir	wind	26.10.2011	9,6	25.000.000	9,6	1,3	uncertain
775	GYY Elektrik Üretim A.Ş.	Özbek	Hatay	wind	01.03.2012	24,0	84.000.000	24,0	*	uncertain
776	Hacim Enerji Yat. Üretim ve Tic. A.Ş.	Geyve	Sakarya	wind	20.10.2011	50,0	180.000.000	50,0	0,5	uncertain
777	Hanay Elektrik Üretim Ltd. Şti.	Elmalı	İçel	wind	08.03.2012	27,0	82.782.000	27,0	0,2	uncertain
778	Hassas Teknik Enerji Elektrik Üretim San. ve Tic. A.Ş.	Urla RES	İzmir	wind	29.05.2008	15,0	60.000.000	15,0	5,6 (July 2011)	uncertain
779	Hilalres Elektrik Üretim San. Ve Tic. A.Ş.	Hilal-2	Karaman	wind	28.03.2012	7,0	24.500.000	7,0	0,0	uncertain
780	Iberdrola Yenilenebilir Enerji Kaynaklarından Enerji Üretimi Tic. ve San. Ltd. Şti.	Yaprak	Kırklareli	wind	28.12.2011	15,0	47.250.000	15,0	0,0	uncertain

Table 44. Other Renewable Plants (continued)

781	Iberdrola Yenilenebilir Enerji Kaynakların dan Enerji Üretimi Tic. ve San. Ltd. Şti.	Muğla	Muğla	wind	29.09.2011	70,0	199.500.000	70,0	0,0	uncertain
782	Iberdrola Yenilenebilir Enerji Kaynakların dan Enerji Üretimi Tic. ve San. Ltd. Şti.	Subaşı	Edirne	wind	09.02.2011	48,0	129.600.000	48,0	0,7	uncertain
783	Isıder Enerji Üretim Paz. İth. Ve İhr. A.Ş.	Kocalar	Çanakkale	wind	22.12.2011	26,0	88.051.100	26,0	1,1	uncertain
784	ITC Bursa Enerji Üretim San. Ve Tic. A.Ş.	ITC Bursa Hamitler Tesisi	Bursa	biomass	01.12.2011	10,0	85.848.000	1,4	0,0 (January 2012)	uncertain
785	ITC-KA Enerji Üretim San. ve Tic. A.Ş.	Mamak Katı Atık Alanı Enerji Üretim Tesisi	Ankara	landfill gas	04.08.2006	37,0	280.000.000	10,9	75,5 (January 2012)	uncertain
786	İçdaş Çelik Enerji Tersane ve Ulaşım San. A.Ş.	İçdaş Biga RES	Çanakkale	wind	06.10.2011	60,0	192.895.200	60,0	*	uncertain
787	İletken Enerji Yatırım Üretim ve Tic. A.Ş.	Gökdağ	Kocaeli	wind	18.08.2011	10,0	36.000.000	10,0	0,9	uncertain
788	İstres Elektrik Üretim Anonim Şirketi	Tayakadın	İstanbul	wind	21.07.2011	50,0	175.200.000	50,0	13,7	2014
789	İzaydaş İzmit Atık ve Artıkları Arıtma Yakma ve Değerlendir me A.Ş.		Kocaeli	biogas	12.01.2012	0,8	6.000.000	0,8	*	uncertain
790	İzdem Enerji Yat. Üretim Tic. A.Ş.	Afyon-2	Afyon	wind	16.03.2011	88,0	316.000.000	88,0	1,1	uncertain
791	İzres Elektrik Üretim A.Ş.	İzres	İzmir	wind	23.02.2012	7,5	23.000.000	7,5	0,1	uncertain
792	Jeoden Elektrik Üretim İnş. San. Ve tic. A.Ş.	Jeoden	Denizli	geother mal	23.11.2011	2,5	20.509.650	2,5	*	uncertain
793	Kale En. Ür. Tic.Ve San. A.Ş.	Dilek	ahramanmara	wind	01.02.2011	27,5	90.226.641	27,5	*	uncertain
794	Kalemirler Enerji Elektrik Üretim Ltd. Şti.	Sezer Bio Enerji	Antalya	biomass	01.03.2012	0,6	4.320.000	0,6	*	uncertain
795	Kangal Elektrik Enerji Üretim ve Tic. A.Ş.	Kangal	Sivas	wind	12.04.2011	128,0	414.873.600	128,0	20,7	2014
796	Kapıdağ Rüzgar Enerjisi Santralı Elektrik Üretim San. ve Tic.A.Ş.	Kapıdağ RES	Balıkesir	wind	12.12.2006	34,9	124.904.000	34,9	91,2	2012
797	Karacaören Elektrik Enerji Üretim ve Tic. A.Ş.	Karacaören	Samsun	wind	31.03.2011	35,0	107.310.000	35,0	1,2	uncertain
798	Karhes Karadeniz Hidro Elektrik Üretim A.Ş.	Gündalan	İzmir	wind	06.07.2011	5,0	18.396.000	5,0	0,5	uncertain
799	Karkey Karadeniz Elektrik Üretim A.Ş.	Karkey Umurlu JES	Aydın	geother mal	06.09.2010	5,0	42.000.000	5,0	9,7	uncertain
800	Kavram Enerji Yat. Ür. Ve Tic. A.Ş.	Uluborlu	Isparta	wind	19.01.2011	60,0	216.000.000	60,0	1,3	uncertain

Table 44. Other Renewable Plants (continued)

801	Kazanım Enerji Yat. Ür. Ve Tic. A.Ş.	Bafa	Aydın	wind	18.08.2011	35,0	130.000.000	35,0	0,3	uncertain
802	Kıroba Elektrik Üretim Anonim Şirketi	Madranbaba	Aydın	wind	17.03.2010	20,0	74.200.000	20,0	86,8	uncertain
803	Kiper Elektrik Üretim A.Ş.	Kiper JES	Aydın	geothermal	28.07.2011	20,0	155.000.000	20,0	5,8	uncertain
804	Kiraz Enerji Yat. Üretim ve Tic. A.Ş.	Kirazlı	İzmir	wind	21.07.2011	50,0	188.000.000	50,0	1,4	uncertain
805	KLF Enerji Yatırım Üretim İth. İhr. San ve Tic. A.Ş.	Civan	Uşak	wind	21.07.2011	15,0	52.500.000	15,0	1,2	uncertain
806	Konbeltaş Konya İnşaat Taşımacılık Hizmet Danışmanlık ve Park İşletmeciliği A.Ş.	Konya Atıksu Arıtma Tesisi Elektrik antrali	Konya	biogas	13.04.2010	2,5	18.350.000	2,5	*	uncertain
807	Koni İnş. San A.Ş.	Datça	Muğla	wind	20.10.2011	12,0	44.000.000	12,0	0,4	uncertain
808	Koni İnş. San A.Ş.	Karakapı	Aksaray	wind	01.02.2011	40,0	124.000.000	40,0	1,7	uncertain
809	Korda Enerji Üretim Paz. İth. Ve İhr. A.Ş.	Denizli	Denizli	wind	18.08.2011	66,0	184.472.600	66,0	1,1	uncertain
810	Kovancı Enerji Üretim Paz. İth. Ve İhr. A.Ş.	HASANoba	Çanakkale	wind	01.03.2012	51,0	203.559.200	51,0	0,3	uncertain
811	Körfez Enerji San. Ve Tic. A.Ş.	Kocaeli Çöp biogas Projesi	Kocaeli	biogas	06.10.2011	2,5	10.000.000	1,2	87,4	uncertain
812	Kurucaşile Elektrik Enerji Üretim ve Tic. A.Ş.	Kurucaşile	Bartın	wind	24.08.2011	27,0	89.877.600	27,0	0,4	uncertain
813	Kütle Enerji Yat. Ür. Ve Tic. A.Ş.	Bağarası	Aydın	wind	18.08.2011	46,0	170.000.000	46,0	0,4	uncertain
814	Lodos Karaburun Elektrik Üretim A.Ş.	Karaburun	İzmir	wind	18.08.2011	120,0	400.000.000	120,0	8,4	uncertain
815	Manastır Elektrik Üretim Tesisleri A.Ş.	Manastır	Yalova	wind	23.02.2012	12,0	42.048.000	12,0	0,6	uncertain
816	Manres Rüzgar Enerji Üretimi San. Ve Tic.A.Ş.	Günaydın	Balıkesir	wind	11.11.2011	12,5	35.040.000	12,5	79,2	uncertain
817	Maren Maraş Elektrik Üretim San. Ve Tic. A.Ş.	Maren Santrali	Aydın	geothermal	30.07.2009	44,0	350.000.000	24,0	24,6	2014
818	MB Elektrik Üretim Ltd. Şti.	Mahyadağ	Kırklareli	wind	17.11.2011	30,0	115.082.300	30,0	0,0	uncertain
819	Meltem Enerji Elektrik Üretim A.Ş.	Ege	İzmir	wind	20.12.2011	7,0	24.528.000	7,0	0,5	uncertain
820	Menderes Geothermal Elektrik Üretim A.Ş.	Dora III JES	Aydın	geothermal	19.08.2010	34,0	220.000.000	34,0	75,4	2013

Table 44. Other Renewable Plants (continued)

821	Menderes Geothermal Elektrik Üretim A.Ş.	Dora IV JES	Aydın	geothermal	09.05.2012	17,0	125.000.000	17,0	*	uncertain
822	Meriç Rüzgar Enerjisi Elektrik Üretim A.Ş.	Hamzabeyli	Edirne	wind	17.02.2011	3,0	5.000.000	3,0	*	uncertain
823	Mersin Büyükşehir İmar. İnş. Ve Tic. A.Ş.	Karaduvar Atıksu Arıtma Tesisi biogas Santralı	İçel	biogas	04.05.2011	1,9	13.300.000	1,9	*	uncertain
824	Mursal Enerji ür. San. Ve Tic. Ltd. Şti	Karaçayır	Sivas	wind	14.06.2011	10,0	26.280.000	10,0	6,0	uncertain
825	Mutluer Enerji İnş. Yat. Mad. San. Ve Tic. A.Ş.	Mutlu RES 5	Konya	wind	24.02.2011	44,0	190.160.000	44,0	1,0	uncertain
826	Nuh Enerji Elektrik Üretim A.Ş.	Hereke	Kocaeli	wind	24.02.2011	2,5	4.807.200	2,5	2,1	uncertain
827	Okman Enerji Elektrik Üretim ve Yatırım A.Ş.	Karadağ	İzmir	wind	29.05.2008	16,3	51.151.750	16,3	0,6	2012
828	Olgu Enerji Yat. Ür. Ve Tic. A.Ş.	Dinar	Afyon	wind	16.03.2011	50,0	180.000.000	50,0	4,8	uncertain
829	Orsa Enerji Elektrik Üretim ve Tic. A.Ş.	Fener	Sinop	wind	20.10.2011	5,0	18.400.000	5,0	0,3	uncertain
830	Ortadoğu Enerji Sanayi ve Ticaret A.Ş.	Kömürcüoda landfill gas Santralı	İstanbul	landfill gas	25.10.2007	14,5	60.000.000	8,7	70,0	2012
831	Ortadoğu Enerji Sanayi ve Ticaret A.Ş.	Odayeri landfill gas Santralı	İstanbul	landfill gas	25.10.2007	29,0	110.000.000	11,6	80,0	2012
832	Osres Rüzgar Enerji Üretim Sanayi ve Ticaret A.Ş.	Kızılcaterzi	Edirne	wind	22.03.2012	12,0	42.000.000	12,0	0,5	uncertain
833	Öres Elektrik Üretim A.Ş.	Salman	İzmir	wind	06.10.2011	20,0	70.080.000	20,0	15,8	2014
834	Öz-Yel Elektrik Üretim Ltd. Şti.	Gaziosmanpaşa RES	İstanbul	wind	18.01.2012	50,0	150.000.000	50,0	0,0	uncertain
835	Pakmem Elektrik Üretim San. Ve Tic. A.Ş.	Cerit	Kahramanmaraş	wind	19.01.2011	90,0	299.592.000	90,0	0,1	uncertain
836	Pamukova Rüzgar Enerji Yatırım Üretim ve Ticaret Anonim Şirketi	Pamukova	Sakarya	wind	20.12.2011	20,0	72.000.000	20,0	0,9	uncertain
837	Paşa Enerji Yatırım Üretim ve Tic. A.Ş.	Mahmut Şevket Paşa-1	İstanbul	wind	14.02.2012	8,0	29.400.000	8,0	0,1	uncertain
838	Petkim Petrokimya Holding A.Ş.	Petkim	İzmir	wind	01.02.2011	25,0	94.170.000	25,0	1,5	uncertain
839	Pitane Elektrik Üretim Ltd. Şti	Pitane	İzmir	wind	26.01.2012	5,0	16.644.000	5,0	0,6	uncertain
840	Polat Elektrik Üretim İnşaat İthalat İhracat A.Ş.	Polat 3	Erzurum	wind	04.05.2011	15,0	55.188.000	15,0	1,5	uncertain

Table 44. Other Renewable Plants (continued)

841	Polat Elektrik Üretim İnşaat İthalat İhracat A.Ş.	Polat 2	Samsun	wind	17.11.2011	9,0	33.901.000	9,0	1,1	uncertain
842	Polatbay Enerji Üretim İnş. San ve Tic. A.Ş.	Ayvalık-I	Balıkesir	wind	20.11.2011	9,0	29.200.000	9,0	1,9	uncertain
843	Poyraz Enerji Üretim San. ve Tic. A.Ş.	Poyraz RES	Balıkesir	wind	04.04.2007	54,9	230.265.652	20,9	55,2	2014
844	Rea Elektrik Üretim Ticaret Ve Sanayi Limited Şirketi	Zincirli	Kayseri	wind	01.12.2011	12,0	47.430.144	12,0	0,1	uncertain
845	RK Rüzgar Enerji Santralleri Elektrik Üretim San. Ve Tic. Ltd. Şti.	Paşalimanı	Balıkesir	wind	11.11.2011	0,8	2.701.330	0,8	15,0	uncertain
846	RSH Enerji A.Ş.	Alören RES	Çorum	wind	24.07.2008	45,0	144.870.600	45,0	1,3	uncertain
847	Rüzgar Elektrik Üretim Ltd. Şti.	Akyar	Muğla	wind	09.02.2012	15,0	57.816.000	15,0	0,5	uncertain
848	Rüzgar Elektrik Üretim Ltd. Şti.	Havza	Çorum	wind	04.05.2011	15,0	49.275.000	15,0	0,6	uncertain
849	Rüzgar Elektrik Üretim Ltd. Şti.	Geriş	Muğla	wind	01.02.2012	11,2	39.244.800	11,2	0,8	uncertain
850	Safir Enerji Yat. Üretim ve Tic. A.Ş.	Meryem	Bilecik	wind	06.01.2011	30,0	110.000.000	30,0	2,0	uncertain
851	Sağanak Enerji Yat. Üretim Tic. A.Ş.	Kandıra	Kocaeli	wind	16.03.2011	49,0	176.000.000	49,0	1,2	uncertain
852	Sancak Enerji Hizmetleri A.Ş.	Yamaçtepe-2	İstanbul	wind	01.12.2011	30,0	116.749.524	30,0	*	uncertain
853	Santral Enerji Üretimi Sanayi ve Ticaret A.Ş.	Sanko JES	Manisa	geothermal	19.08.2010	15,0	118.450.000	15,0	11,0	2014
854	Saray Döküm ve Madeni Aksam San. A.Ş.	Saray RES	Tekirdağ	wind	10.03.2011	4,0	12.869.564	4,0	*	uncertain
855	Se Santral Elektrik Üretim San. Ve Tic. A.Ş.	Yahyalı	Kayseri	wind	17.11.2011	52,5	174.800.000	52,5	*	uncertain
856	Serbest Enerji San. Ve Tic. A.Ş.	Aydos	İstanbul	wind	15.03.2012	14,0	52.700.000	14,0	0,0	uncertain
857	Sibelres Elektrik Üretim A.Ş.	Sibelres	İzmir	wind	23.11.2011	80,0	308.352.000	80,0	1,1	uncertain
858	Sigma Elektrik Üretim Mühendislik Ve Pazarlama Limited Şirketi	Sigma Suluova biogas Tesisi	Amasya	biomass	26.10.2011	2,0	14.000.000	2,0	*	uncertain
859	Silivri Enerji Anonim Şirketi	Silivri RES	İstanbul	wind	29.09.2011	45,0	151.609.500	45,0	0,8	uncertain
860	Simay Elektrik Üretim A.Ş.	Küptepe	İstanbul	wind	04.04.2012	10,0	37.423.244	10,0	1,2	uncertain

Table 44. Other Renewable Plants (continued)

861	Simge Enerji Elektrik Üretim ve Gıda İmalat San. Tic. A.Ş.	İpsala 2 MW biomass Elektrik Üretim Projesi	Edirne	biomass	06.09.2010	2,0	14.000.000	2,0	*	uncertain
862	Sone Enerji Yatırım Üretim ve Tic. A.Ş.	Korudağı	Tekirdağ	wind	15.03.2012	3,0	10.500.000	3,0	*	uncertain
863	Sonses Enerji Yatırım Üretim ve Tic. A.Ş.	Zonguldak	Zonguldak	wind	06.01.2011	120,0	431.000.000	120,0	0,9	uncertain
864	Söke Rüzgar Enerjisinden Elektrik Üretim Santralı Ltd.Şti.	Söke RES	Aydın	wind	04.01.2012	45,0	110.000.000	45,0	0,7	uncertain
865	Steag Rüzgar Süloğlu Enerji Üretim ve Ticaret A.Ş.	Süloğlu	Edirne	wind	16.03.2011	60,0	226.000.000	60,0	0,9	uncertain
866	Suay En. San. Ve Tic. A.Ş.	Akbük	Aydın	wind	05.07.2011	10,0	35.916.000	10,0	0,0	uncertain
867	Süper Elektrik Üretim A.Ş.	Çataltepe	İstanbul	wind	04.01.2012	10,0	37.856.436	10,0	*	uncertain
868	Şehzade Enerji Üretim Ticaret Sanayi Limited Şirketi	Amasya	Amasya	wind	26.01.2011	42,0	148.085.920	42,0	5,8	uncertain
869	Tamyeli Enerji Yatırım Üretim ve Ticaret Anonim Şirketi	İncesu	Afyon	wind	24.03.2011	10,0	36.000.000	10,0	7,3	uncertain
870	Tan Elektrik Üretim A.Ş.	Gaziemir	İzmir	wind	10.01.2012	20,0	57.816.000	20,0	0,4	uncertain
871	Tatlıpınar Enerji Üğretim A.Ş.	Tatlıpınar RES	Balıkesir	wind	21.06.2012	125,0	266.304.000	125,0	0,5	uncertain
872	Tayf Enerji Yat. Üretim Tic. A.Ş.	Ödemiş	İzmir	wind	28.04.2011	20,0	74.000.000	20,0	0,9	uncertain
873	Tektuğ Elektrik Üretim Anonim Şirketi	Sincik	Adıyaman	wind	02.12.2010	25,0	82.287.460	25,0	14,1	uncertain
874	Tepe Enerji Santralı Elektrik Üretim Sanayi ve Ticaret Limited Şirketi	Karatepe	Tekirdağ	wind	21.07.2011	13,0	53.000.000	13,0	0,6	uncertain
875	Teperes Elektrik Üretim A.Ş.	Tepe RES	İstanbul	wind	24.09.2008	6,9	21.000.000	6,0	23,1 (January 2012)	2014
876	Turna Elektrik Üretim A.Ş.	Yellibel	Karaman	wind	18.01.2012	50,0	195.844.152	50,0	*	uncertain
877	Türkay Alternatif Enerjiden Elektrik Üretim. San. Ve Tic. Ltd. Şti.	Gündoğdu	Bursa	wind	01.03.2012	9,6	27.000.000	9,6	2,0	uncertain
878	Türkerler Jeotermal Enerji Arama ve Üretim A.Ş.	Türkerler Alaşehir Jeotermal Enerji	Manisa	geothermal	01.02.2012	24,0	177.840.000	24,0	6,8	uncertain
879	Ufuk Enerji Elektrik Üretim A.Ş.	Poyrazgölü	Balıkesir	wind	18.08.2011	30,0	121.000.000	30,0	0,6	uncertain
880	Üçgen Seferihisar Rüzgar Enerjisi Elektrik Üretim A.Ş.	Seferihisar	İzmir	wind	30.04.2009	18,0	49.000.000	18,0	7,0	uncertain

Table 44. Other Renewable Plants (continued)

881	Ütopya Elektrik Üretim Sanayi ve Ticaret Anonim Şirketi	Düzova	İzmir	wind	03.05.2007	40,0	113.000.000	40,0	60,6	uncertain
882	Vento Elektrik Üretim A.Ş.	Bergama	İzmir	wind	09.02.2012	25,0	83.000.000	25,0	0,1	uncertain
883	Yares Elektrik Üretim A.Ş.	Yalova	Yalova	wind	26.10.2011	50,0	175.200.000	50,0	14,0	2014
884	Yaylaköy RES Elektrik Üretim A.Ş.	Yaylaköy	İzmir	wind	29.05.2008	15,0	57.518.555	15,0	*	uncertain
885	Yel Elektrik Üretim Ltd. Şti.	Alsancak	Hatay	wind	24.05.2012	1,0	3.500.000	1,0	0,0	uncertain
886	Yeni Adana İmar İnşaat Tic. A.Ş.	Doğu Atıksu	Adana	biogas	25.05.2007	0,9	5.926.140	0,9	*	uncertain
887	Yeni Belen Enerji Elektrik Üretim San. Ve Tic. A.Ş.	Şenbük	Hatay	wind	09.02.2012	27,0	94.500.000	27,0	0,3	uncertain
888	Yeni Enerji Yat. Üretim ve Tic. A.Ş.	Yenihisar	Aydın	wind	18.08.2011	20,0	75.000.000	20,0	0,8	uncertain
889	Yerköy Rüzgar Enerjisinden Elektrik Üretim Santralı Ltd.Şti.	Yerköy RES	Yozgat	wind	24.08.2011	45,0	126.000.000	45,0	1,4	uncertain
890	YGT Elektrik Üretim San. Ve Tic. Ltd. Şti	Adares	Aydın	wind	12.05.2011	10,0	40.000.000	10,0	0,3	uncertain
891	Yiğit Rüzgar Enerjisinden Elektrik Üretimi San. ve Tic. Ltd. Şti.	Kumres	Antalya	wind	28.04.2011	10,0	41.600.000	10,0	1,2	uncertain
892	Yuva Enerji Yat. Üretim ve Tic. A.Ş.	Yuvacık	Kocaeli	wind	22.12.2011	120,0	442.000.000	120,0	0,9	uncertain
893	Zeytineli RES Elektrik Üretim A.Ş.	Zeytineli RES	İzmir	wind	13.04.2010	49,5	165.000.000	49,5	10,1	uncertain
894	Ziyaret RES Elektrik Üretim San. Ve Tic. A.Ş.	Ziyaret	Hatay	wind	24.12.2009	57,5	140.000.000	57,5	14,4	uncertain
895	Zorlu Doğal Elektrik Üretimi A.Ş.	Sarayköy JES	Denizli	geothermal	21.08.2008	75,0	492.500.000	60,0	47,5	uncertain
896	Zorlu Jeotermal Enerji Elektrik Üretim A.Ş.	Alaşehir Jes	Manisa	geothermal	28.07.2011	30,0	189.216.000	30,0	3,4	uncertain
897	Zorlu Rüzgar Enerjisi Elektrik Üretimi A.Ş.	Sarıtepe RES	Osmaniye	wind	15.07.2010	50,0	236.000.000	50,0	4,6	uncertain
898	Zorlu Rüzgar Enerjisi Elektrik Üretimi A.Ş.	Demirciler RES	Osmaniye	wind	15.07.2010	60,0	221.000.000	60,0	5,0	uncertain
899	ZT Enerji Elek. Ür. San. Ve Tic. A.Ş.	Çerçikaya	Hatay	wind	01.03.2012	53,0	185.500.000	53,0	0,0	uncertain