ÇUKUROVA UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES

MSc THESIS

Kutlu YİĞİT

AN ENERGY OVERVIEW OF THE REPUBLIC OF TURKEY

DEPARTMENT OF MECHANICAL ENGINEERING

ADANA, 2006

ÇUKUROVA ÜNİVERSİTESİ

FEN BİLİMLERİ ENSTİTÜSÜ

TÜRKİYE'NİN ENERJİ POTANSİYELİ

Kutlu YİĞİT

YÜKSEK LİSANS TEZİ

MAKİNA MÜHENDİSLİĞİ ANABİLİM DALI

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ABSTRACT

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DEPARTMENT OF MECHANICAL ENGINEERING
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In this study we tried to analyze how global rapid changes about "supply of energy in desired time, quality, continuity, amount and cost". Within this frame, historical development of important energy sources in the world, actual and possible future positions and global reserves are analyzed. Then, the energy source potential of Turkey is analyzed within the same contents. Turkey is analyzed within the same contents. Economical comparison of fuels in Turkey from past to nowadays are performed and employability of some energy sources in Turkey are considered. Economic comparisons of these fuels, form past to this time, were calculated. General energy production and consumption analyzed until year 2025. Speciality three energy sources like Petrol, Natural Gas and Electric were considered. Some amount predictions were found for these sources. Also, some alternative solutions were found for these sources like PV systems.

Keywords: Energy, Policy, Turkey, Source, Prediction

ÖZ

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Bu çalışmamızda, enerji politikalarının temel formülü haline gelen, "Enerjinin istenen zamanda, kalitede, süreklilikte, istendiği miktardan ve fiyattan temini" konusunda dünyada yaşanan hızlı değişimin, "Enerji Krizi" tartışmalarının yaşandığı ülkemizde ve özellikle elektrik enerjisi sektöründe, kendini nasıl gösterdiği analiz edilmeye çalışılmıştır. Bu çerçevede öncelikle dünyada önemli enerji kaynaklarının tarihsel gelişimi, bugünkü ve gelecekteki olası durumu incelenmiştir. Ardından aynı sıralama içinde Türkiye ele alınmıştır. Geçmişten bugüne Türkiye'de kullanılan yakıtların ekonomik anlamda bir mukayesesi yapılmıştır. 2025 yılına kadar genel enerji üretimi, tüketimi analiz edilmiştir. Özellikle üç enerji kaynağı (Petrol, Doğal Gaz ve Elektrik) üzerinde durulmuştur. Ayrıca bu enerji kaynaklarına alternatif kaynak uygulaması için hesaplamalar yapılarak yorumlar yapılmıştır ve PV sistemler gibi alternatif çözümler önerilmiştir.

Anahtar Kelimeler : Enerji, Politika, Türkiye, Kaynak, Tahmin

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NOMENCLATURE

BTEP	: Billion Tone Petrol
CDDP	: Coverage of Demand by Domestic Production
CFB	: Circulating Fluidised Bed
DEKTMK	: World Energy Committee Turkish Public Committee
DİE	: State Institute of Statistics
DPT	: State Planning Organization
DSİ	: State Water Works
EC	: Energy Community
EMO	: Chamber of Eletricity Engineers
ESM	: Energy Simulation Model
ETBK	:Ministry Energy and Naturel Resources
EU	: The European Union
GDP	: Gross Domestic Product
GNP	: Gross National Product
GOÜ	: Developing Countries
Gt	: Billion Tonnes
GTEP	: Giga Tone Petrol
GW	: Giga Watt
GWh	: Giga Watt Hour
IEA	: International Energy Agency
KEP	:Kilogram Petrol
KTOE	: Thousand Tonnes of Oil Equivalent
kWh	: Kilo Watt Hour
LNG	: Liquid Naturel Gas
MAED	: Model for Analysis of Energy Demand
MTEP	: Million Tone Petrol
MW	: Mega Watt
NRC	: Nuclear Regulatory Commission
OECD	: Organization for Economic Cooperation and Development
OPEC	: Organization of Petroleum Exporting Countries

PURPA : Public Utility Regulatory Policies

Tcf : Trillion Cubic Feets

TEK : Turkish Electricity Administration

TEP : Tone Petrol

Tm^3 : Trillion Meter Cubes

TTK : Turkish Hard Coal Institution

TWh : Tera Watt Hour

WED : World Energy Database

1. INTRODUCTION

Global technological developments have been increasing energy need of every country. Although energy consumption of industrialized and industrializing countries vary and energy sources are governed by some group of countries, as is today, in the 21st century energy will be one of the most strategic sectors in the world.

Almost every development reflects an energy period. While changing consumption practices, urbanization rates, increasing population and developing scientific improvements impede use of some energy types less than before, forms of production and consumption are changing and new energy types are coming on the scene. Natural, economic, political and environmental issues and the obligation of use of energy parallel to economic, socio-cultural development periods, make it necessary for every country to make planning of its energy policies more carefully according to stated criteria.

Oil, hydraulic, natural gas, coal and nuclear energy sources which are obtained from nature as a result of production are called “primary sources”. Electric, coal gas, petrol products and coke which are obtained by transformation of sources are called “secondary sources”. Sun, wind, geothermal and sea are called “renewable sources”. As energy production via primary sources are rapidly decreasing in the world, industrialized countries have attached up most importance to Research & Development studies for new energy sources especially to be replaced by oil. On the other hand, decrease in traditional energy sources such as oil and coal, shortage of energy, increasing prices in accordance with environmental problems and funds awarded for research of new energy sources make it really hard for countries who are addicted to energy import and foreign investments due to their limited capacities of currency.

In this respect, according to new dimensions of global industrialization, concentration and specialization among central and surrounding countries differ significantly. According to some opinions, central countries, by means of globalization, move huge sized industries, which create a heavy burden by means of

environment and society pressure, to surrounding countries. So they not only get rid of the burden on their back but also supply their economic needs by means of having an impact on production and after production phases of these countries with their domestic and international companies.

When this vision is applicable to energy sector, heavy industry with high energy needs spreads to surrounding countries which adopt the idea of rapid industrialization, intensive energy need for this heavy industries is supplied by huge power stations, also energy gained in markets which are under control of central countries will be able to be delivered to central countries via interconnected systems, by this means central countries will not only be able to tend to renewable energy sources without making huge investments but also they will get rid of environmental problems such as coal dust from thermic power stations or wastes of nuclear power stations.

Energy investments had continued also after electric lines all round the country had been established. Turkey, today, with 8% annual increase in energy demand has been the center of attraction for especially foreign investment. However, the rate of supply & demand by domestic sources due to economic problems decreased dramatically and structural, financial and legal problems of the sector have created “energy crisis” discussions.

Aim of this study is to investigate general structure of energy sector in Turkey in the light of historical developments in the country and abroad through economical environments as summarized above. By this means we also aim to determine the position of the sector in the coming 10 years’ time as well as analyzing the ways of determining types of energy to meet the energy need of the country in parallel to economic growth.

Within the frame of this aim ; in the first part developments in energy sources in the world and Turkey. In the second part, World’s and Turkey’s energy conditions will be considered. In the last part, some alternative energy sources applications will be compared. Finally, some economic results will be found and author’s advices will be declared.

2. IMPROVEMENTS IN ENERGY SECTOR IN THE WORLD AND APPLIED POLICIES

2.1 First Periods of Energy

Literal meaning of energy is “the ability to perform work”. Although modern history of energy goes back to 19th century, when we compare the use of first natural sources we can say that history of energy goes back to be as old as the history of humankind. Human kind had used first forms of energy by using his arm power and than these forms had been widespread through its surroundings, by using animals or simple tools. In this respect first uses of natural energy sources goes back to thousands of years from to-day.

With the first efforts of humankind by making the first sparks with the help of Flintstones, they found the fire and thus energy had become a usable and social aspect of society giving the opportunity to survive in cold and hard climates. First uses of water power transformation were seen firstly in antique eras in the descriptions of Strabon. According to Strabon in 1st century B.C. in Kabeira-Kingdom of Mithridades in North Anatolia a water mill had been constructed. Investigations show us that Çengi coal mines in China had been run hundreds of years B.C. Also Roman and Greek civilizations had used coal as an energy source. Use of water for energy had firstly been performed in middle ages(Gimpel 1996 :24).

Pre-industrialization societies had developed with the use of traditional energy types such as water, wood, wind, animal power whereas in the 15th century more than 80% of energy consumption of today’s developed countries had been met by wood, human and animal power. Exploring historical development of energy sector after the period of Industrial Revolution will help us better understand what’s going on in the energy sector of the world at present times. From the beginning of 20th century energy consumption of the world had increased rapidly and between 1876-1976 in the first 100 years era primary energy consumption had raised from 600 MTEP to 6800 MTEP presenting a 11 times increase (Yücel 1994: 72).

2.2 General Overview to World Energy Potential

Exploring consumption and production visions of energy sources one by one will help us have an opinion about future energy policies. Practically, due to rapid industrialization, consumption of energy sources increase continuously and conditions where variation of sources do not occur create the problems of exhausting actual reserves. In this respect, history of world primary energy sources' consumption and production and possible future developments have an important role on determination of energy policies.90% of global consumption of energy is met by oil, natural gas and coal, and hydraulic and nuclear energy follows. In recent years renewable sources such as sun, wind and geothermal sources have gained a commercial identity and they are regarded as energy sources of 2000s. Development and future of these five energy types depend on basis of energy policies.

While in 1890 population of the world was 1.6 billion and primary energy consumption is around 1000 MTEP, in 1997 population had reached to 6.5 billion and primary energy consumption had reached to 8639,6 MTEP. Thus in one century primary energy consumption had reached up to more than 8 times.

According to statistics of Enerdata – World Energy Database, in 1996 primary energy consumption of world average is 1.45 tep/person, EC (Energy Community) average is 3.69 tep/person and OECD (Organisation for Economic Co-Operation and Development) average is 4.56 tep/person. Annual primary energy consumption in the USA is 7.74 tep/person, in Germany 4.20 tep/person, in France 4.10 tep/person, in England 3.88 tep/person, in Japan 4.02 tep/person and in Turkey below world average is 0.97 tep/person. According to World Energy Council Committee energy consumption of Turkey reaches to 1.10 tep/person in 1997.

In 1997 primary commercial energy production had increased 3.8% compared to previous year and had increased %13.5 compared to 1990 reaching up to 8639.6 Mtep. 39% of this production belongs to OECD countries of which Turkey is a member. Turkey only provided 0.24% of this amount. Share of EC in production is 11%. Depending on 1997 data, 89.9% of world primary energy sources is obtained from fossil fuels. In primary energy sources production share of coal is 26.7 % with

2320.7 Mtep, share of oil is 40.2% with 3474.6 Mtep, share of natural gas is 23.2% with 2000.9 Mtep, share of hydraulic energy is 2.6% with 225.9 Mtep, and share of nuclear energy is 7.2% with 671.4 Mtep. Compared to 1990 production of coal has increased 6.1%, production of oil 10.6%, production of natural gas 13.1%, hydraulic energy 25.2% and nuclear energy 22.9%.

In 1997 world oil production increased 3.1% compared to previous year. In almost all regions increases in production are recorded. 30% of the production has been realized in Middle East and USA followed this with 11% share, after comes the Russian Federation with 9% share. Although in 1997 natural gas production decreased by 0.2% it can be deemed to have been unchanged. 33% of production of natural gas had been realized in the USA and 28% in the Russian Federation. With 30% share in coal production comes China and followed by the USA with 25% share, India with 7% share and South Africa Republic with 5% share. In 1996 primary energy production of OECD countries had increased by 10.9% and consumption by 10.3%. In the same period for EC these percentages are relatively 8.1% and 6.5%.

In 1997 world primary commercial energy consumption used to meet 89.5% of primary energy production and total consumption was 8509.5 Mtep. Shares of primary sources in this consumption are stated in figure 2.1. Fossil fuels which have the biggest share in commercial primary energy budget are shown in figure 2.2 as per regions and production/consumption rates. Although natural gas consumption increased in 1996 as 4.7%, more than average trends to previous years, in 1997 compared to 1996, consumption trends of fossil fuels have not significantly changed. Use of hydraulic energy increased 2.6% compared to previous year while use of nuclear energy had dramatically decreased 0.6%.

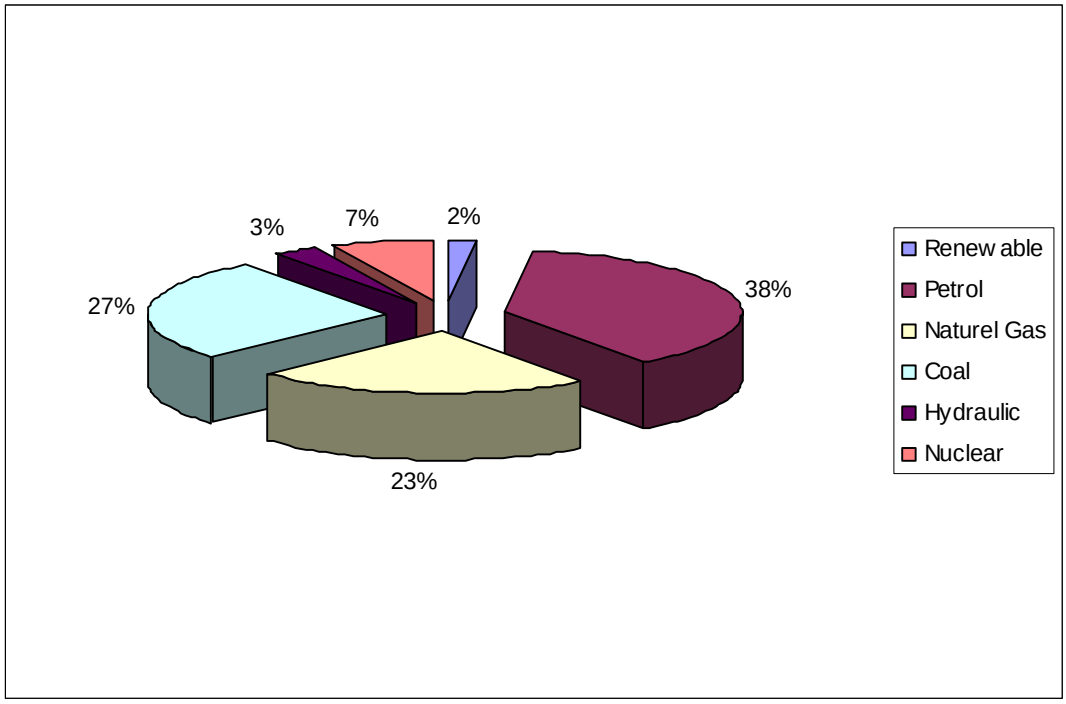

Figure 2.1 Shares of sources in world primary commercial energy consumption

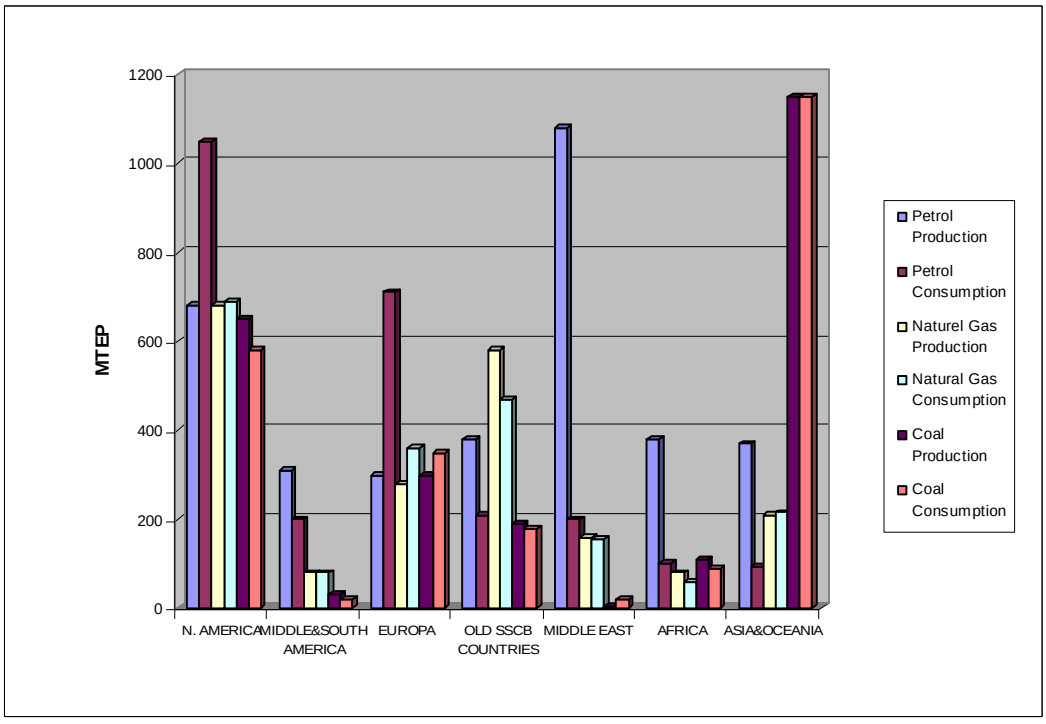

Figure 2.2 Distributions of fossil fuels production and consumption per regions

2. IMPROVEMENTS IN ENERGY SECTOR IN THE WORLD AND APPLIED POLICIES Kutlu YİĞİT

In the world, 85% of consumed energy is "Commercial Energy" which is produced only for direct sales and coal, oil, natural gas trio meets ¾ of total world needs. Remaining ¼ is met by nuclear, hydraulic, biomass (wood, plants and animal wastes), new and renewable sources. As energy budgets mainly rely on fossil fuels, relations between fossil fuels seller countries and fossil fuels buyer countries have been important strategic aspects of world strategic balances.

As fossil fuels are main sources to meet the energy demand in the world and for the reason that fossil fuels are used for burning reactions and emission of CO_2 other harmful gases create environmental problems. Today the most challenging problem our earth faces is the global warming and is caused by increasing CO_2 emissions which enforces greenhouse effect of the atmosphere.

Although many initiatives had been performed to limit CO_2 emissions globally, yet no definite solutions are found for this complex problem. As a result of globalization in the world economy a rapid growth in global energy trading, energy researches, production, international investments and technology transfers to reach the goals are clearly seen. In the world sensitivity has come up for increase in energy productivity and environmental aspects. World energy markets had led to market dynamics from governmental interventions and had been shaped according to this. These positive improvements have to be increasing and continuous. In the meantime Asian countries, non members of OECD, have rapid growing economies and effect of other developing countries' on global energy demand had caused changes in distribution of consumption.

Lately in developed and developing countries terms about "privatization" and re-establishment" as well as saving, environment, supply safety and sustainable energy have made their place and came up in the energy sector. Policies are being reformulated in order to support private investors' share in investments and in order to help them compete in the international arena.

In the current period, by means of meeting energy demand in the world, there is no insufficient sources problem and supply sources are at sufficient levels. World fossil reserves (coal, oil, natural gas) are up to a proven amount of 720.000 Mtep.

Proven amounts of oil reserves are 140.9 billion tons (Gt), natural gas reserves are 144.8 trillion m3 (Tm^3), coal 519.4 Gt and lignite is about 512.2 Gt.

2.3 Energy Sources

2.3.1 Primary Energy Sources

Oil, regarded as "the most valuable liquid after water", is accepted to be the basic energy source of the world.

During macro economical problems when 1973-74, 1979-80 economic crisis periods happened inflation was accelerated and global trade limits were damaged. During these times increase in oil prices reflects the economic power of this natural source. As well fight between countries, wars and military interventions have all happened due to the desire to have a voice in the management of oil reserves. And all these signs show the importance oil in world economy.

History of oil goes back to 3000 B.C. during these periods Chinese used to run oil wells with the help of bamboos, as well it is reported that Assyrian and Sumerians had benefited oil leaks off the ground. First oil well in the world was run by Colonel Drake, an American, in 1859. Oil at the beginning was used for illumination. The fact that boosted oil demand was the invention of internal combustion engine in the 20th century which was replaced by steam engine (Pala 1996).

"T type automobiles" developed by Henry Ford was generalized to world countries by the USA and is regarded as "the motherland of oil industry". 68.000 tons of oil out of 70.000 tons world production was produced by the USA in 1860. 10 years after world oil production increased up to 790.000 tons and USA shared 720.000 tons of this amounts. Companies of Rockefeller Trust, Exxon, Mobil Oil, Gulf Oil, Texaco and Social and Royal Dutch Shell and British Petroleum also known as "7 sisters" who own almost the whole American market had conquered privileges for global oil reserves for more a century periods and thus had gained great competitive advantage for oil prospecting, refination, sales and marketing

against "independent companies". 2nd World War had caused great changes in oil markets from demand to pricing, and after Venezuela, Mexican oils Middle East oils in 1950s have come into scene. So by 1970s more than half of world total energy consumption had been met by oil (Pala 1996:23).

Oil production in 1995 was 70.3 million tons drum/day and 40% of this amount was met by OECD member countries. OECD member countries meet 30% of world oil production, Middle and East European countries and former USSR countries produce 11%, non OPEC member countries meet 17% of world oil production (OECD/IEA1996:56). Today's oil reserves are dominated by Middle East countries. Figure 2.3 shows that 70% of the reserves are dominated by Middle East, 9% by mid-north and South America. Europe is the poorest continent of oil reserves.

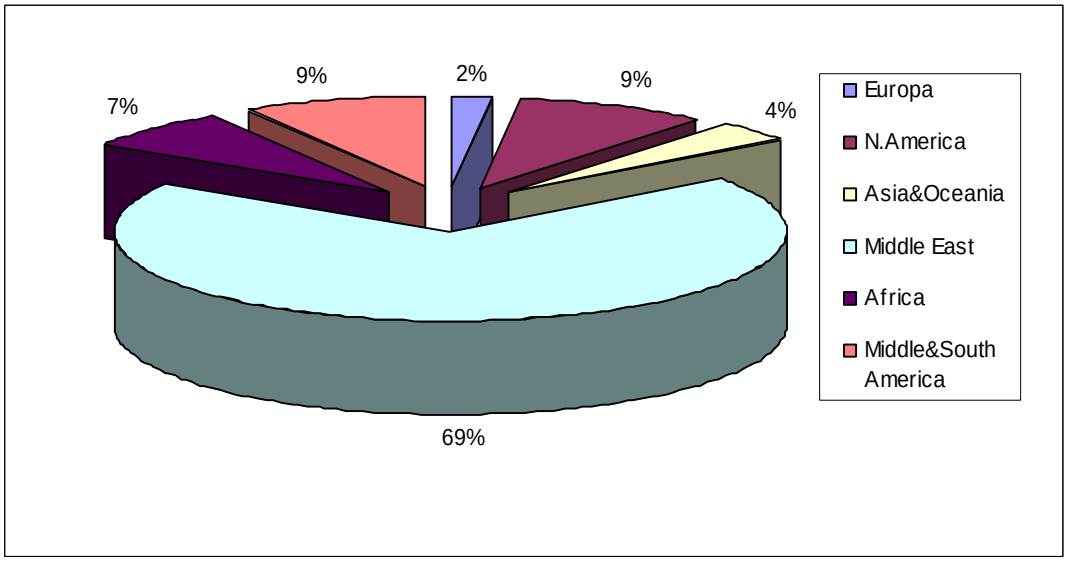

Figure 2.3 Distributions of world oil reserves

According to OECD projections, the daily oil production in OECD member European countries, which was 6.3 million drums in 1995, is estimated 7.5 million drum by 2000. As a result, the dependence of oil import of Europe, which was 55% in 1995, is estimated to decline 47% by 2000. This ratio is predicted to be declined lower via development of nuclear power plants and alternative energy sources by 2010 (Source: DEKTMK 2002: 46).

Within all aspects above, the recent developments in world oil production show that production shifts to non OPEC countries. Analyzing the production quantity of non OPEC countries through last 5 years, an increase of 4 million barrel in production in daily basis of non OPEC countries and production quantity of 33 million barrel in daily basis in 1995 is observed. The technological improvements and decreasing production costs of such countries are the main factors of the case mentioned above (DTM 1997:3).

According to studies of IEA, International Energy Association connected to OECD, although there is a rapid growth of oil production of non OECD countries in middle run, OPEC countries will take the first place to meet world oil demands. Having large oil reserves and lower production costs, Saudi Arabia, Kuwait, Iran, Iraq, UAE and Venezuela are expected to hold their advantageous position versus OPEC member countries. Particularly, in recent years supply of oil higher than quotes to market by non OPEC countries such as Mexico and Venezuela, and countries such as Saudi Arabia and Kuwait, has significantly lower the unit price of oil. The price of oil per barrel, of which average price is $20 for last 5 years, declined to $9 in 1998, lower than in 1974. The tendency of such decline in oil prices is predicted to continue until 2010. According to researches, oil will hold the first place as the most important primary energy consumption in 2010, concerning whether the general development process based on oil and derivatives in last decade or important changes in consumption habits are not to be expected.

In all cases, the increase in future demand of oil will be greater than last two decades because of scarcity of alternatives to be substituted in other sectors, especially in transportation, and rapid economic growth in developing countries. The aggregate demand of oil is estimated to be 92-97 million barrels per day by 2010 (OECD/IEA 2001:152).

In respect with such developments, the main problem of oil and oil products with its increasing demand is the exhaustion of stock reserves. In Table 1.1, it can be concluded that the stock oil reserves will be exhausted within 42 years, even the consumption quantity of year 2003 is taken into account. The stock reserves are predicted to be exhausted in Europe, North America, CIS, Middle East countries,

within 7, 18, 22 and 92 years, respectively. Thus, activities of prospect for oil take great importance.

In recent years, Caspian Basin, which is presented to be a competitor, moreover as an alternative, is another oil field and remarkable activities are executed for this field regarding supply to world market. Intensive diplomatic, economic and political activities are executed among region countries such as Azerbaijan, Kazakhstan, Turkmenistan, Russia, Iran, Turkey and Georgia, regarding share and transportation of oil and natural gas, which is considered as most important source by former USSR countries in their economic developing process and is also prior in investment program of the world most important oil companies, is estimated to be around 20-30 billion tones, according to energy strategists and prospect for oil companies. Besides,. The total value of stock reserves in Caspian Basin which represents %16 of actual reserves is estimated 50-200 billon barrels in quantity and $4 trillion.

2.3.2 Coal

Coal, of which first use was thousands of years ago, has started to be used widespread as an energy source since 1300's, as it is considered in the terms of industrialization. The increasing attraction of this mine day by day resulted in inventions that are important within civilization aspect.

As a result of use of coal based technology in metallurgical industry of steel, the dependence of this type of energy has increased with development of machines operated by steam power, invention of steam locomotives and ships. It was spread out whole world from Britain by scientific and technological developments and increase in quantity of consumption of energy based on coal, and aggregate coal production of world that is 20 million tones in 1800's has increased to 700 million tones in 1900 (Yücel 1994:62). The share of coal in energy sector balance sheet, is declined in periods such as 2nd World War and First Oil Shocks, as 46.3% in 1960 is decreased to 29% in 1974. From 1970's, coal was started to be used in thermal power plants, particularly in USA, and its share in energy sector balance sheet has

reached to 30%, which would not show much change in future (OECD/IEA 2003: 18).

In 1995, 3 billion 622 million tones of hard coal and 1 billion 213 million tones of lignite, 4 billion 835 million tones in total was produced worldwide. In lignite production, which is preferred because of high efficiency in industrial production, USA, Germany and former USSR countries are main producers with their shares 29.4%, 15.9% and 8.3%, respectively (DEKTMK 2002: 7).

The inequalities in distribution of intercontinental coal reserves, also reflects to regional production quantities. The main part of hard coal produced worldwide is met by Asia, 3 billion 622 million tones in quantity. Almost half of the aggregate coal is produced in China with 1 billion 200 thousand tones in quantity, and followed by USA, CIS countries, India, South Africa and Australia. The coal produced is consumed in Asia at most, and this continent is followed by North America and Europe. Although, great increases in use of energy sources such as natural gas is expected by 2020, coal which takes the first place among world's fossil energy sources, regarding whether in respect of amount or consumption lifetime, is anticipated to hold its second place following oil in energy production and consumption (Source: DEKTMK, 2003:33).

Table 2.1 Available lifetime of stock reserves of fossil fuels on the world

Region	Oil	Natural gas	Coal
North America (years)	18.8	12.0	246
Middle and South America	39.3	73.9	268
Europe	6.9	21.5	183
Former USSR Countries	22.0	80.4	>500
Middle East	92.3	>100	289
Africa	29.2	>100	289
Asia and Ocean Asia	17.0	45.8	158

As it is seen in table above, however, it is estimated that the stock reserves of oil and natural gas that are competitors of coal will be exhausted within 20-100 years due to their region, coal reserves are anticipated to be used throughout 200-500 years of period. Energy economists evaluate average lifetime of 43 years for oil and 64 years for natural gas worldwide, but twice of those sources for coal and anticipate that the coal reserves would be exhausted within 228 years, if its consumption rates in 1995 is considered.

Another remarkable case is that from now on, this energy source is demanded intensively by undeveloped or developing countries, rather than by developed countries. Production and consumption of coal is decreased significantly in European countries such as Germany, England and France because of production fields getting deeper, increasing operation and labor costs and cause environmental pollution. But these countries will provide an important market for the exporters with their necessity of coal, 200 million tones in quantity until 2000. In long term, the developed countries that uses energy more efficiently and creating environment friendly sources by integration of technological developments with their industries, are predicted to decrease their consumptions. (TMMOB 2004:149). But, there is a continuous increase in coal demand of undeveloped countries. However, above mentioned richness of stock reserves and length of usage period in comparison with other energy sources affect such an increase, coal is still an important input in industry sectors provide high income, such as iron-steel.

The consumption of OECD, of which member countries are involved in highly solid fuel consumption region, is estimated to be only more than 1/3 of world solid fuel consumption by 2010, while it was twice of that in 1993. The developing countries will hold more than half of the world total consumption (OECD/IEA 1996:3).

Another reason that causes the increase in production of coal in undeveloped and developing countries is its important share in producing electricity power, as particularly changes in steel production technologies in developed countries results in decline in coal production. The share of coal consumption in electricity power production is 40% in European countries, 57% in North American countries, while

this share is about 70% in developing countries. If these countries are considered to make important investments to meet increasing electricity power demand in further years, it can be suggested that coal consumption of these countries will probably increase for production of electricity power. Consequently, the world coal consumption is estimated to reach 5.3 billion tones by 2010, with the increasing rate of production by 2.4% per year, calculated in 1973-1992 period. It is obvious that new investments which provide stock reserves of coal to be operated more efficiently should be made to meet 70% expected increase in aggregate demand worldwide in 2010 (DEKTMK 1997 e:387).

2.3.3 Natural Gas

Natural gas had been known much earlier than Colonel Drake had found oil and benefited by. However, in spite of being gained with oil production naturally-Natural gas had been in secondary consideration for a long time. In the beginning it delayed the operations over resolving the issues regarding coal and oil's being cheap, gas stocking and its transporting. Large amount of natural gas taken out from oil wells had been burned onsite (Petrogas 2002: 24).

The first attempt aiming to use natural gas on a large scale failed over against competing advantage of coal gas. This target had been realized in the year of 1872 by designing and constructing a convenient pipeline for short distances. While approaching to the year of 1880, since the Iron and Steel Industry had shown concern for this low priced heat source and some rich reserves had been found in the west, southeast and central of USA, natural gas stood at the forefront and there arose several pipeline networks covering larger and larger regions than the districts of the wells in the very first years of 20^{th} century. However, since %93 of world natural gas production was performed only by USA in the beginning of II. World War, the natural gas secured its character dominated by USA regionally.

Table 2.2 Natural gas – growth in reserves, tcm (IEA, 2003)

Years	1982	1992	2001	2002
North America	10,67	9,45	7,55	7,15
South & Central America	3,14	5,34	7,16	7,08
Europe & Eurasia	39,96	61,02	61	61,04
Middle East	21,78	43,05	55,91	56,06
Africa	5,36	9,82	11,74	11,84
Asia Pacific	4,99	9,66	12,27	12,64
Total World	85,9	138,34	155,63	155,81

World natural gas reserves have risen from 85,9 tcm at the end of 1982 to 155,63 tcm at the of 2001 and 155,81 tcm at the end of 2002. At the end 2002, Europe, Eurasia and the Middle East account for more than 75% of the world's natural gas reserves. Russia Iran and Qatar together accounted for 54.5% of the total reserves (Table 2.2).

World consumption of natural gas grewby 2.8% in 2002 an account of a 3.9% increase in US consumption and robust growth in Non-OECD Asia Pacific of of more than 7%. According to IEA estimates, the share of natural gas in total primary energy consumption is projected to rise up to 3,2% during the first decade of the 21st century. In absolute terms, natural gas consumption is expected to almost double from 2.4 tcm in 1999 to tcm in 2020 (Kiliç A.M., Turkey's natural gas necessity, consumption and future perspectives).

2.3.4 Nuclear Energy

In the most general and simple sense, the nuclear energy covers the entire energy set free resulting from disintegration of nucleus (nuclear fusion) of atoms - which are the smallest parts of substance- and merging (nuclear fission). This energy source which the world got acquainted with in August 6-9th 1945 when atomic bomb was released in Hiroshima and Nagasaki, has been mentioned with electric energy

production as much as being mentioned with nuclear armament as a result of the studies which have been executed since the beginning of the year 1900 (TMMOB 2002).

Due to the effect of that cold war years when there is oil crisis in the years of 1960 and 1970 speeded up the nuclear armament, scientific technologic studies about nuclear energy has been attached importance to and some studies have been executed in Turkey as well. In these years when investigated how USA and West European countries are in front in using nuclear energy as alternative energy source, significant results can be obtained for Turkey where there are concrete steps taken newly in order to use nuclear energy.

Table 2.3 Share of nuclear energy in production of electricity power in OECD Countries **(NET TWH)**

	1995			2010	
Countries	**Operating Power Plants**	**Nuclear Production**	**%**	**Nuclear Production**	**%**
Belgium	7	40.8	52	43.6	55.7
Canada	21	109.1	20.3	103.7	17.9
Finland	4	18.5	28.5	18.5	24.2
France	56	365	78.5	410	80.4
Germany	20	150	27.3	155	26.3
Japan	51	260	31.1	292.2	31.7
Korea	11	64.3	35.1	96.5	38
Mexico	2	8	5.8	9.4	6.2
Holland	2	3.5	4.9	3.5	4.5
Sweden	12	66.9	46.4	70	46.7
Switzerland	5	22	36.7	22	36.1
England	35	90.7	29	91.9	27.3
USA	109	624	18.6	637	18.7

2. IMPROVEMENTS IN ENERGY SECTOR IN THE WORLD AND APPLIED POLICIES Kutlu YİĞİT

Before passing on to historical development of nuclear energy, if we have a look at the lots of nuclear power plant in world energy production, %5 of world primary energy production and %24 of electricity production has been met with nuclear energy. 875 Twh electrical energy has been produced in 437 power plants which are run in the world and this production means %24.1 of general electricity production. The production shall show an increase by 125 Twh in the year of 2000 according to the calculations of International Atomic Energy Agency.

The maximum nuclear energy which is 624 Twh on earth is produced in USA where there are 109 nuclear power plant built. The country which meets the most significant part of need of electrical energy with nuclear energy is France in the world. Despite using insufficient hydraulic sources at the highest levels up to %80, France has been facing energy shortage and has met % 78.5 of annual electricity need from nuclear energy by means of 56 power plant they built. This country will be obtaining %80.4 of electrical energy in the year of 2000. With respect to the installed capacity and production rates, France is followed by Sweden (%46.4), Switzerland (%36.7), Korea (%35.1), and Japan (% 31.1) respectively. The countries such as Germany and England with their %30 lots have reached high nuclear energy installed capacity.

Nuclear power plants was started to be built in small scales and away from city centers in 1950's. Nuclear power plant technology of which USA is initiator met a restricted part of electricity need of this country (%1) with its 800 MW installed capacity in the year of 1962. In the years ahead in accordance with forming nuclear energy market, the installed capacity was increased by putting more high-tech and higher scaled power plants into service in order to increase the commercial success, the new nuclear power plant with 30 000 MW was ordered worldwide in the year of 1968, 157 power plants in 19 countries in the world went into operation in 1975. With the great confidence in overcoming the energy crisis with nuclear energy, it has been considered that nuclear installed capacity will be increasing exponentially in the future-oriented projections and it has been anticipated that all the world countries including USA at first will meet half of their need of energy with nuclear energy.

2. IMPROVEMENTS IN ENERGY SECTOR IN THE WORLD AND APPLIED POLICIES Kutlu YİĞİT

Vertiginous developments in nuclear technology in 1970's have caused power plant's capacities to increase at a very high rate and some problems with standard designs towards the end of this year. After Three Mile Island power plant accident in Pennsylvania, USA in 1979. There observed a letup in nuclear energy subject in the beginning of the year of 1980's. While the power plant became unusable again in this accident which is core meltdown as being called the biggest accident which ever can be seen in a nuclear power plant, there came out a great tense about the security of the nuclear power plants despite the low radiation rates which is permissible for the environment and station workers. There became significant increase in investment and operating costs at these times when 30 years-old nuclear power plants which were designed and gone into commercial operation at the very first times of nuclear power plants had been reviewed.

The most affected countries from letup are Russia, France, Japan and Germany in addition to USA who retains %74 of world nuclear energy. This country backed out of 152 reactors whose majority is after TMI accident in 13 years. (Yücel 1994:725) Security cautions increased against radioactive permeation and its danger formed the biggest reason of increase in operating and maintenance costs in nuclear power plants in the length of time. The increase in first investment costs by %80, fuel costs with an increase by %40 and annual operating and maintenance costs with an increase by %180 caused a back-up from reactor construction in USA nuclear energy programs (Yarman 1995: 49).

Furthermore, since Nuclear Regulatory Commission (NRC) made taking out a license difficult and delayed, the duration of construction increased and this reflected to the costs. The reasons of letup in building nuclear power plants in 80's are not restricted with only Three Mile Island power plant accident and increases in operating and maintenance costs. Furthermore, since the world lived two big oil crises, we can consider that the decrease in nuclear power plants is caused by energy saving, tending from intensive energy consuming industries towards the industries using less energy and paying attention to renewable energy sources.

If we have a look at the development of nuclear energy, we can see that it increased with a very high speed but as of this date decrease course has been seen.

While adding 33 GW to available nuclear electric installed capacity every year in period of 1970 – 1975, this rate decreased to 12 GW in period of 1976 – 980, then 5 GW and 3GW respectively at the end. The installed capacity in 1990 is 3 times lower than what is expected before 15 years ago. The contribution of nuclear energy to world energy balance-sheet stood fairly behind than the specialists anticipated in 1970's. It has been anticipated that this contribution will be at the rates of 5.8-6.2% instead of the rate expected 20% in the year of 2006.

Cohen (1996) has mentioned that delaying nuclear power plant programs and tending to traditional fuel sources was a great error which could cost billions of dollars and thousands of human lives. Stating that a fake nuclear energy fear created in the public forced the governments into political apprehensions and to take unnecessary precautions and as a result of this the power plants whose costs were just 170 million dollars in 1970's became 1.7 billion dollars in the year of 1983-Cohen have sustained that it would be understood that the only energy source will be plutonium which is reprocessed and at low cost after scientific views dominated (Cohen 1996). Cohen's anticipation of that new power plant would not be built realized and there could be observed a great letup in building new plants in USA. However, Cohen's assumption which sustains that there would be no large scale nuclear power plant accident worldwide with the current licenses has turned out to be wrong after the 3 years with Chernobyl disaster.

While entering in the year of 1990, another subject causing discussions about nuclear energy has been Chernobyl nuclear power plant accident. As a result of a nuclear test performed in 4th Unit of Chernobyl plant in Soviet Unions in 25 April 1986, there occurred a partial meltdown in the reactor and since there is no protection wall of the plant, radioactivity spread. Very different sayings have been put forth by anti-the nuclear energy supporters after the Chernobyl accident as it is in all matters relating nuclear energy. There have become complete opposite views from different sides about its economic cost, live losses, injuries, being affected from radioactivity. For example, "Ukrainian Environment Minister, Juri Scherbak said that there were approximately 6000 persons died in his country and the dead toll would reach 40 000 and besides hundreds of thousands people would be cancer."

Nuclear energy supporters have been trying to hide these numbers from public. At the present time, it is seen that the children born around Chernobyl have bone cancer and leukemia symptoms, and also defective births have been seen (Komanoff 2000).

The groups who are in opposition with nuclear power plants suggests energy problem to be solved via prioritize to alternative energy sources. For this reason, the question "Are alternative energy sources suggested really sufficient in order to meet energy demand ?" should be answered.

The nuclear power plants constructed in recent years were defended as they are technically safe and have no negative effects on health of individuals who live in the same environment. It is stated in research of Environmental Institute Munich dated March 14th, 2001 that children live in neighborhoods that surround nuclear power plants located in Bayern Province have experienced cancer disease with %40 ratio more than other children.

2.3.5 Hydraulic Energy

The prototypes of hydraulic plants used in today's electrical energy production and executed over water turbines in 1800's came out and these turbines were used to operate the workbenches and used as grinder at the beginning. Due to the reason that the energy obtained from water sources could not be transported to long distances, becoming prevalent of hydraulic energy on earth delayed to the beginning of 1900's. Especially, putting large scale dams and hydroelectric power plants into service realized in the last 50 years.

The importance of hydroelectric energy increased because of its being renewable source, relative sag of environment effect, low costs of operating and maintenance compared with thermal and nuclear power plants and most importantly being a source which will supply the reliable energy demand with its national nature. Generally even if the first investment cost for hydraulic energy is high and its construction duration is long, Hydraulic energy has become one of the most preferable energy source with zero cost (Source: DEKTMK 2005 d: 23).

Table 2.4 Development of hydraulic energy

Years	Installed Capacity (Billions W)	Annual Production (Billions KWh)
1900	1	4
1910	5	16
1920	17	50
1930	34	115
1940	50	200
1950	72	331
1960	162	684
1970	307	1307
1980	403	1719
1990	634	2460
2000	680	2640
2005	800	2900

The technological developments in transmission lines and networks which provides the electricity produced in the dams that have to be built outside the residential areas to be transported to the city centers easier solidified the preference of hydraulic energy more and more. The half of the electricity produced in the year of 1925 worldwide was met from hydroelectric power plants. With the effects of developments in turbine generator manufacturing starting from the second half of 1900's, today high efficiency rates which are 95% in turbines and 98% in generators are obtained.

It is understood better when stated that 18.5% part of world electricity production is met from hydroelectric power plants today. The countries who reach the highest hydroelectric production on earth are Canada (330 TWh), USA (296 TWh), Brazil (250 TWh), China (167 TWh), Russian Federation (163 TWh), Norway (113 TWh), Japan (91 TWh), India (72 TWh), France (66 TWh). Norway,

Canada, USA and Japan together meet 99%, 62% and approximately 10% of the need of electricity production from hydroelectric energy respectively. -Putting 28% of gross potential and 57% of technical potential into service and having close hydroelectric potential with Turkey- Japan can use 80% part of current potential by putting even a small water sources into service. (DSİ 2000: 6) If we investigate the rate of conversion of hydroelectric potential into economically feasible potential over the world, big regional differences are observed. While this rate is at about 60-65% in developed regions such as Europe, North and Central America, It has been ascertained that this rate is 20% in Asia (Russia & Turkey) and 6.5% in Africa despite there are rich potentials because of fiscal and technological insufficiency. It has been planned that hydroelectric production in underdeveloped countries whose energy demand increases rapidly but whose hydroelectric usage rate is low would be reaching 4000 TWh by means of the dams and hydroelectric power plants constructed in these countries in 2000's. The 5.5% part of world primary electric production and 14% part of electricity production will be supplied from hydroelectric by the year 2000's.

Periodically, the lot of hydroelectric in world primary energy and electricity production tends to decrease. This situation is definitely caused because the increase of primary and electric energy production is more rapid than hydroelectric energy production. However, what should be denoted here is the existence of "economically feasible hydroelectric potential" which waits to be used. This potential expressing that technically-feasible potential can be developed in current and expected regional economic conditions, it would not cause an environmental damage, it could be used more economically in terms of price with alternative energy sources has been determined as 9000 TWh. This rate is more than twice as much of expected world electric potential in 2006. This situation means that the workings related with new generators, turbines, dam construction technologies and also new construction techniques such as storage plants with pumps, balloon plants which is still used and increase the reliability of energy systems can long as well as the investments related with hydroelectric energy increase. In addition to that especially in the last years large scale dams are put into service with low costs ; paying attention to the

constructions of small and middle scale dams whose capacities are between 5-50 MW and which makes impossible to benefit from water potentials in small rivers and reservoirs whose water flow is low confirms this opinion. In preferring small scale dams, it is a need to state that ecological criticisms have a significant effect due to the fact that large lakes cause environmental heating and the efficient lands stay under water.

2.4 Renewable Energy Sources

Solar and wind energy, the types of energy of which history starts at the same time with human being, have been using since the ancient times. In recent years, geothermal, photovoltaic, solar, and hydrogen energies are included in the category of energy sources, which is called “environment-friendly technologies in energy production and consumption”. The reason why such energy sources are called “new” is that they are involved into the economies later than fossil energy sources, regarding production possibilities, costs and extensive production.

When the expectation depends on exhausting of fossil fuels which exist in nature as non-renewable, and their increased consumption as a result of rapid worldwide industrialization was integrated with two petrol crisis experienced in 70’s, the need for producing heat and electrical energy via economic and alternative energy sources was increased, and finally the scientific-technological researches was accelerated. As a result of developments, particularly limiting the fields of production systems of wind and solar energy, high employment opportunities caused by related sectors and competitive costs resulted in conclusions as the 21st century would be the era of alternative energy sources.

In 1961, the sources discussed in “Conference of Energy’s New Sources”, arranged by United Nations at Rome, were just wind, solar and geothermal energies. Although, geothermal power plant technology, being similar to the thermic power plants, was classified in the group of ordinary and well-known technologies, its problems were attempted to be solved. At the stage of technology of energy after 1960, it was wondered that which of the alternative sources such as wind and solar

energies would lead in production of electricity power. The available technology of wind power plants was not considered adequate and wanted to be improved, while for solar energy a new technology was needed (DEKTMK 2002d:56).

The biomass energy, which is categorized in renewable energy sources, is produced by burning of plant and animal wastes that people use for heating and cooking for thousands of years. In 18th century, the gradually increased worldwide scarcity of wood has disappeared by 19th century, as other types of energies have gained activity. The method quitted in developed countries, is still in practice widely in developing countries. By the end of 20th century, from now on, the method considered important by industrialized countries is use of waste of forestry industry and city wastes for energy production via waste-burning power plants.

The effects, e.g. ozone depletion caused by intensive use of fossil fuels such as oil, coal and natural gas particularly in 20th century, acid rains, global warming, resulted in the world to be face to face with a possible irreversible environmental pollution. Above mentioned conditions, directed the researches towards the efforts to meet gradually increasing the energy need and find energy sources which do not cause pollution and are sustainable. Solar and wind energies take the first two places among such sources. Sun is the source of entire life on the world since the beginning. Today, solar and wind energies are the dominant sources which are concluded to be perfect substitutes of fossil fuels. Nowadays, fuels used such as oil and coal in order to produce energy will be exhausted before the end of the century we live through. The sources to be considered as substitutes of these fuels are renewable energies.

The fossil fuels (oil, natural gas, coal, lignite, and asphaltit), water power (hydraulics) and nuclear energy has been traditional sources of energy, which meets 95% of the world's energy need yet. In spite of such a high usage ratio, because of scarcity of such sources (fossil fuels), possessing negative effects on environment (fossil fuels, nuclear energy, hydraulics), resulted in obligation and desire for benefit from more safe, renewable, economic energy sources which do not have negative effects on environment and living organisms. The sources except above mentioned classical sources are called alternative energy sources. Principally, the ways to benefit from every kind of sources which has energy can be used for energy

production or spreads energy or radiates. These sources are wind, geothermal and thermal energy, solar, biomass (vegetable and animal wastes), waves and tide, sea water temperature, sea streams and fusion energies.

As the financial, ecological, technical and social outcomes of nuclear energy were presented, the question that "What should be its substitute?" has to be answered. At this point of view, the use of fossil fuels more rationally is not thought. However, even the lifetime of fossil fuels is not 15 years as nuclear energy supports suggest these sources are scarce and limited in quantity and one day they will be exhausted. But, this period is as long as that will provide us to achieve important innovations regarding the development process of renewable and healthy energy sources. In this context, note that the source of nuclear energy is also limited, and an energy type based on scarce natural sources, as thorium and uranium, the raw materials of the nuclear energy are limited.

2.4.1 Wind Energy

Among renewable energy resources, particularly the wing energy is the type which steps forward in production of electric energy. The superiorities of wind energy are not to be the cause of wastes, to be domestic energy resource, having no transportation costs and not to generate thermal emissions to the nearby rivers or seas, and the wind turbines starts to generate electricity approximately within 3 months after construction is commenced by a relative simple technology. The efficient use of this energy resource is related to wind potential of the country. As the specific gravity of atmosphere is small, the energy to be produced via wind is proportional with its speed. Wind speed increases proportionally with altitude, power, and cubic of its force (Elektrik Mühendisliği 1998:29).

Electricity via wind force is produced in Denmark in 1890 for the first time. In 1918, Denmark where potential of wind energy is high and 12 thousands of people were employed in the sector, has commenced a programme which electrificates 120 country area by 20-35 KW capacity turbines. Nowadays, in USA where these technologies are advanced alternative energy power plants such as wind and solar are

developed by Public Utility Regulatory Policies (PURPA) approved by passed in Congress of United States in 1978. The experimental studies accelerated in Russia, England and USA enabled wind power plants of 5 MW of capacities to be established by 1991.

In USA, American wind energy industry which is the biggest of world is created through environmental regulations and with the contribution of private sector investments. Approximately 15 thousands of wind turbines are established in California in the period of 1982 – 1992 and 3 billons kWh energy is produced by these turbines. Today, the world's biggest wind farm is Altamount Pass Wind Farm, where 3500 turbines of 100 kWh and 40 turbines 300 – 405 kWh operates, and is owned by KENETECH Windpower.

In worldwide, the installed capacity of wind power annually increases by 20%, as it is reached to 6097 kWh by 1996 from 2160 kWh in 1990. 57.5% of this installed capacity is located in Europe, 26.4% is in North America (98% in USA), and 14.7% in Asia. It is calculated in the projections that the installed capacity of only Europe would reach the world capacity of today by early 2000's. Germany is predicted to be in the first place by 2000 MW and foolowed by Denmark, England and Spain by 1000 MW capacities. The expectaitions of USA is electricity generated by wind power would be cheaper than by others in forthcoming 10-12 years of period. USA projects to generate 20% of electricity power via wind power plants by the end of forthcoming decade. EU assessed 2% portion to wind power in generating electricity power, as EU aims to generate 8% of primary energy and 20% of electricity power via renewable resources. The installed capacity of wind power will be 12.000 kWh by 2006 and the installed capacity projected by 2030 is 100.000 kWh, which equals to 10% of present electricity demand of European Union (Ültanır; İnan 1996).

World's primary energy consumption has been increased by 2.6% in 2002, ahead of the 10-year growth trend of 1.4% per annum. Despite their potential, the contribution of renewable energies to world energy supplies is still modest. Renewable energies are estimated to supply about 17% of world primary energy at

present. But, most of this is from hydropower. The other renewable energies such as solar, biomass, and wind contribute a much smaller proportion of energy needs.

Since wind energy is currently viewed as one of the most promising renewable energy resource, the growth is relatively high. Cumulative global wind energy generating capacity was reached 47,317 MW by addition of worldwide installed new equipment totaling 7976 MW at the end of 2004 (Ozerdem B.,Ozer S., Tosun M., Feasibility study of wind farms: A case study for İzmir, Turkey).

2.4.2 Solar Energy

Solar energy which becomes prevalent in many areas provides heat and electricity production. Although the idea of converting solar energy into electricity by photovoltaic cells is discussed in 1839 for the first time, primary results were obtained in USA by 1950's, and realized in USA via establishment of solar thermal plants in 1974. In this country where power plants with capacity of 10MW were activated, middle-capacity power plants in lower limits were also activated by "Solar Thermal Energy Systems". Today, annual production capacity of photovoltaic electricity is 50 MW and installed capacity is 400 MW.

Solar energy takes an important place in future projections of countries. The number of houses uses solar energy in Germany is 10.000 and the demand is tripled in last two years. Holland projected to power 500 thousands households until 2020. Greece will power 100.000 people by a 50 MW capacity plant which will be activated in 2003. Japan aims 400 MW installed capacity and 1 billion of houses. The aim of the project commenced by Bill Clinton in 1996 is installation of solar energy system in at 1 billion of houses (Elektrik Mühendisliği 1998:31).

The cost of photovoltaic system is decreased in last 2 decades, as it fell from $30 to 30 cent. Innovations in cell efficiency and manufacturing, and duplicated or more increase in demand decreases the prices (Brown; Flavin; Postel 2003:36).

2.4.3 Geothermal Energy

Geothermal energy is the process of hot water, steam and gas accumulated underground converting into energy on the surface of earth. The studies regarding generate electricity by this energy which is widely used in heating, commenced in early 1900's and today Italy who has rich reserves had reached installed capacity of 127 MW in 1944. In 1996, the electricity power generated via this resource of which costs are very low unless there are no reserves, is 84 million kWh and heat energy is 90 thousands TEP. In USA, who leads in regarding studies, present and projected installed geothermal power plant capacity is 3395 MW by 2006, and 2000 MW in Phillipines, 1000 MW in Indonesia and Mexico (DPT 2003).

2.5 Secondary Energy Sources

2.5.1 Electricity Energy

In the period of 1990 – 2005, the annual growth of electricity energy consumption was 9.9%. The lowest growth recorded was 4.4% in 1983, and the biggest was 18.4% in 1991. Since 1995, the annual growth observed per year is higher than 10%, and it was recorded as 12.4% in 2005. The progress trend of installed capacity through 1987 – 2005 to meet demand is demonstrated in by the following figure.

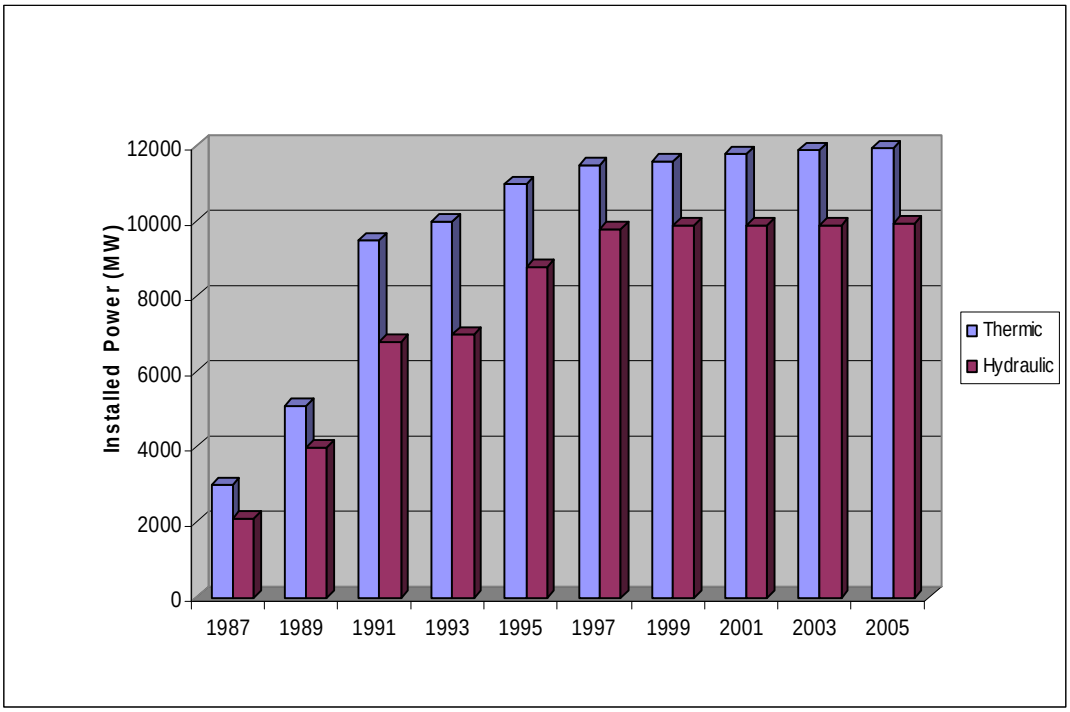

Figure 2.4 The progress of thermal and hydroelectrical installed capacity in 2005

Between 1990 and 2005, the growth of installed capacity is observed higher than 5% throughout 19 years, and higher than 10% throughout 10 years. However, the number of the years in which the growths lower than 5% recorded before 1990 is 4 years, and after 1990 is 5 years. This growth is realized by 2.6%, 0.5%, 1.4% and 3.0%, in 1994, 1995, 1996 and 2005, respectively.

The data regarding values of progress trends in installed capacity, production, consumption, and import – export are represented in the following table. In 2005, Turkey's electrical installed capacity was 21889.4 MW, electricity production was 104285.1 GW, and electricity import was 2492.3 GWh and total consumption was 106506.4 GWh. The primary resource shares in electrical installed capacity in 2005 are represented by the following graph:

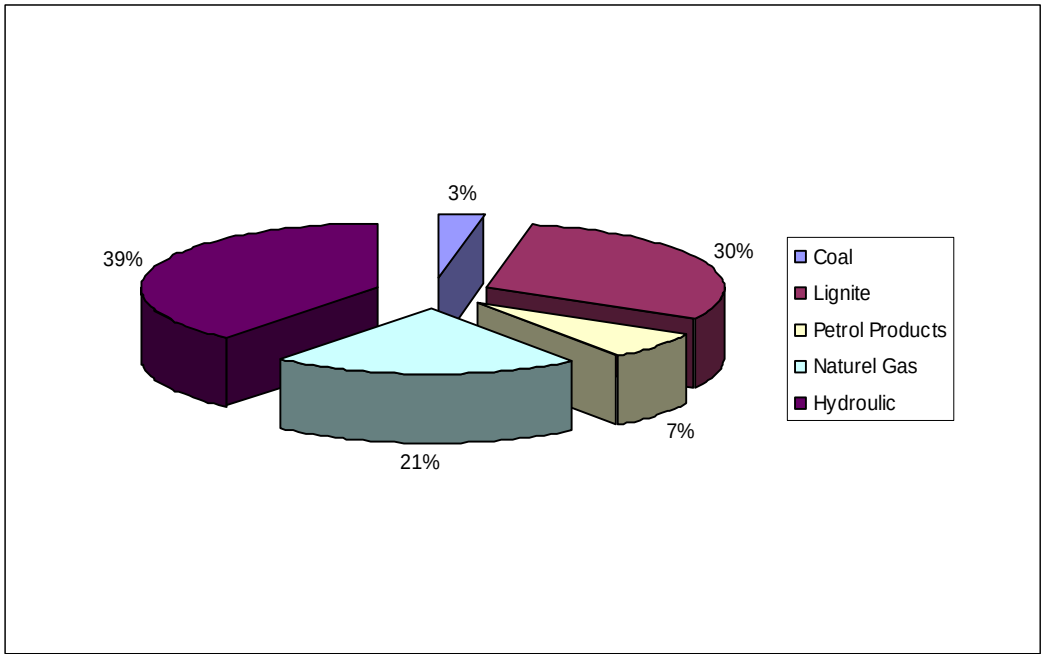

Figure 2.5 The resource shares in electricity production in 2005

2.6 Development of Energy Sources & Facilities in Turkey

The production of domestic primary energy resources was increased by 1.9 times, from 14493 Btep to 27687 Btep, between 1970 and 2005. In this period, the utmost contribution was provided by lignite, 6.8 times increase in production. The lignite production of 2005 was 11759 Btep, as it covers 42.5% of aggregate production. The other resources regarding production size with shares in production following lignite are firewood by 19.9%, oil by 13.1%, and hydraulic energy by 12.4%.

The decrease in oil production in 2005 compared to 1970, 97.6% of 1970, is considered as a trouble. The domestic production of oil was lower than of 1970 through 1971 – 1990, although significant decrease was seen between 1976 and 1984, the production size of 1970 was exceeded by 1990, but after 1995 the oil production was again realized lower than of 1970.

However, the energy production categorized in non-commercial energy group via animal and plant wastes increased through 1970 – 1982, it tended to decrease. By

2005, 29% decrease that of 1970, in production of energy via animal and plant wastes, should be evaluated as affirmative development. Between 1970 and 2005, natural gas by 1976, geothermal energy by 1984, and solar energy by 1986 were included in domestic production resources, and the production via these resources was 1.8% of aggregate primary energy production in 2005. The primary energy consumption was multiplied by 3.8 times through 1970 – 2005 and increased from 18849 Btep to 71367 Btep, and the annual growth in consumption was 2.8% in 2005. However, the maximum rate of growth in period of 1990 – 2005 is achieved in 1996, as 9.8%. A new trend started by 7.7% growth in 1995, after a decrease of 2.2% in 1994. Although the growth rate of recent years is relatively bigger than 1-2%, that of the developed countries, it is obvious that it is a must for Turkey, who consumes energy lower than world's average and aimes to develop by industrialization. But, the growth rate is observed to be curbed in 2005. The compensatory ratio of consumption, which was 76.9% in 1970, decreased to 38.8% in 2005 as a result of the differences of trend progress in energy production and consumption. This ratio is calculated to be trend such decrease in future projections of Ministry of Energy and Natural Resources. The 9.1% of oil consumption, 2.3% of natural gas, and 15.8% of hard coal was meet by domestic production, and 100% of lignite consumption is supplied domestically. In addition to having scarce resources, Turkey's domestic production is also restricted by investment and technology limitations. As the production and consumption was equal in 2005, hydraulic energy and biomass decreased by 1.7% and 1.4%, respectively, and geothermal energy increased by 10.5%, while solar energy and firewood production and consumption stayed constant. There was no production and consumption of wind energy in 2005. The energy generated from above listed renewable resources covers 38.7% of aggregate energy supply. If, particularly, biomass based on utilization of animal and plant wastes is excluded, the share of renewable energy in aggregate energy supply is about 33.2%. The share of hydraulic energy in domestic production is solely 12.4%, while classical biomass (firewood + animal and plant wastes) is 25.4%.

According to 2005 data, the share of renewable energy in aggregate energy consumption of Turkey was calculated as 15%. This share decreases to 12.9%, if

utilization of animal and plant wastes is excluded. The total share of hydraulic, geothermal and solar energy in consumption was 5.2%. As for energy generated by hydraulic resources, is 13 times that of generated by solar and geothermal resources. The trend progress of total primary energy consumption as per years and in resource basis is represented in the following figure.

Natural gas is the resource of which demand and/or consumption gradually decreases in Turkey. Although not listed in 1975, natural gas was included in the energy budget with symbolical production in 1976, and its consumption gradually increased by import started in 1986. In 2005, the share of natural gas among consumption of primary energy resources increased to 12.8%. In the same year, total consumption is 10.1 billion m^3, and its demand increased to 13.4 billion m^3 in 1998. However, the quantity of demand by 2000 is estimated to be 20.8 billion m^3, the question how such a demand will be met is remaining unanswered.

The shares of energy consumption realized in subsectors of industry as well as the contribution shares of energy resources in industry sector are represented below.

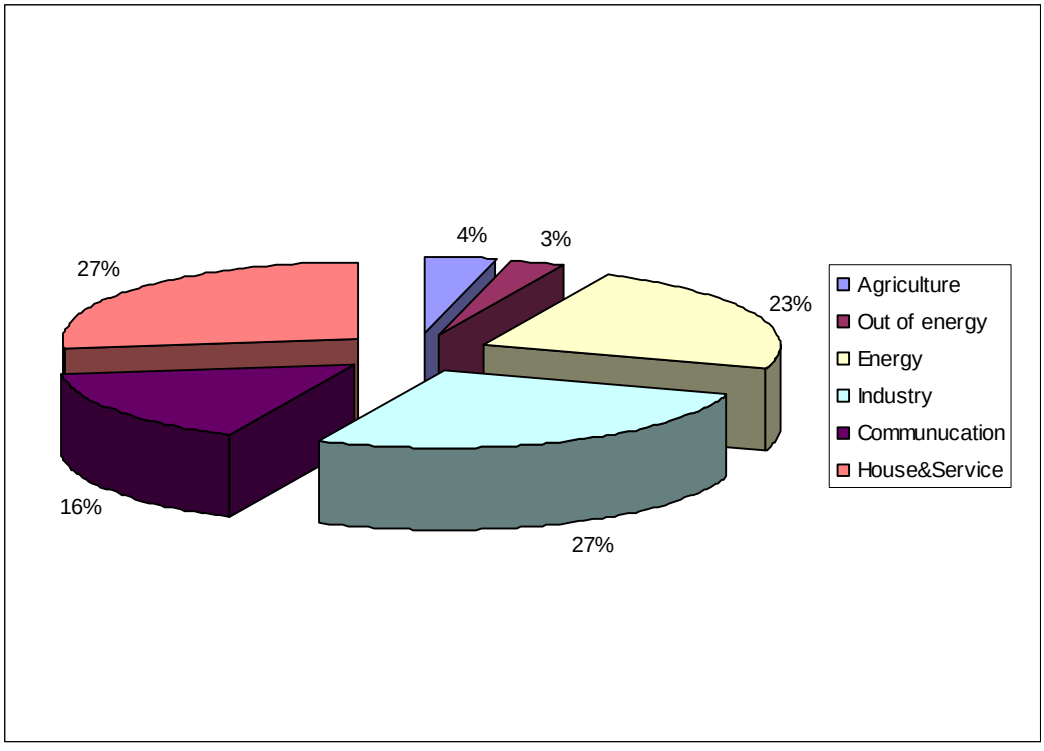

Figure 2.6 The shares of sectors in energy consumption in Turkey (2005)

2.7 Turkey's Energy Resources and Energy Import & Export

In Turkey, there are reserves of fossil resources, such as hardcoal, lignite, asphaltit, bituminous schists, crude oil, natural gas, uranium, and thorium, along with potential of undepletible resources, such as hydraulic energy, geothermal energy, solar energy, wind energy, wave energy and biomass energy. In brief, although Turkey has almost every kind of energy sources related to geological and natural structure, today's leading fossil fuels do not have adequate reserves excluding lignite, and have low production.

Turkey is, particularly, a poor country regarding ostensible reserves of liquid (fluid and gas) fossil fuels. According to 2005 data, 90.3% of oil and natural gas, which meets the country's energy need, was imported, as oil imported was 29430 Btep and natural gas and LNG was 8995 Btep, by 2005. The consumption of natural gas in 2005 was 30% of oil consumption. However, the estimated growth of natural gas consumption is higher than of oil, natural gas consumption will be equal to the 50% of oil consumption in 2000 – 2001. Assured suppliers are inquired, as the entire gradually increasing natural gas demand is projected to be met by import, and remaining unsolved yet.

The hardcoal production is not even adequate in meeting industrial demand. However, in addition to usage directly in industry, it is a raw material for coke factories producing secondary coal, it is also used consumed in electricity production, housing and service sector, and transporting sector, symbolically. According to 2005 data, hardcoal production is 57.3% of industry consumption. The hardcoal is imported for the fuel need of cities which has dense air pollution, in addition to meet the demand of iron – steel sector, cement sector and other industrial sectors. Construction of thermal electricity power plants are proposed for the agenda. In 2005, the hardcoal imported is multiplied by 4.4 times of domestic production. Besides, it is imported as secondary coal, in form of coaked. The import of hardcoal and secondary coal was total 6258 Btep in 2005.

As our lignite reserves which have great importance in domestic resources are analyzed, it is observed that it has minimum calorific value. Besides, the high

sulphur content also devalues the lignite quality regarding environmental pollution. The lignite production has 69.3% of total fossil fuel production. 13% of total lignite production is used in Afşin – Elbistan power plant, while 56% of that is used in other plants, and the remaining in heating. Asphaltit, which is scarce in our country, is almost removed from budget in recent years. Bituminous schists, which are not used yet, can be utilized both as low calorific valued fuels, and in production of synthetic oil. Limited uranium and rich thorium reserves are among inactive resources. Turkey, contrary to depletable conventional fossil fuel reserves, is a lucky country in potential undepletable natural resources. 29% of available economic hydraulic potential is in operation, and 10% is under construction, final project of 14% is prepared, 19% is at planning stage, the remaining 28% is at master plan and preliminary analysis stage. In brief, whole economic potential was considered to be utilized.

Although Turkey is known as rich regarding geothermal resources, the reserves used for whether heating systems or generating electricity is limited. But, even such limited reserve could not be made spaciously available. Similarly, however there are important potentials regarding solar and wind energies, the commencement stage could not be passed in point of utilization. The importance of new and renewable energy resources are not approved in Turkey's limited energy plannings, and use of such resources are not promoted.

Turkey endeavours to meet energy demand via import of fossil oil, as domestic conventional fossil fuel production is inadequate. The primary energy import in 1990, increased from 4.64 Mtep to 43.68 Mtep by 2005. In period of 1990 – 2005, domestic production was multiplied by 3.3 times, while primary energy import was multiplied by 9.8 times. In 1990, 30936 Btep of energy was imported, and 2102 Btep was exported. In 2005, the energy export decreased to 1630 Btep, while the import increased to 45629 Btep. Total payment made for energy import was $ 5.9 USD, and its share in total import was 12.1%. The energy export value is equivalent to 3% of GNP. The energy projected to be imported in 2000 is 59940 Btep. The export and import values are represented in the following table, in terms of realized and expected that:

Table 2.5 Energy import and export of Turkey

Years	IMPORT						Export Rate
	Hardcoal	Oil	Natural Gas	Electricity	Total	Export	in Consumption
	(thousand tones)	(thousand tones)	(million m3)	(GWh)	(Btep)	(Btep)	(%)
Realized							
1990	5556	22396	3257	176	30935	2118	58,8
1991	6083	19982	4035	759	29597	2808	54,9
1992	5414	21768	4437	189	31488	2042	55,9
1993	5640	25729	4954	213	36180	2254	59,1
1994	5463	24629	5375	31	35344	2280	60,2
1995	5941	27169	6755	0	39684	1947	62,8
1996	5525	28330	7837	270	41828	1883	60,3
1997	8311	28264	9885	2492	45629	1630	63,9
1998	10648	29496	12384	2859	48736	1500	63,1
1999	11217	31461	16481	-	54874	1500	65,1
2000	13237	34496	18102	-	60768	1500	66,8
2001	14600	34480	18150	2800	61000	1600	70,0
2002	14780	35900	18170	2900	62000	1620	72,5
2003	15300	36120	18190	3000	63000	1650	76,0
2004	15500	36190	19150	3200	65000	1709	80,0
2005	15844	36200	20200	3300	67000	1720	82,0

2.8 Electricity Energy In Turkey

In the period of 1990–2005, the annual growth of electricity energy consumption was 9.9%. The lowest growth recorded was 4.4% in 1983, and the biggest was 18.4% in 1991. Since 1995, the annual growth observed per year is higher than 10%, and it was recorded as 12.4% in 2005. The progress trend of installed capacity through 1987 – 2005 to meet demand is demonstrated in by the following figure. The electricity produced via primary resources throughout this period is also represented in Figure 2.7 :

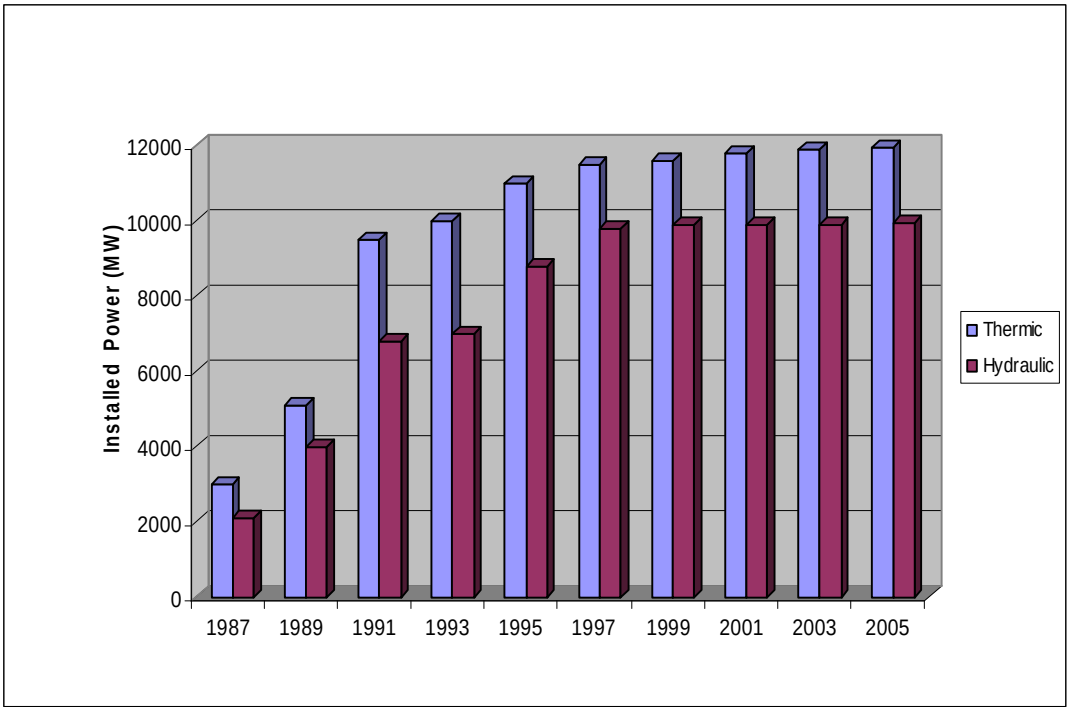

Figure 2.7 The progress of thermal and hydroelectrical installed capacity

Between 1987 and 2005, the growth of installed capacity is observed higher than 5% throughout 19 years, and higher than 10% throughout 10 years. However, the number of the years in which the growths lower than 5% recorded before 1990 is 4 years, and after 1990 is 5 years. This growth is realized by 2.6%, 0.5%, 1.4% and 3.0%, in 1994, 1995, 1996 and 2005, respectively.

The data regarding values of progress trends in installed capacity, production, consumption, and import – export are represented in the following table. In 2005, Turkey's electrical installed capacity was 21889.4 MW, electricity production was 104285.1 GW, and electricity import was 2492.3 GWh and total consumption was 106506.4 GWh.

Table 2.6 The production & consumption trend of electrical installed capacity In Turkey

Years	Installed Capacity (MW)	Production (GWh)	Import (GWh)	Export (GWh)	Consumption (GWh)	Consumption Growth(%)
1985	2234.9	8623.0	0,0	0,0	8623,0	10,0
1987	5118,7	23275,4	1341,1	0,0	24616,5	4,5
1989	9119,1	34218,9	2142,4	0,0	36361,3	9,3
1991	16315,1	57543,0	175,5	906,8	59811,7	8,0
1993	17206,6	60246,3	759,4	506,4	60499,4	6,5
1995	18713,6	67342,2	188,8	314,2	67216,8	11,1
1997	20335,1	73807,5	212,9	588,7	73431,7	9,2
1999	20857,3	78321,7	31,4	570,1	77783,0	5,9
2001	20951,8	86274,4	0,0	695,8	85551,6	10,0
2003	21246,9	94861,6	270,1	343,1	94788,6	10,8
2005	21899,4	104285,1	2492,3	271,0	106506,4	12,4

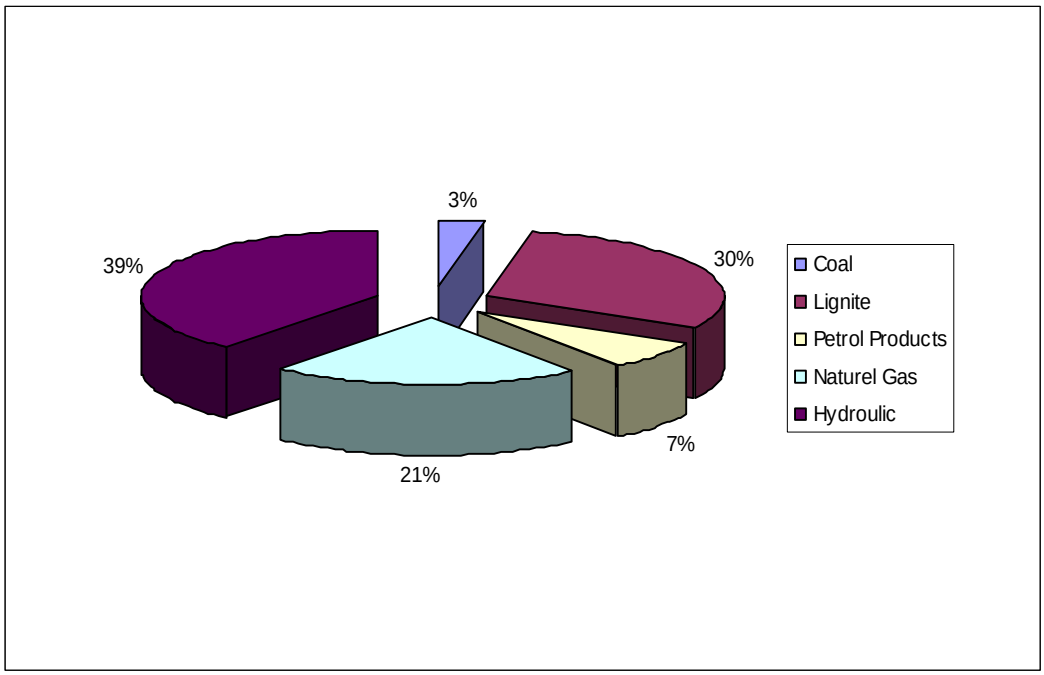

Figure 2.8 The resource shares in electricity production in 2005

100 of 493 hydroelectric power plants which have technical and economic feasibility in Turkey are now operating. Six hydroelectric power plants, of which installed capacity is higher than 500 MW (Atatürk, Karakaya, Keban, Altınkaya, Oymapınar and Hasan Uğurlu), and with 7270 MW in total, form 72% of hydraulic installed capacity of Turkey. Again, 10 thermal power plants, of which installed capacity is higher than 500 MW (Afşin-Elbistan, Ambarlı Kombine Çevrim, Soma B, Ambarlı, Kemerköy, Yatağan, Hamitabat, Hamitabat Tevsii, Seyitömer, Sugözü), and with 7391 MW in total, form 63% of thermal installed capacity of Turkey.

The continuous decrease in electricity production investments in period of 1980 – 1994, brought Turkey on the verge of another electricity crisis. In period of 1990 – 1996, only 4931.8 MW of capacity was added, while the required production capacity to be added was minimum 1400 W, 7x144=9800 MW in total. In other words, there occurred a capacity shortage of 4800 MW. The capacity surplus realized in 1990 by 30% (4500 MW) was consumed throughout 15 years, and also the addition capacity in 2005 realized was only 642.5 MW. The difficult situation of electricity, in which Turkey is, depends on peak capacity and reliable energy

production level. In Turkey, no correlation between peak capacity and installed capacity increases was established, and continuous growth could not be achieved in peak capacity. While peak capacity/installed capacity ratio varied between 50 – 60% since 1987 and installed capacity was 21246.9 MW in 1996, peak capacity/installed capacity ratio increased to 71%, as peak capacity increased to 15136 MW. In 2005, peak capacity was 16926.1 MW, while the installed capacity was 21889.4 MW, thus peak capacity/installed capacity ratio increased to 77% in 2005, and this high ratio should be also sustained in further years.

2.9 The Fossil Fuel Reserves, Production & Development

In this chapter, Turkey's hardcoal, lignite, oil, natural gas, asphaltit, bituminous schist, uranium and thorium reserves are explained, and realized productions and development facilities are considered. Although Turkey has reserves of largely consumed fossil energy resources, such as coal, oil, and natural gas, the size of these reserves are limited excluding lignite, and production can not meet the needs. The other fossil resources are waiting to be evaluated, as they are not used in production. The sum of visible, probable and feasible reserves of coal, oil, natural gas, asphaltit and bituminous schist are 2454 Mtep.

2.9.1 Hardcoal

Turkey's most important hard coal basin is in the vicinity of Zonguldak, on a zone with 200 km length through Ereğli in the west and Söğütözü in the east, which is also known as Northwest Anatolia Carbofiber Basin. The definite coal reserve in this vicinity is in view 428 million tons and probable 449 million tons. Besides, another two small hard coal reserves about 20 million tons exist in vicinity of Antalya-Kemer and Diyarbakır-Hanzo. The whole hard coal field in Zonguldak Basin is owned by Turkish Hard Coal Institution (TTK).

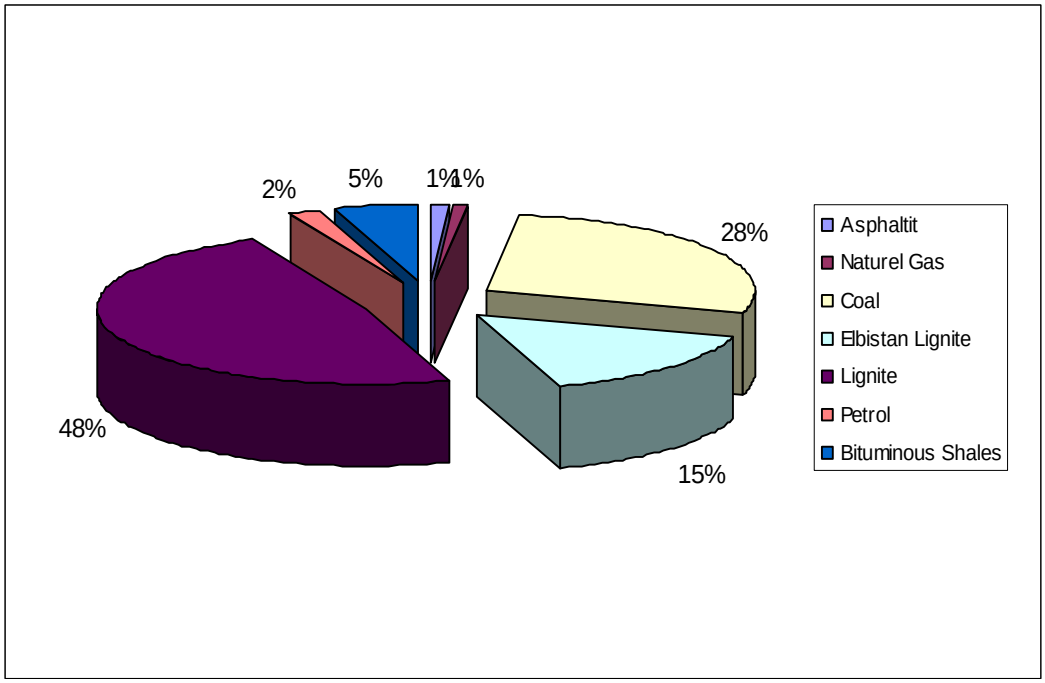

Figure 2.9 The distribution of fossil fuel reserves on resources

The evident hard coal reserve in Turkey is 1.126.548.000 tons in total. The distribution and properties of hard coal reserve on fields is represented in the table below. The coal lodes, geologically, are in vaulted structure, not smooth. Thus, there exist important problems in process of the fields, in other words, this hard coal seam is hardly processed.

Table 2.7 The hard coal reserves in Turkey (2005)

	1.000 tons							
Field	**Visible**	**Probable**	**Feasible**	**Total**	**Water (%)**	**Ash (%)**	**S**	**AID kj/kg**
Zonguldak Armutçuk	19615,0	11509	10185	41309	6	9	0,9	6275
Zonguldak Kozlu	63400	55926	47975	167301	5	12	0,8	6740
Zonguldak Üzülmez	161135	94342	74020	329497	5	12	0,8	6740
Zonguldak Karadon	151442	153752	117144	422338	5,5	13	0,8	6710
Bartın Amasra	32799	133304	-	166103	7	14	1,5	5840
Total	428391	448833	249324	1126548				

The hard coal production on overall Zonguldak Basin was 2.513.000 tons in 2005. The production does not meet the needs since 1970's, as the needed hard coal quantity is increasingly imported. The imported hard coal in 2005 was 8.311.000 tons. In respect to projections of Ministry of Energy and natural Resources, imported hard coal will be 6.6 million tons by 2000, and 41.9 million tons by 2010, and 148.9 million tons by 2020. Discovery and utilization of new hard coal seams takes great importance in Turkey. The researches of MTA excluding above mentioned fields, resulted negatively. However, it seems probable that there exist new seams convenient for production in fields, again in vicinity of Zonguldak, through Bartın and Cide. First of all, the geological structure of the region. Besides, the presence of hard coal was determined by TPAO in deep oil drillings. The projection of researches, intended for production of hard coal from seams in this region, will be beneficiary. The researches regarding coal and other fossil-based energy raw material

has been quit in the country, as a result of economy policies of last 15 years, and restrictions on activities of General Directorate of MTA. Mine Law with no. 3213 has bounded mine researches within General Directorate of MTA's licensed fields. Presences of licensed fields owned by General Directorate of MTA lower than 4% when the law is issued, has negatively affected discovery of new coal seams. Although General Directorate of MTA has attempted to overcome such restriction via issuing "Project of Type-Contracted Preliminary Studies" in 1993, these researches was failed, as well. MTA, which is non-commercial, should carry on its research process without any need for license, and transmit the findings to producers, as a main principle.

Nowadays, the limited coal researches which are decreased to be said nonexistent, are carried on by inductive prospection method, which is not considered sufficiently. Although, since 1980's MTA has commenced comprehensive preliminary studies on basins. In our country, deductive coal prospection aiming sedimentation basins that potentially contains coal formation, rather than inductive prospection based on display sample or indication, should be performed.

2.9.2 Lignite

Lignite holds an important place among energy resources in Turkey, as lignite fields with high heating values were usually focused in researches up to 1960. In1960's, employment of lignite with low heating values as fuels for thermal power plants became a current issue. This point of view provided the researches a new direction, as 117 economic lignite fields were found by these researches. Total reserve has attained to 8075 million tons, of which 7339 million tons is visible, and 3900 million tons is producible. 3300 million tons of total reserve is in Elbistan region, and 2860 million tons of total reserve is owned by TKİ, and 3480 million tons by TEAŞ, and the remaining by private sector. The humidity of 70% of total lignite reserve is higher than 30%, as 60% of total is exceeds 40%. Ash content of 85% of total lignite reserve is higher than 20%. Sulphur content of 35.8% of total reserve is lower than 2%, and 54.6% of total reserve contains 2-3% sulphur, as 7.7%

contains 3-4%, and 1.9% contains higher than 4%. The lower thermal limit of known lignite reserve is within 2930-23500 kj/kg, as that of 69% of reserve is lower than 8400 kj/kg, and 29% of reserve is 8400-16800 kj/kg. The distribution of lignite reserves is represented in below figure:

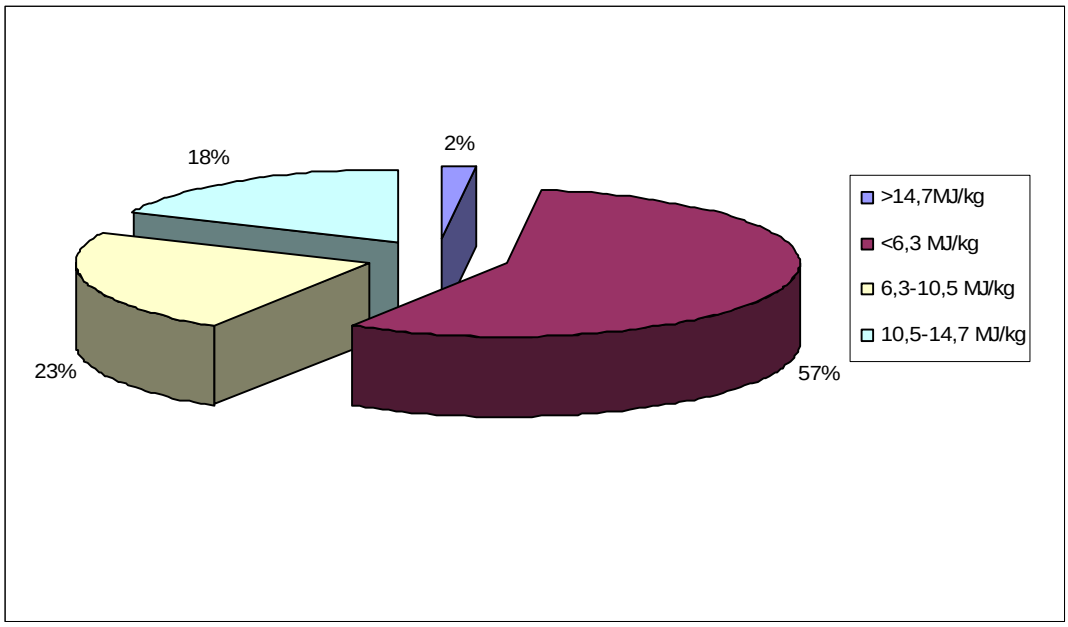

Figure 2.10 The distribution of lignite reserves in Turkey by thermal values

The lignite production in 2005 was 57.387.000 tons. In Turkey, 90% of lignite is produced by open mining and remaining by subsurface mining. However, lignite production is aimed to be attained at 65 million tons by 2000, 108 million tons by 2010, and 199 million tons by 2020, there are some suspects regarding the issue. While the TKİ investments were at level of 146-344 million USD within period of 1980-1988, they rapidly decreased to 10 million USD after 1988. Investments for new projects can not be realized.

The considerable point regarding lignite issue is that no noteworthy increase was achieved in reserves through recent years. The field Adana-Tufanbeyli, which is discovered by MTA in 1989, is the recent field that contributes an important amount to the reserves, as total reserves determined here is 334 million tons with thermal value of 5450 kj/kg. However, the feasibility of the field is disputatious, as the

stripping amount required to obtain 1 ton of coal is 7.43 m^3, depending on existence of coal lodes deeper. A new strategy should be developed regarding lignite researches, as any noteworthy reserve contribution could not be achieved after this discovery in 1989.

The problems mentioned above regarding hard coal researches are also effective in lignite researches. The covered areas should be researched for the Eocene aged lignite with high thermal values and required by the country. In scope of deductive prospection, particularly, as hopeful fields and potentials regarding coal, we should advise to investigate following regions; pontide sectors of Anatolian plateaus, which are Eocene aged and lacustrine forms, limnic formed, and capable of containing coal formations of high quality, with limited reserve; terrestrial fresh water deposits in Thrace, of Oligocene aged, which are paralic formed, much grained, and capable of containing coal formations of average quality; and sectors in West Anatolia, which are Miocene aged, with terrestrial-lacustrine facies, limnic sediments similar to the ones in coal basins of Seyitömer, Tunçbilek and Soma; fresh water deposits in East Anatolia, of Pliocene aged, which are few grained, and capable of containing limnic coal formations of high quality. In general, sedimentary basins in character of Palaeozoic-Mesozoic aged crystal-based sedimenter basins in Turkey and peneplens revealed by modern topography can be assumed to be hopeful lignite fields. In this scope, along with mechanical drilling researches, geophysics methods should be used in programs of general deductive prospection in Turkey. The investigation of sedimentary bodies with terrestrial-lacustrine facies below vulcanite in East and Southeast Anatolia should be put on the agenda.

2.9.3 Asphaltit

In Turkey, the asphaltit seams are found in seams of Southeast Anatolia Region, vicinity of Şırnak and Silopi, as two fields are owned by TKİ. Total reserve is about 82 million tons. The annual production attained at 860000 tons, but then it gradually decreased, in this way the production in 2005 was 29000 tons. Although asphaltit, which includes uncommon minerals and has high thermal value (18000

kj/kg), is used as solid fuel, it is raw material that is employable in synthetic oil, whereas the asphaltit produced is used in house heating within many cities of East Anatolia. Besides, with reasons such as total reserves to be considered as few, and of which important portion convenient for open mining to be treated, production of synthetic oil is extracted outside the agenda. Recently, it is projected to be employed as power plant fuel.

2.9.4 Bituminous Shales

Bituminous shales, which include kerogen and are known as sedimentary rocks with little grained and foliated structure, are considered as fuel because of containing kerogen. Although they are called as bituminous schist, petroleum shales, being defined as bituminous shale is more suitable. Along with obtaining synthetic oil and gas from these rocks, they can be also employed in thermal power plants as solid fuel. There are bituminous shale seams in many regions of our country, excluding Thrace, Middle and East Anatolia, as they are involved in various geological formations from Palaeozoic to Tertiary. In our country, the bituminous shales were generally formed in shallow cavities caused by tectonic motions and most of them are tertiary. There is much bituminous shale in Turkey, particularly in West Anatolia. Total reserve determined is 1.6 billions of tons, as 555 millions of tons visible, 1086 millions of tons probable, with thermal value through 1528-5820 kj/kg. The following table represents the reserves of bituminous shales in Turkey. The most important shale seams are in fields Beypazarı, Seyitömer, Hatıldağı and Himmetoğlu. These fields, except Hatıldağı, are lignite fields, as well. As bituminous shales are located over the lignite lodes in fields Seyitömer and Himmetoğlu, they are terminated by stripping during lignite production. Although the researches indicated that bituminous shales in Seyitömer could be employed in power plants with fluidized beds after mixed by lignite, it was not put into practice yet. However the bituminous shales are used as thermal plant fuel or raw material of synthetic oil by distillation, it is not produced or consumed because of low thermal value, operating difficulties, and high ash ratios, as they just stand as potential fuel. There

were a few favourable results obtained in ignition experiments of bituminous shales mixed by lignite in fluidized beds in Beypazarı. However, also there are difficulties in excavation in these seams. The main reasons in waving aside of these seams are presence of import possibilities of cheap oil and natural gas, rather than difficulties and low fuel quality. Nevertheless, nowadays new technologies are developed for synthetic oil production from bituminous shales.

The bituminous shales, which are not convenient in oil production, were contingent on Law of Mine with number 6309, as same issue was placed in Law of Mine with number 3213, which has changed the previous. However, with respect to 3rd article of Oil Law with number 2808 which changes Oil Law with number 6326, "the solid hydrocarbon fields such as asphaltit or bituminous shales, which can be convenient in oil production, can be concluded to be ruled under Oil Law by Decree of Council of Ministers, with proposal of Ministry of Energy and Natural Resources. In this point of view, the seams of bituminous shales should be reconsidered.

2.9.5 Peat

These are fossil-based fuels which did not complete formation yet. The most important peat seams are found in Kayseri and Yüksekova. Total peat fields in Turkey, with respect to 1998 statistics of World Energy Council, 56 thousand hectares. The thermal values of peats in vicinity of Ambar Köyü of Kayseri are calculated as 6100 kj/kg, with reserve of 105 million tons. However, these peats were covered by settlement fields. The peat reserves in Yüksekova are determined as 85 million tons, of which dry sample's thermal value is 12560 kj/kg. In Turkey, utilization of peats as raw material for energy is not dwelled on yet.

2.9.6 Oil

It is the resource which has importance in the energy imports of Turkey for long years and expected to continue its importance in the future. It has been permitted to explore oil and its operation for domestic and foreign private capitals in

the year of 1954. A number of 188 firms had activities in exploring oil and its operation in 1954-2005 in Turkey. The number of firms which were in activity of exploring and operation in 2005 is 25. A number of 21 of these firms are foreign and 4 of them are domestic.

A number of 2850 wells of which 1004 are for searching, 450 are determined, 1248 are for production, 30 are for injection and 78 are for exploratory were dug in Turkey by the end of the year 2005. The total length of these wells is 5662812 meters. A number of 21 natural gas field of which 4 are CO_2 and 96 are oil were explored by the end of the year 2005.

The oil and natural gas fields which are being searched are at high levels with respect to the number of wells which have been dug in Turkey and the reason of this is that some fields are close to each other and have the same structure by separating each other with tectonic lines. While the number of wells dug in one year in some countries is expressed in thousands and ten thousands, besides while there are hundreds of wells in hopeless countries, The length of wells dug as searching, fixing, production, injection and exploratory is 87120 m/years and its number is 44 well/year with respect to the mean average of 65 years in Turkey. When only taking searching wells in hand, the drilling made from the year 1934 to the end of the year 2005 is 2.430.505,72 meters and the number of opened well is 1044. The number of searching wells is 11 in 2005 and the performed drilling is 107.167,22 meters. The total wells opened in 2005 are 51 and total drilling is 107.167,22 meters.

The oil reserves are a fact depending upon geological structure. There are reserves alternatives betrayed with theoretical studies in the areas which have effective oil and have the possibility of having oil. The total area of the fields which might have effective oil on land is %1-10 of total area and in sea it is %6-9 of total area. Therefore, the possibility of effective field which might have oil is totally 335.105 km^2 of which 188.662 km^2 is on land, 146.443 km^2 is on sea. The areas which need to be searched in detail in order to fix these fields certainly are 545.000 km^2 on land and 296.000 km^2 on sea and so the total area is 841.000 km^2. The minimum area which might be the reserves of oil and similar hydrocarbons with respect to the structural and strategic analysis is totally 10.591 km^2 of which 6.947

km^2 is on land and 3.644 km^2 is on sea. According to the options put forth for oil amount which the above mentioned reserves might have, it has been given an impulse to that there may be oil reserves between 1.8- 10.4 billion tones in Turkey in the calculations performed by means of previous searches. The oil occurrence from such reserves is between 274 million tones and 1.58 billion tones. The oil fields in Turkey are focused on X. region Siirt, XI. Region Diyarbakır, XII. Region Gaziantep and then it is carried on with I. Region Marmara, XIII. Region Hatay, XIV. Region Adana, XV. Region Konya, XVI Region Antalya. The restricted searches were performed in II. Region Bolu, I. Region Ankara and XVII. Region İzmir. However, it cannot be said that the whole of the 18 regions were searched. It is possible to increase the expected oil reserves with the searches in Southeast Anatolia, West Taurus, West Black Sea, Central Anatolia and seas.The oil reserve in reservoir of Turkey (proved+probable+possible) by the end of 2005 is 6.670.189.000 of barrel, namely 978.749.000 of tons. So, producible oil is 149.699.000 tons. The remaining producible oil reserve is 317.161.852 barrels, namely 46.336.132 tons, as the cumulative production from this reserve is 103.362.868 tons.

2.9.7 Natural Gas

The natural gas production fields of Turkey are in Thrace and Southeast Anatolia. The main production fields are Bayramşah, Değirmenköy, Hamitabat, Hayrabolu, Kandamış, Karacaoğlan, Karaçalı, Kumrular, K. Marmara, Silivri, and Umurca in Thrace, Derin Barbeş, Çamurlu, G. Dinçer, G. Hazro, and Katin in Southeast Anatolia. More than 83% of production is performed in Hamitabat field. The natural gas reserves of Turkey in known fields by the end of 2005 is 18.104.718.000 m^3 as total gas in reservoir, and 12.338.576.000 m^3 as total producible gas. However, the remaining producible reserve is 9.367.157.704 m^3, as performed cumulative production is 2.971.418.296 m^3, of which 72.5% is owned by TPAO. The shares of firms in natural gas reserves in Turkey is shown in following figure:

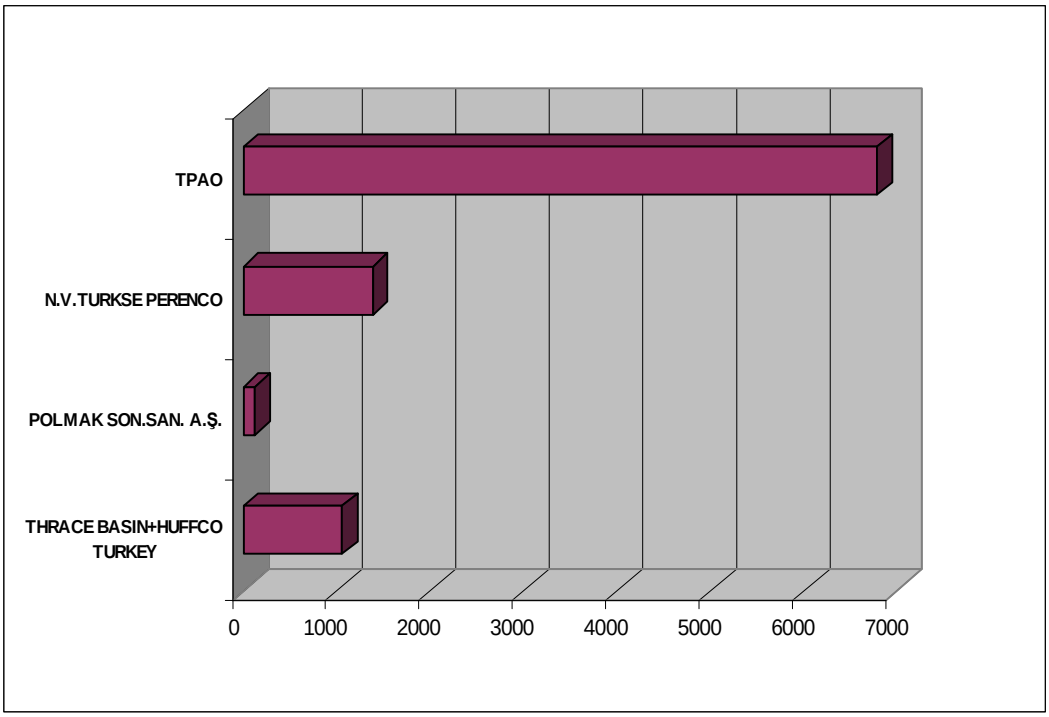

Figure 2.11 The shares of firms in natural gas reserves in Turkey (2005)

There exists probability of discovery of new natural gas fields in our country. Particularly, West Black Sea, Marmara and Middle Anatolia regions are perceived as hopeful fields. The most important discovery regarding such hopes was North Marmara natural gas field, which was discovered in offshore of Silivri by 1998 and activated with production capacity of 1.500.000 m^3 per day by 2005. The domestic natural gas production of Turkey utilized in 2005 was 253.215.832 m^3, of which nearby 100% was performed by TPAO. Thrace Basin Natural Gas Corp. Turkey + Huffco Turkey Inc. partnership performs a symbolic production. In 2005, natural gas of 9.874.000.000 m^3 was imported to meet the demand. Therefore, the natural gas consumption in 2005 was reached to 10.127.216.000 m^3. The projection of domestic production for 2006 is 760 millions of m^3, as North Marmara field is commenced to serve. But, the demand of Turkey in 2006 is about 13.4 billions of m^3.Turkey has an agreement with West terminal and Russia Federation, natural gas suppliers of Turkey, about annual 6 billions of m^3, in addition to LNG agreement with Algeria, annual 4 billions of m^3 natural gas, as LNG is also spot imported. Meanwhile,

although another agreement of 8 billions of m^3 was signed by Russia and West terminal, the line should be developed by new loops for import, in addition to increasing capacity in compressor stations. The expansion process of existing natural gas line is ongoing. An agreement of annual 1.2 billions of m^3 of LNG commenced by 1999 was signed. There is an import agreement of annual 10 billions of m^3 with Iran by 1999, although presence of political uncertainties in Iran. The realization probability of this line, also called as East terminal, seems to be weak. Black Sea Natural Gas Pipeline agreement with Russia, which will begin with annually 0.5 billions of m^3 by 2000 and gradually increase to 16 billions of m^3, is now on realization process.

The demand of natural gas in Turkey is estimated to attain 20.790 millions of m^3 by 2000, 53.553 millions of m^3 by 2010, and 80.000 millions of m^3 by 2020. However, the total of the agreements made to date is 45.2 billions of m^3, the uncertainties regarding realization points out that the depression in natural gas to be continued.

2.10 Uranium

In Turkey, first of all, sedimentary uranium seam research was commenced in Neocene aged deposits, which was resulted in discovery of minor seams with low tenor. Then, it was understood that most suitable geological targets were Eocene aged deposits around metamorphic massifs and granites, new fields were found of which tenor was higher than previous ones but lower than the ones in process worldwide. Although the Pliocene aged formation, on which Bulgaria produces economic uranium, goes over to Turkey and is widespread, it stands by further researches.

Some part of uranium seams in Turkey is majorly accumulated in West Anatolia, with 0.04-0.08% U_3O_8 tenor, as Manisa-Salihli-Köprübaşı has an important place among these seams, with 0.05% tenor. In order to utilize uranium in Köprübaşı field, a facility has been established by MTA in 1974 and produced yellow cake, as this facility was transferred to Etibank, and then was shut down. The latter

discovered Yozgat-Sorgun field is the richest one in Turkey, with 0.1% U_3O_8 tenor. However, the tenors of seams in process all around the world are over than 1%. The known total reserves in Turkey are equal to 9129 tons of U_3O_8, of which distribution over fields in Turkey is represented in Table 2.8 in detail:

Table 2.8 Uranium reserves in Turkey

Field	Tenor (%)	Reserve (in tons)
Salihli Köprübaşı	0,05	2852
Eşme-Fakılı	0,05	490
Söke-Küçükçavdar	0,04	208
Söke-Demirtepe	0,08	1729
Yozgat-Sorgun	0,1	3850
TOTAL :	**0,04-0,1**	**9129**

In Turkey, uranium with 3-6 ppm concentration in deposits or Back Sea floor and 0.1-0.5 ppm was discovered. A little uranium is also found in phosphate rocks, as uranium concentration in Mazıdağ seams is about 50-60 ppm. Besides, uranium accumulation of 100 ppm in ash samples of various coal seams, and 200 ppm in asphaltit of Şırnak are discovered.

Economic uranium production is not feasible with recent technology in Turkey's known seams. In respect with report "Survey of Energy Resources 2005" of World Energy Council, in spite of operating seams with cost $80 per kg, the production cost evaluated for reserves in Turkey is $80-130 per kg. The decrease in U_3O_8 price to $40 per kg in further years, which was $120 per kg in 1979, brought a stop in uranium researches in Turkey, as well as all over the world. We think it is beneficial to carry on uranium researches systematically with low costs, as uranium is inalienable and most important energy resource of future.

The prevalent opinion is that the reserves discovered to date do not show the real uranium reserves in Turkey. There exists strong possibility of discovering of uranium seams in new researches, particularly, throughout South Marmara and East Black Sea Regions. The period required through discovery and production of a uranium reserve is more than 10 years.

Although the first nuclear power plant in Turkey is in contract bidding process, it is beneficial that to commence new researches again and as soon as possible, as share of nuclear power plant in energy will increase by 2010.

2.11 Thorium

The only known thorium seam of Turkey is found in Eskişehir-Sivrihisar-Kızılcaören, but this field is one of the most top-notch reserves of the world. This reserve is 380.000 tons in quantity with 0.2% tenor ThO_2. This reserve includes the section of seams which goes to 200 m depth, as the deeper reserves and the rest of the field are not included. The reserve can be expected to increase considerably with new discovery process. In addition to Kızılcaören, some signs of thorium are found in Malatya-Hekimhan-Kuluncak, as well. Such researches
should be expanded. However, the thorium reserves of the world being owned by specific some countries, including Turkey, and having no difficulties, for now, in uranium production slow down the developments of thorium-based nuclear power plants. Along with its nuclear strategy, Turkey will imply utilization of thorium seams in middle and long-terms.

2.12 Renewable Energy Potential Usage & Development of Turkey

The potential of hydro, geothermal, solar, wind, wave, and biomass energy of Turkey should be considered, usage levels should be explained, and the development facilities of usable potentials regarding these resources should be examined. The following table represents the potential of main energy resources of renewable character. The economic potential in the table is equivalent of usable potential.

Table 2.9 Renewable energy potential of Turkey

RESOURCES	GROSS	TECHNICAL	ECONOMIC
Hydraulic energy			
MW	**107500**	**53750**	**34862**
Billion kWh/year	**430**	**215**	**124.5**
Geothermal energy			
Heat (MW)	**31500**	**7500**	**2843**
(Mtep/year)	**-**	**5,4**	**1,8**
Electricity (MW)	**4500**	**500**	**350**
(billion kWh/year)	**-**	**-**	**1,4**
Solar energy			
Heat+electricity (MW)	**111500000**	**1400000**	**116000**
(billion kWh/year)	**977000**	**6105**	**305**
(Mtep/year)	**80000**	**500,0**	**25**
Wind energy			
Electricity (MW)	**220000**	**55000**	**20000**
(billion kWh/year)	**400**	**110**	**50**
Wind energy-marine			
Electricity (MW)	**-**	**60000**	**-**
(billion kWh/year)	**-**	**180**	**-**
Sea-wave energy			
Electricity (MW)	**75000**	**9000**	**-**
(billion kWh/year)	**150**	**18**	**-**
Classical biomass energy			
Fuel	**30**	**10**	**7**
Modern Biomass			
Fuel	**90**	**40**	**25**

In Turkey, biomass energy and hydraulic energy is used at most, among renewable resources. Although geothermal energy takes the third place, its usage is limited. The usage of wind energy has just commenced, and sea-wave energy is not considered yet, while solar energy is used symbolically. However, the modern biomass energy has great potential, cultivation of energy plants is not well-known

and not put into agenda, and energy forestry is considered in a limited extent. The non-economic biomass will be ceased by development of modern biomass. The total economic and/or employable potentials of renewable resources listed above are about 68.000 Btep per annum, as their shares are represented in Figure 2.12

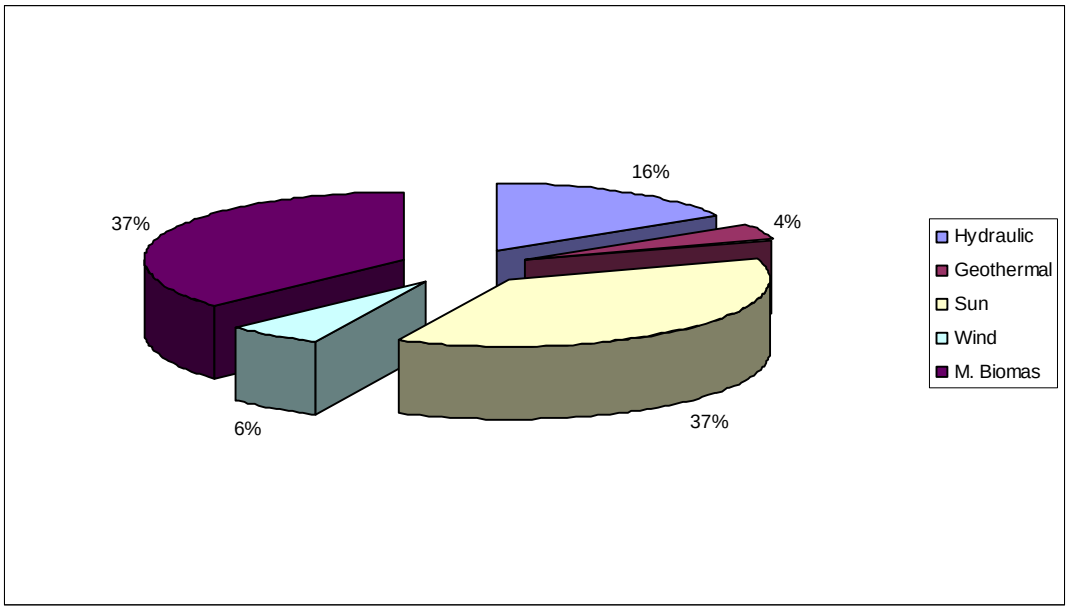

Figure 2.12 The distribution of employable/economic potential of renewable energy resources in Turkey

2.12.1 Hydraulic Energy

Hydraulic energy can be defined as development and usage of water resources. In other words, it is the energy generated by transforming potential energy of water into kinetic energy. It can be suggested that our probability of safely benefiting from this energy resource by full capacity will be only 65%, as current rainfall and rivers' situation of our country is considered. Hydroelectric energy is the most important employable and renewable energy resource of Turkey. Although the developed countries have widely utilized their potential, only 29% of potential was employed by facilities in process in Turkey. Within next 25 years, the projects which will provide utilization of whole potential should be accelerated. The hydroelectric

projects which have worthwhile energy production capacity, particularly in Çoruh, Dicle and Harşit basins, should be deliberated along with evaluating the probability in majority of technical potential to achieve character of economic potential.

The energy generated by high-powered hydroelectric power plants is categorized as classical renewable energy production in literature, while that of low-powered power plants not. However, this source was utilized to this day in our country. Such facilities of which power is less than 10 MW and of a few MW should be utilized. Organizations and laws or regulations should be fulfilled for such facilities which can be utilized by domestic technology. These power plants should be provided to be established as integrated with multipurpose use of water. Besides, a legislation which provides cooperatives to be able to establish such power plants and to sell electricity to production and distribution firms should be considered.

The advantages and disadvantages of hydroelectric power plants are:

Advantages:

1. Causes no pollution
2. Cut-in immediately in peak demand
3. Cut-out in case of emergency
4. Consumes natural resources, externally independent
5. Additional use in irrigation

Disadvantages:

1. High investment costs
2. Long construction process
3. Negative effects regarding rainfall.

The total volume of flow of rivers, dispersed through 26 river basins in Turkey, regarding energy production is 186 km^3 per annum. The biggest shares of basins are Fırat, Dicle, East Black Sea, Antalya, with 17%, 11.5%, 6% and 5.9%, respectively. However, the regime of our rivers is not regular, volume of flow is multiplied 1.5 or

2 times by excessive rainfall, and decreases to one half in excessive rainless years. Besides, it occurs higher than the mean value within period of April-June, and lower within period of June-August. The annual volume of flow and energy potential of the basins, of which average energy production potential is 1 TWh per year, is represented in the following column graph:

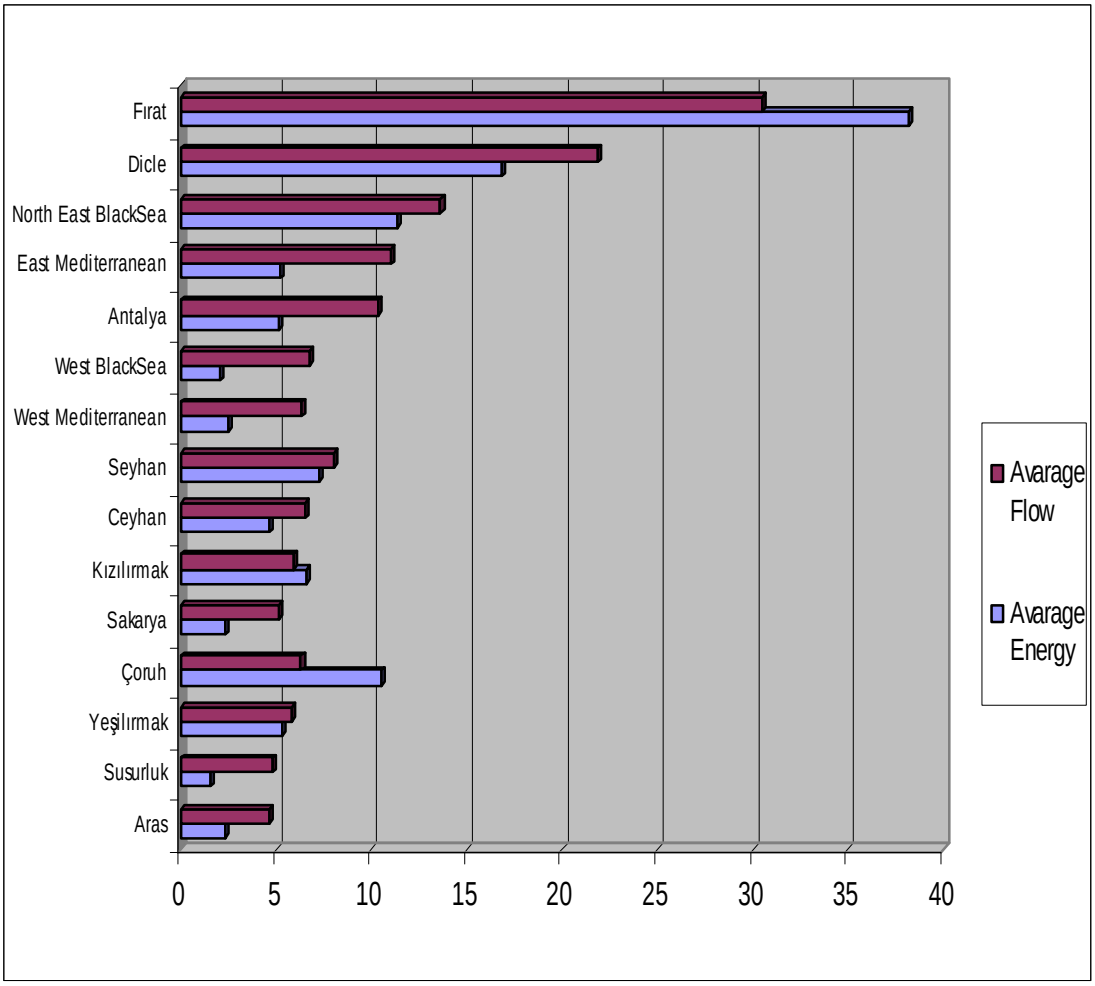

Figure 2.13 The annual volume of flow and energy potential of major basins

The gross potential of Turkey's hydraulic resources calculated theorically regarding mean volume of flow and head pressure is 430 billion kWh per year, without consideration of technical and economic feasibility. The technical potential to be utilized by this resource with consideration of only technical feasibility is calculated

as 215 billion kWh per year. However, if both aspects are taken into consideration, feasible potential, for today is calculated as 124.5 billion kWh per year, reliable energy production potential related to economic potential is calculated as 79.7 billion kWh per year. In 2005, energy generated via hydraulic resource was 39.8 billion kWh, which is projected to be reached to 85.4 billion kWh in 2010 and 103.7 billion kWh in 2020.

The energy potential of the major basins, except Çoruh and East Black Sea, is largely utilized, as 29% of economic hydraulic potential is employed. 38% of economic hydraulic potential will be utilized after all hydraulic power plants in construction process are activated. The costs of hydroelectric power plants, higher than other resources, resulted in lower utilization values.

2.12.1.1 The Hydroelectric Potential and Its Feasibility In Turkey

Turkey's total installed capacity is 21 889 MW by the end of 1997, 11 786 MW of such amount pertains to thermal, and 10 103 MW to hydroelectric power plants. The total amount electricity produced by the end of same year is 103296 GWh, 63 480 GWh of such amount (61%) pertains to thermal, and 39 816 GWh (39%) to hydroelectric power plants. However, total production of hydroelectric power plants vary in total energy production every year, depending on rainfall, 40% of electricity power is generated from water.

For today, our hydroelectric economic potential is 123kWh billion, of which 30% is utilized, 11% is under construction process, and 59% is in projections of various stages.

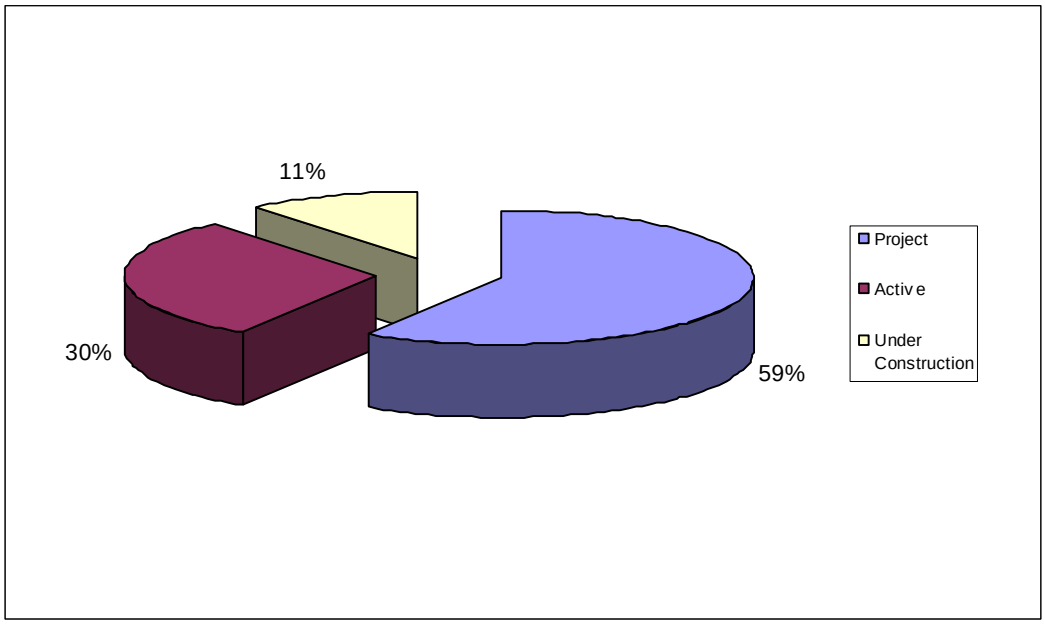

Figure 2.14 Hydroelectric potential of Turkey

In Turkey, most important functions of the corporations, such as DSİ and EİE, regarding hydroelectric projects are master planning of basins, preliminary studies, planning and projection, and gathering data required for etudes and studies. It is agreed to be the principle that adequate projects to be made available before due time, for providing the part of hydroelectric potential which is yet not utilized to be put in service. Some noteworthy developments were achieved in construction of HEPP's via BOT model, which was performed by ETBK in our country and of which scope includes "Auto producer Manufacturers" method and "Conveyance of Operation Right" practice, and "100% Foreign Credited Turnkey Basis" model, which was performed by DSİ.

In scope of BOT model, total installed capacity of 8 HEPP which were constructed by private sector as of January 1999 and activated is 153 MW, and annual energy production capacity is 707 GWh. Similarly, in scope of this model, total installed capacity of 60 projects officially approved is 4752 MW and annual energy production capacity is 16707 GWh. Besides, evaluation of 113 HEPP is ongoing, of which total installed capacity is 5282 MW, and annual energy production capacity is 21462.5 GWh. Thus, there are overall 173 hydroelectric power plant

projects in scope of BOT model, which were officially approved and in evaluation process, with total installed capacity of 10 034 MW and annual average energy production capacity of 37 953,5 GWh.

On the other hand, total installed capacity of 29 HEPP is 7502 MW and annual energy production capacity is 24,791 billion kWh, which are in scope of "100% Foreign Credited Turnkey Basis" model performed by DSİ, in accordance with protocols signed by Turkey and some countries. Among these projects, the constructions of Deriner Dam on Çoruh River and Karkamış Dam on Fırat River are presently ongoing. The total installed capacity of two projects is 859 MW and annual energy production capacity is 2770 GWh, and five of the projects are in contract negotiation, decrees of thirteen of them were processed, decrees of four of them were submitted, and decree process of five of them is ongoing.

2.12.2 Geothermal Energy

Geothermal energy is a type of energy which is generated by transferring of heat from deep in earth to underground circulation of water and reaching of water to the earth's surface. Turkey is one of the countries who are fortunate regarding geothermal energy. The existence of natural steam, hydrothermal alteration and more than 600 hot water resources which reaches to 100 ^{0}C, related to graben bounded by active faults and prevalent young volcanism, proves that Turkey has a great geothermal potential.

Along with 95% of the geothermal fields discovered to date are in available temperatures for heat treatment, and140 geothermal fields over 30 ^{0}C are spread on planes of Turkey, most of them are accumulated in West, Northwest, and Central Anatolia. The distribution of these resources regarding to temperature is represented in the figure below. However, three of these fields can be deemed fields with high enthalpy, which are Aydın-Germencik, Denizli-Kızıldere and theorically Nevşehir-Acıgöl, are favorable for electricity production and integrated heating, 6 more fields with higher than medium enthalpy can be listed, Aydın-Salavatlı, Çanakkale-Tuzla, İzmir-Balçova, İzmir-Seferihisar, İzmir-Dikili, Kütahya-Simav, as favorable fields

for electricity production and integrated heating, as well. Although electricity production is feasible, by today's technology, in fields with well temperatures over 90 ^{0} C, economization decreases with lower temperatures.

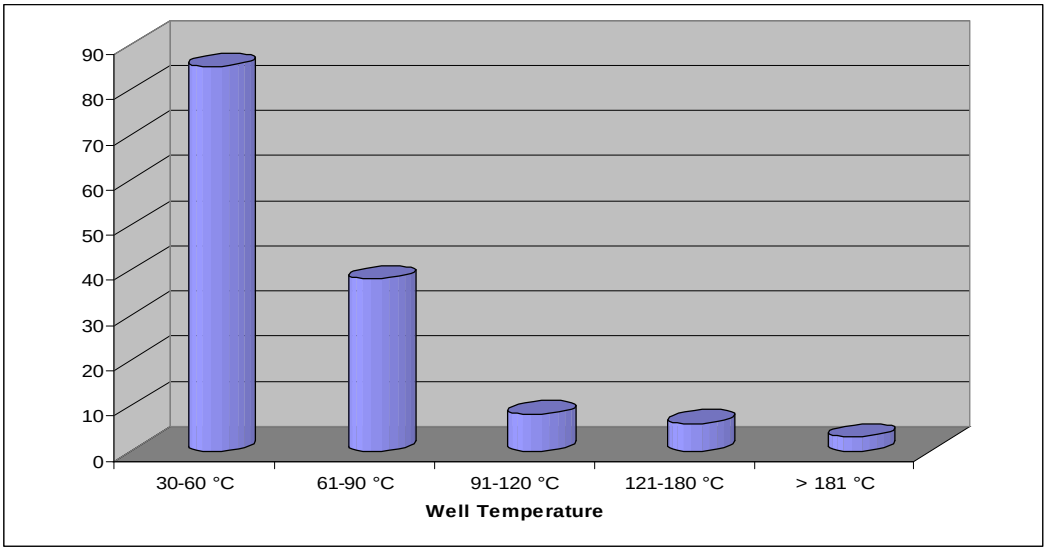

Figure 2.15 The well temperatures regarding geothermal field

However, the probable total geothermal heat treatment capacity of Turkey is about 31500 MW, as it is equivalent to gross potential, employable thermal target potential is 7500 MW. Within today's condition, the proved thermal potential appropriate for utilization and deemed economic is about 2843 MW. Total geothermal thermal capacity of 635 MW, 350 MW installed thermal capacity for heating and 285 MW thermal powers used as spa, was utilized to date. However, the theorical geothermal electricity potential of Turkey is assumed to be gross 4500 MW, the technical potential is estimated to be lower than 500 MW, and finalized geothermal energy potential based on the drills is about 200 MW. Presently in Turkey, there is a geothermal electricity power plant in Denizli-Kızıldere, with installed capacity of 20.4 MW. The project of a geothermal power plant, with 100 MW potential, which is to be built in Afyon-Germencik by Build-Operate-Transfer model, was signed after approval of Council of State.

In Turkey, the geothermal wells dug are not adequate in number, as only 200 wells are dug through 140 geothermal fields, which is too lower than world's

average. More wells should be dug in order to utilize Turkey's geothermal energy potential. The geothermal drilling footage in Turkey, since 1990, is very inadequate, as it varies within the values minimum of 971 m and maximum of 4870 m. In 2005, only 28 hot water drillings were performed, as two of them were MTA projects of which footage was 1236 m., and total footage of these 28 wells were 12200.85 m. Significant rises are expected in geothermal potential by development and improvement of explorations.

2.12.3 Solar Energy

Turkey is geographically located among 36 – 42 ^{0}N latitudes and in solar zone. Its annual period of sunning is 2609 h, which is 29.8% of overall year. The Southeast Anatolia is the leading region by 3016 h with regarding period of sunning, and is followed by Mediterranean (2923 h), Aegean (2726 h), Middle Anatolia (2712 h), East Anatolia (2693 h) and Marmara (2528 h) regions, respectively, and minimum values are recorded in Black Sea region by 1966 h. The maximum and minimum values of Turkey's average recorded are, respectively, 362 h in July and 98 h in December. The annual average intensity of solar radiation in Turkey, recorded horizontally on plane is 3.7 kWh/m^2, and varies amongst 5.9 – 1.5kWh/m^2 per day within months. The annual regional average intensity of solar radiation can be listed in order as, in Southeast Anatolia by 3,97kWh/m^2 per day, in Mediterranean by 3,86kWh/m^2 per day, and in Middle Anatolia by 3.81kWh/m^2 per day. The annual average, minimum and maximum values of solar energy among regions is represented in Table 2.10.

The solar energy received by planes in Turkey is about 977x1012 kWh, which is equivalent to 111.5x106 MW powers, as it is more than 5000 times of installed capacity of our electricity power plants. The above mentioned values are equivalence of gross potential level of 80000 Mtep per annum. The entire gross potential can not be employed to produce energy, as technically, the potential aimed to be employed can be assumed about 500 Mtep per annum. The potential which can be aimed to employed, for today, can be about 25 Mtep per annum.

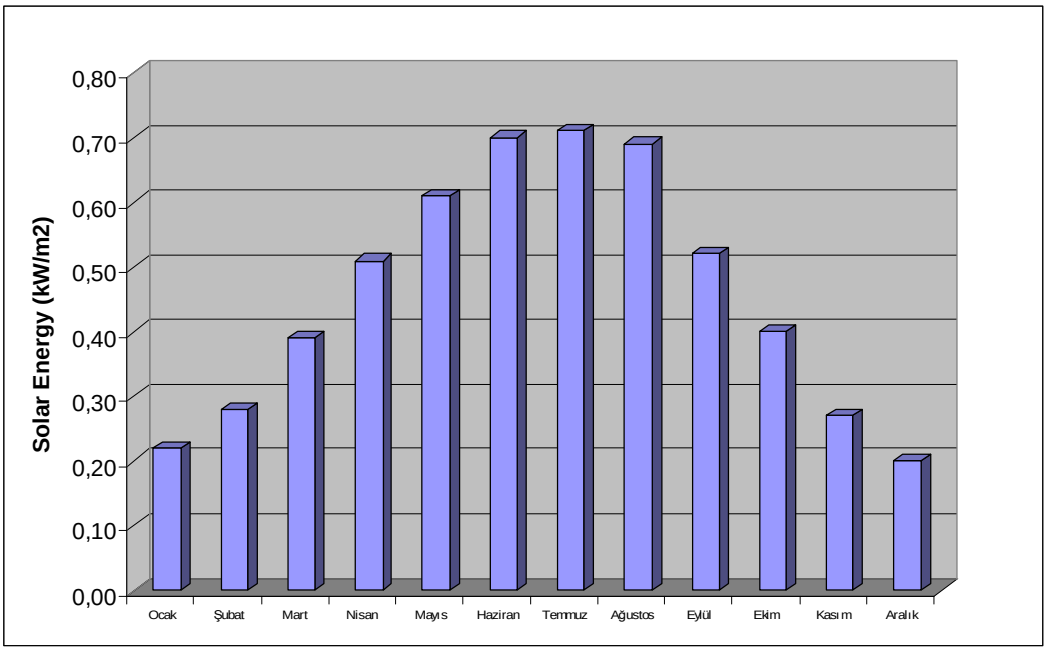

Figure 2.16 The distribution of intensity of solar radiation in Turkey

Table 2.10 The Annual average intensity of solar radiation by regions

	ANNUAL		JULY		DECEMBER	
REGIONS	**MJ/m^2 per day**	**kW/m^2**	**MJ/m^2 per day**	**kW/m^2**	**MJ/m^2 per day**	**kW/m^2**
Southeast Anatolia	14,3	0,477	23,0	0,767	8,5	0,283
Mediterranean	13,9	0,463	21,7	0,723	5,5	0,183
Middle Anatolia	13,7	0,457	21,6	0,72	4,8	0,16
Aegean	13,5	0,450	21,7	0,723	5,0	0,167
East Anatolia	13,4	0,447	20,0	0,667	4,9	0,163
Marmara	10,9	0,363	17,8	0,593	4	0,133
Black Sea	10,3	0,343	15,3	0,51	4,7	0,157

In Turkey, for the present, the solar energy used via water heating collector of 3 million m^2 is 120 Btep per annum, as it is equivalent to 5% of economic potential, and to 500 MW thermal powers by installed collector area.

2.12.3.1 The Solar Potential and Its Feasibility In Turkey

Turkey is geographically located among 36 – 42 ^{0}N latitudes and in solar zone. However, this part of solar zone gets the sunlight adequately, is exposable to the effects of seasonal changes, less in lower, more in higher limits. According to meteorological observations, Turkey's annual period of sunning is 2609 h, as the maximum and minimum values of Turkey's average recorded are, respectively, 362 h in July and 98 h in December. The regions regarding period of sunning can be listed in order as, the Southeast Anatolia by 3016 h, Mediterranean by 2923 h, Aegean by 2726 h, Middle Anatolia by 2712 h, East Anatolia by 2693 h and Marmara by 2528 h, respectively, and minimum values are recorded in Black Sea region by 1966 h. The annual electricity energy on land area of Turkey is calculated 3517 EJ, with respect to sunning periods and values of solar radiation intensity. In other words, the solar energy annually obtained by Turkey is about 80 billion Btep, which is equivalent to 115,5 TW and more than 5300 times of installed capacity of electricity power plants. The obtained amount of solar energy is also equivalent to 1286 times of overall energy consumption, and 32 times of known fossil fuel reserve and 22000 times of oil reserve.

Turkey is geographically located within solar zone. The size of potential of solar energy in regions, excluding Black Sea, is as much as to be seriously considered to utilize. The transformation of solar energy into electricity is feasible, as it can also be utilized in thermal purposes, such as heating of water and house, cooking, drying, cooling, etc. Our country should utilize its high potential of solar energy by intelligence and intensifying technological developments, and should not be just a market for developed countries. Therefore, institutional infrastructure should be formed and required legislations be completed which will provide development and prevalence of solar energy practices. As to efficient and effective solutions regarding

practices and costs, funds should be allocated for the studies and concerning firms should be supported by incentives. In our country, for present, annual energy gain is 120 thousand TEP via 2.5 million m^2 area of installed capacity. The photovoltaic systems are as few as to be neglected, and solar cooling and solar thermal power plants are nonexistent.

2.12.4 Wind Energy

There are no reliable measurements and definite data based on mapped wind atlas regarding energy potential of Turkey. The wind measurements recorded by weather stations for years are regarding climate, as the estimation of wind potential becomes impossible. The energy to be generated by wind depends on its speed, as its mass is small. The speed of wind increases by altitude and its power increases proportionally by its cubic speed. The energy to be generated varies power and blowing hours. Specific wind power is the power per unit plane vertical to air current. The annual average wind speed, in Turkey outside of residence district, at 10 m altitude is 4.5-5.6 m/sec in Aegean and shore sectors, and amongst 3.4-4.6 m/sec in inner sectors. In the regions where annual average wind speed at 10 m altitude is 4-5 m/sec, energy density exceeds 500 W/m^2 at 50 m altitude, where turbines may be installed.

In Turkey, the measurements recorded at Stations of Turkish State Meteorological Service, regarding climate, fails to represent the characteristics of the places where wind power plants to be installed. Therefore, Electrical Power Resources Survey and Development Administration and private sector corporations perform measures regarding energy at regions where important wind potential exists and wind power plant is considered to be installed.

In respect to theorical surveys on wind energy, gross potential of 400 billion kWh per annum and technical potential of 120 billion kWh per annum are estimated in terrestrial areas of Turkey. The gross potential is equivalent to 160.000 MW wind power, as technical potential is equivalent to 48.000 MW. However, the economic

wind potential of Turkey is estimated as 50 billion kWh per annum, and installed wind capacity required for utilization of such potential is 20.000 MW.

The estimations based on satellite data indicate available potential of 8200 MW in shore sectors, majorly the west regions. Today, reliable wind potential of 12.4 billion kWh per annum, proved by measurements is available for utilization, with its approximately 5000 MW installed capacity. The most productive regions are Marmara, Aegean, Mediterranean, and Black Sea, respectively. Besides, it is known that some sectors in Southeast, Middle and East Anatolia are also productive in wind energy. In addition to above listed terrestrial potentials, the technical potential of wind in marine sectors is estimated to excess 60.000 MW. However, there is no available preliminary study regarding economic or technical section of such sectors. In Turkey, for the present, the installed wind capacity is 1.8 MW, as the construction of first power plant with 7.2 MW was commenced. There are 30 applications with total capacity of 700 MW for wind power plant construction, and installed wind capacity of Turkey by 2000 is estimated to be about 500 MW.

2.12.4.1 The Wind Energy Potential and Its Feasibility In Turkey

The demand for energy, especially for electricity, is growing rapidly in Turkey as a result of social and economical development of country. According to the predictions of the Turkish Ministry of Energy and Natural Resources, Turkey needs to increase its electric generation capacity to 60 GW by 2010. It's known that hydroelectric power plants produce 40% of electricity demand of Turkey and the remaining 60% of electricity is produced by thermal power plants mostly based on fossil fuels. Turkey doesn't have large oil and natural gas reserves. Almost all types of oil and natural gas are imported from neighbouring countries. These limited sources force Turkey to search for renewable energy sources. One of the best renewable energy sources for Turkey is wind energy. Due to a change in government policy concerning wind energy, potential wind energy sites are now being investigated. However, the potential sites of wind energy generation of the country have not been completely investigated in detail yet. Although several studies

investigating the wind potential of the Aegean region of Turkey are available, these studies don't cover all sites where a substantial rate of wind power potential are available.

Turkey presently has an economical wind power potential of about 10.000 MW, but progress in wind turbine technology continuously increases. This progress may extend economical wind power potential further. The total installed wind power capacity is 20.1 MW by the end of 2003. According to the projection of the Turkish Electricity Generation and Transmission Cooperation, the installed capacity will reach 60.034 MW by the year 2010. Presently, thermal and hydraulic power plants generate the electricity. Wind power has more advantages compared to the thermal and hydraulic power plants. Environmental pollution is caused mainly by the use of fossil fuels. In this regard, wind energy possesses many advantages and its competitive. The result of present study indicates that wind energy potential in the eastern Mediterranean region is high enough to produce electricity.(Besir Sahin, Mehmet Bilgili, Huseyin Akilli; The wind power potential of the eastern Mediterranean region of Turkey).Electrical Power Resources Survey and Development Administration performed measures in many regions of our country after 1990, and determined the sectors with high potential of wind energy. It is indicated that there exists convenient potentials in the west and north shores and on some hills of inner regions, particularly Karaburun Peninsula, Çanakkale Strait and shores, Southeast and North Anatolia hills.

In 1998, first wind power plant was built in Çeşme district Germiyan village. Presently, four plants each has 500 kW power is operating, as the new ones are just about to be activated and installed capacity of wind energy to reach at 9 MW. Particularly, South Aegean and Thrace regions are convenient regarding facilities, as where annual speed of wind is 6 m/sec. In Aegean Region the average is 8 m/sec in summer, and it is a congenial advantage as energy consumption increases in summer with respect to tourism season. We see wind farms in many regions all over the world. The cost of a wind machine of 500 kWh capacity, including all installation expenditures and insurance premiums and couplings, is $ 600 000. The construction cost of a plant consists of such units and identical to nuclear power plant in Akkuyu

is $ 2,2 billion, as insufficient attention should not be paid to such reality. The installed capacity of wind power is attained 10 000 MW and the new ones are considered to be built. The cost of wind energy is about 4.5 cent per kWh and the annual capacity in our country, theorically, is supposed to be around 160 TWh. Nature wind potential of Turkey is estimated to be 400 billion kWh per annum and technically utilizable potential around 120 billion kWh per annum. Also, the gross electricity consumption of Turkey is estimated to be about 120 billion kWh per annum. Wind farms are practicable along with agriculture and raising livestock, and another advantage of wind energy is practicability of settlement of turbines offshore. There exist only two systems, in Ankara and Çeşme, to produce electricity from wind energy in Turkey. The wind energy potential of Turkey by regions is represented in the following table :

Table 2.11 The wind energy potential of Turkey by regions

REGIONS	AVERAGE POWER INTENSITY (W/m^2)	AVERAGE WIND SPEED (m/sec)
Marmara	51,91	4,3
South East	29,33	3,5
Aegean	23,47	3,3
Black Sea	21,31	3,2
Mediterranean	21,36	3,2
Middle Anatolia	20,14	3,1
East Anatolia	13,19	2,7

2.12.5 Biomass Energy

Biomass energy originates from obtaining energy by photosynthesis. The materials of biomass energy are vegetal and animal products. However, animal production is procured by intensifying vegetal production. Therefore, 1J of animal production requires 7J of vegetal production. Turkey is a convenient country for

production of biomass materials with respect to its characteristics, such as sunning, serviceable fields, water resources, and climate. In Turkey, however, gross potential of biomass related to energy gained by cultural agriculture and photosynthesis excluding food production is calculated as 135-150 Mtep per annum, after the loss are deducted the net value is estimated to be 90 Mtep per annum. But, all of the raising fields of the country are not available for biomass fuel production throughout the year. The technical potential related to probableultimate production is about 40 Mtep per annum. The economic biomass energy potential of Turkey can be assumed as 25 Mtep per annum.

The biomass energy resources are divided into two groups; the first is classical, which consists of firewood and wastes of plant and animals obtained from normal forests. In Turkey, 18.374 tones of firewood and 6.575.000 tones of plant and animal waste are consumed as fuel in 2005, of which energy value is 7024 Btep and equivalent to ¼ of domestic energy production, though this consumption is equivalent to non-economic energy. The second is modern biomass resources, which consists of firewood obtained from energy forests and heat, electricity and synthetic fuel type energy obtained by utilization of energy plants produced for energy raw material and agricultural by-products and wastes by low/high biomass techniques. In Turkey %15 of convenient fields for energy forestry is utilized, as the rest is pending for application. Agriculture for energy and cultivation of energy plants known as C_4 type has not been attempted. Biomass material can be used in biogas production by low technique and in hydrogen production by high technique, as also vegetal oil to be added in diesel fuel and ethanol to be added to gasoline is produced by energy plants cultivation.

The comparison of biomass energy production facilities is represented in the figure below. It seems possible that, in Turkey, biomass energy production can be start from scratch and increased to 5 Mtep per annum and then some.

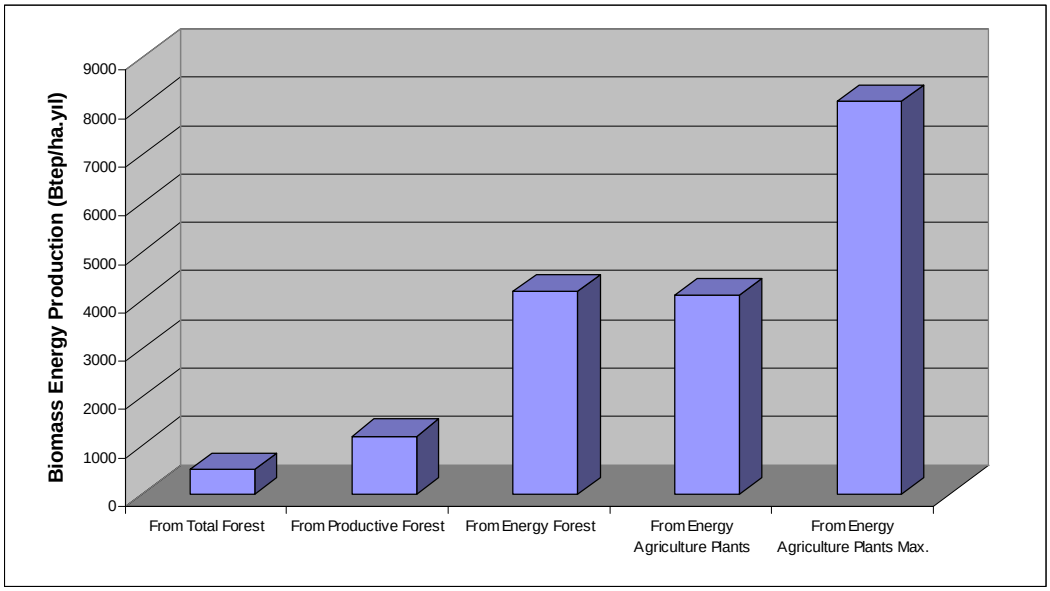

Figure 2.17 The comparison of biomass energy facilities for Turkey

However, Turkey's forested area is 20.2 million hectares; the productive forest area is only 8.9 million hectares. In other words, 44% of forested areas are productive. This ratio is 66% worldwide, as it is 81% in Europe, 72% in Asia, 61% in America, 56% in Middle East. The productive forested areas in Turkey should be increased by upkeep. Turkey's annual firewood production is 18.4 million tones. The production per total forested areas is 0.919 tones/hectares and per productive forested areas are 2.067 tones/hectares. In this respect, the annual energy production per total forested areas is 0.273 Mtep/hectares, and per productive forested areas is 0.620 Mtep/hectares. This annual value in energy forestry by tree types of rapidly growth can reach to 4.25 Mtep/hectares. The feasible energy production can be increased to 38 Mtep per annum by transforming the 60% of non-productive forested areas into type of forests for energy production, as it is equivalent to 32% of energy demand in 2000.

3. RESULT AND DISCUSSION

It is exact that, Turkey will meet huge energy deficit by year 2025. In this section, alternative energy solutions will be found to three energy sources that Oil, Electricity, Natural Gas. Also, these energy solutions will be proven with some numerical calculations.

Turkey's important alternative energy sources are that ;

1. Oil
2. Electricity
3. Natural Gas

3.1 Oil

3.1.1 Increasing vehicles amounts in the Turkey

Table 3.1 Vehicles improvements in the Turkey (1990-2006)

Years	Total	Car	Bus	Truck	Other Diesel
1990	**2 033 956**	1 649 879	63 700	257 353	63 024
1991	**2 273 707**	1 864 344	68 973	273 409	66 981
1992	**2 616 140**	2 181 388	75 592	287 160	72 000
1993	**3 088 850**	2 619 852	84 254	305 511	79 233
1994	**3 346 028**	2 861 640	87 545	313 771	83 072
1995	**3 557 343**	3 058 511	90 197	321 421	87 214
1996	**3 797 721**	3 274 156	94 978	333 269	95 318
1997	**4 132 738**	3 570 105	101 896	353 586	107 151
1998	**4 435 725**	3 838 288	108 361	371 163	117 913
1999	**4 684 416**	4 072 326	112 186	378 967	120 937
2000	**5 064 074**	4 422 180	118 454	394 283	129 157
2001	**5 181 621**	4 534 803	119 306	396 493	131 019
2002	**5 252 265**	4 600 140	120 097	399 025	133 003
2003	**5 366 810**	4 700 343	123 500	405 034	137 933
2004	**5 938 549**	5 224 890	133 347	431 228	149 084
2005	**6 185 267**	5 450 180	137 513	441 758	155 817
2006	**6 415 908**	5 659 688	141 500	452 387	162 332

PETDER (1990-2006)

Table 3.2 Total petrol consumption of Turkey (1000 m^3)

Years	Consumption
1994	4800
1995	5200
1996	6050
1997	5900
1998	6000
1999	5800
2000	4800
2001	4200
2002	4025
2003	3900
2004	3850
2005	3600
2006	3500

PETDER (1994-2006)

Table 3.3 Diesel oil consumption of Turkey (1000 m^3)

Years	Consumption
1994	9000
1995	9500
1996	11000
1997	9000
1998	7800
1999	9500
2000	10500
2001	11000
2002	11100
2003	11800
2004	12500
2005	13000
2006	13500

PETDER (1994-2006)

Table 3.4 LPG Consumption of Turkey (1000 tones)

Years	Consumption
2003	1152
2004	1370
2005	1511
2006	1436

MOGAZ PETROL GAZLARI A.Ş.(2006)

There are three tables has been above. These tables shows increasing fuel amounts by 2006. These three tables change with first table values. Table 3.1 shows 2006 vehicles amounts (4.600.140 Car, 120.097 Bus, 399025 Truck, 5.252.265 Total).

Diesel oil consumption has increased, bio diesel fuel kinds has increased to meet these needs. Other vehicles values are increased but gasoline consumption hasn't changed. Because, LPG is the best alternative to gasoline. Prices comparison has given with following values (09.12.2006).

Auto Gas (Propane + Butane) 1,43 YTL/lt
Petrol (95 Octane) 2,75 YTL/lt

Gasoline is more expensive than LPG (Approximately two times by 09.12.2006; Thus, gasoline consumption is decreasing year by year.)

3.2 Electricity

Electricity consumption is the most important parameter for Turkey. Because, Turkey has serious deficit in Electricity Sector. Thus, renewable energy sources is inevitable way to meet this consumption. These solutions are clean and harmless for environment. In this frame, best choice will be renewables by 2025.

Wind Turbines and PV systems are more useful than others like thermic establishments. Turkey has huge solar regions with 4 solar factor. This situation reminds that, solar systems will be best choice in the future for government.

Following table shows system loads for typical PV application. System calculations, costs and also it's systematical advantages are shown with basic calculations.

Table 3.5 System loads

DC	W		h		Wxh	
ELECTRICAL FAN	30		5		150	
TV	50		4		200	
LAMP	15		6		90	
RADIO	30		2		60	
					500	Wh
AC						
COLOUR TV	90		6		540	
COOKER	800		1		800	
DEEPFREEZE	80		12		960	
					2300	Wh
Total Daily Energy Needs	**2800**	**Wh**				

Calculations :

Total DC + %30 ……. 500 + 150 = **650 Wh**

Total AC + %40 …….. 2300 + 920 = **3220 Wh**

Total Consumption : **3870 Wh**

55 W

SIEMENS SM55 type module 55 W can meet.

Earth Factor is **4** for Turkey conditions.

Productable Daily Energy : 220 W

Total Consumption : 3870 W

4 x 55 : 220 W

19 units must be assemblied.

Battery :

Daily Needs : 3870 Wh

Autonomy Times : 5 days 19350 19350 + %30 (Factor)

25155 Wh (Battery Capacity)

Table 3.6 Cost analysis

Number	Material	Specification	Amount
1	Solar Panel	Polikristal	19
2	Battery	OPzV	24
3	Inverter Charger	DC/AC	1
4	Regulator	Solar Type	1
5	Assembly Materials	Stainless	.....
6	Transport Costs	Under Guarantee	.....

Total : 13.800 Euro……..26.000 YTL

These Energy Needs Can Be Met With Electrical Generator :

Cost Analysis :

Total Energy Needs (Daily) : 2800 Wh …….. 3000 Wh…… 3 kWh

Generator Type **AAP 3500 DC** was choosen.

Table 3.7 Generator Specifications

MODEL - AAP3500DC	
AC NOMINAL POWER	2.8 kvA/2,3 kW
AC MAX.POWER	3 kvA/2,5 kW
AC VOLTAGE	230 V
AC FREQUENCY	50 Hz
NOMINAL CURRENT	10 amper
DC VOLTAGE	12 V
DC CURRENT	8 amper
CYLINDER VOLUME	196 mL
TANK VOLUME	15 lt.
OIL VOLUME	0,6 lt.

Generator Price : 350 Euros…….665 YTL

Fuel Consumption : 1,7 lt./h

Working Time (day) 16 h

27 lt./day

9855 lt./year…….9.855 x 2,7 = 26.600 YTL

Service Cost : 400 YTL

Total : 27.665 YTL

3.3 Natural Gas :

Table 3.8 Natural gas production and consumption in Turkey (in Tcf)

Years	Total Production	Total Consumption
1990	0,007	0,122
1991	0,007	0,15
1992	0,007	0,164
1993	0,007	0,182
1994	0,007	0,194
1995	0,06	0,248
1996	0,07	0,29
1997	0,09	0,346
1998	0,02	0,366
1999	0,026	0,442
2000	0,022	0,524
2001	0,018	0,621
2002	0,014	0,736
2003	0,01	0,872
2004	0,007	1,033
2005	0,003	1,223
2006	0,0018	1,448

* This table shows increasing total consumption of natural gas in the Turkey. Therefore, some measures must be taken.

In 2000, Turkey consumed 524 billion cubic feet (Bcf) of natural gas. Nearly this entire amount was imported and was approximately 17% of Turkey's total energy consumption for the year. In 2002, the amount of the natural gas consumed reached around 700 Bcf. Owing to severe economic problems in the last few decades, in addition to fluctuating prices before Turkey's recent severe economic meters, the Turkish natural gas was anticipated to increase excessively rapidly over the next years, with the most important consumers anticipated to be natural-gas-fired electric power plants and industrial users.

Natural gas is Turkey's chosen fuel for new power plant capacity development due to several requirements. These are firstly for environmental reasons because gas is less polluting than coal, lignite, or oil; secondly, for geographic reasons because Turkey is close to very large amounts of gas in the Middle East and Central Asia; and thirdly, for economic reasons because Turkey could balance part of its energy import bill through transit fees it could charge for oil and gas shipments across its territory and seas; and lastly, for political reasons because Turkey is looking to develop strong relations with Caspian and Central Asian countries, some of which are naturally very big gas exporters.

Table 3.9 Sectoral natural gas demand in Turkey

	Electricity	%	Industry	%	Household	%	Total
2000	9,73	67	2	13,11	2,8	19	14
2001	10,99	69	2,06	12,85	2,85	17,77	15,9
2002	11,63	66,91	2,27	13,06	2,97	17,08	16,87
2003	13,51	61,4	3,01	13,68	3,94	17,9	20,46
2004	19,49	64,98	5,16	17,2	4,81	16,03	29,46
2005	19,41	61,79	6,16	19,61	5,31	16,9	30,88
2006	21,86	48,06	14,1	31	9,22	20,27	45,18

Table 3.9 proves sectoral share of natural gas demand in Turkey. It's exact that, electricity increasing is bigger than others. (Industry And House Hold Demand)

3.4 The Prediction of Vehicles and Oil of Turkey (Until 2025)

Table 3.10 shows predictions of vehicles amount by 2025. It's exact that, oil needs change with this prediction.

Table 3.10 The prediction of increasing vehicles amounts in the Turkey

Years	Total	Car	Bus	Truck	Other Diesel
1990	**2 033 956**	1 649 879	63 700	257 353	63 024
1991	**2 273 707**	1 864 344	68 973	273 409	66 981
1992	**2 616 140**	2 181 388	75 592	287 160	72 000
1993	**3 088 850**	2 619 852	84 254	305 511	79 233
1994	**3 346 028**	2 861 640	87 545	313 771	83 072
1995	**3 557 343**	3 058 511	90 197	321 421	87 214
1996	**3 797 721**	3 274 156	94 978	333 269	95 318
1997	**4 132 738**	3 570 105	101 896	353 586	107 151
1998	**4 435 725**	3 838 288	108 361	371 163	117 913
1999	**4 684 416**	4 072 326	112 186	378 967	120 937
2000	**5 064 074**	4 422 180	118 454	394 283	129 157
2001	**5 181 621**	4 534 803	119 306	396 493	131 019
2002	**5 252 265**	4 600 140	120 097	399 025	133 003
2003	**5 366 810**	4 700 343	123 500	405 034	137 933
2004	**5 938 549**	5 224 890	133 347	431 228	149 084
2005	**6 185 267**	5 450 180	137 513	441 758	155 817
2006	**6 415 908**	5 659 688	141 500	452 387	162 332
2007	**6 643 701**	5 866 586	145 531	462 922	168 663
2008	**6 894 425**	6 095 021	150 063	474 245	175 096
2009	**7 144 810**	6 324 199	154 449	485 067	181 094
2010	**7 386 907**	6 546 877	158 494	495 036	186 500
2011	**7 622 171**	6 763 433	162 416	504 541	191 780
2012	**7 865 233**	6 986 006	166 582	515 001	197 644
2013	**8 115 977**	7 214 048	171 079	526 563	204 286
2014	**8 369 027**	7 444 625	175 615	538 059	210 728
2015	**8 648 002**	7 699 020	180 607	550 667	217 708
2016	**8 918 397**	7 946 260	185 290	562 526	224 321
2017	**9 164 193**	8 171 313	189 430	573 136	230 315
2018	**9 379 495**	8 367 973	193 201	582 443	235 877
2019	**9 631 648**	8 598 623	197 608	593 473	241 943
2020	**9 885 787**	8 831 166	202 034	604 522	248 066
2021	**10 139 471**	9 063 191	206 443	615 594	254 243
2022	**10 391 297**	9 293 333	210 826	626 666	260 472
2023	**10 643 911**	9 524 011	215 250	637 860	266 791
2024	**10 897 443**	9 755 453	219 705	649 129	273 155
2025	**11 150 624**	9 986 686	224 140	660 335	279 463

Table 3.11 The prediction of petrol consumption of Turkey (1000 m^3)

Years	Consumption
1994	4800
1995	5200
1996	6050
1997	5900
1998	6000
1999	5800
2000	4800
2001	4200
2002	4025
2003	3900
2004	3850
2005	3600
2006	3500
2007	3403
2008	3305
2009	3207
2010	3115
2011	2733
2012	2549
2013	2364
2014	2180
2015	1996
2016	1812
2017	1627
2018	1443
2019	1259
2020	1074
2021	890
2022	706
2023	522
2024	337
2025	153

Table 3.12 The prediction of diesel oil consumption of Turkey (1000 m^3)

Years	Consumption
1994	9000
1995	9500
1996	11000
1997	9000
1998	7800
1999	9500
2000	10500
2001	11000
2002	11100
2003	11800
2004	12500
2005	13000
2006	13500
2007	14020
2008	14560
2009	15120
2010	15700
2011	15598
2012	16033
2013	16468
2014	16903
2015	17338
2016	17773
2017	18208
2018	18643
2019	19078
2020	19513
2021	19948
2022	20383
2023	20818
2024	21253
2025	21688

Table 3.13 The prediction of LPG consumption of Turkey (1000 tones)

Years	Consumption
2003	1152
2004	1370
2005	1511
2006	1436
2007	1400
2008	1430
2009	1480
2010	1540
2011	1575
2012	1610
2013	1646
2014	1682
2015	1717
2016	1753
2017	1788
2018	1824
2019	1859
2020	1895
2021	1930
2022	1966
2023	2002
2024	2037
2025	2073

3.5 The prediction of electricity demand & consumption of Turkey

Table 3.14 shows spent fuel amounts for electricity energy production until 2025. It's exact that some serious energy deficits will be occur. Finally, this study proof that , Turkey will apply to Renewable Energy Sources.

Table 3.14 The prediction of natural gas production and consumption of Turkey (Until 2025,in Tcf)

Years	Total Production	Total Consumption
1990	0,007	0,122
1991	0,007	0,15
1992	0,007	0,164
1993	0,007	0,182
1994	0,007	0,194
1995	0,06	0,248
1996	0,07	0,29
1997	0,09	0,346
1998	0,02	0,366
1999	0,026	0,442
2000	0,022	0,524
2001	0,018	0,621
2002	0,014	0,736
2003	0,01	0,872
2004	0,007	1,033
2005	0,003	1,223
2006	0,0018	1,448
2007	**0,0014**	**1,714**
2008	**0,0011**	**2,028**
2009	**0,0009**	**2,399**
2010	**0,0005**	**2,837**
2011	**0,0003**	**2,8122**
2012	**0,0001**	**3,0524**
2013	**0,00009**	**3,2926**
2014	**0,00006**	**3,5328**
2015	**0,00004**	**3,773**
2016	**0,00001**	**4,0132**
2017	**0,000009**	**4,2534**
2018	**0,000007**	**4,4936**
2019	**0,000005**	**4,7338**
2020	**0,000003**	**4,974**
2021	**0,000001**	**5,2142**
2022	**0,0000009**	**5,4544**
2023	**0,0000007**	**5,6946**
2024	**0,0000005**	**5,9348**
2025	**0,0000003**	**6,175**

* This table shows prediction of increasing total consumption of natural gas in the Turkey. Therefore, some measures must be taken.

3.6 Natural Gas

In 2000, Turkey consumed 520 billion cubic feet (Bcf) of natural gas. Nearly this entire amount was imported and was approximately 17% of Turkey's total energy consumption for the year. In 2002, the amount of the natural gas consumed reached around 700 Bcf. Owing to severe economic problems in the last few decades, in addition to fluctuating prices before Turkey's recent severe economic matters, the Turkish natural gas was anticipated to increase excessively rapidly over the next years, with the most important consumers anticipated to be natural-gas-fired electric power plants and industrial users.

Natural gas is Turkey's chosen fuel for new power plant capacity development due to several requirements. These are firstly for environmental reasons because gas is less polluting than coal, lignite, or oil; secondly, for geographic reasons because Turkey is close to very large amounts of gas in the Middle East and Central Asia: and thirdly, for economic reasons because Turkey could balance part of its energy import bill through transit fees it could charge for oil and gas shipments across its territory and seas; and lastly, for political reasons because Turkey is looking to develop strong relations with Caspian and Central Asian countries, some of which are naturally very big gas exporters.

4. CONCLUSION

In Turkey, especially increasing vehicle amount will cause to oil and oil products crisis. Also, some Electricity crisis will come quickly. Because, unconsciously using is increasing. It can be met with alternative energy sources like wind energy, solar energy and bioenergy. Renewable Energy Sources will be most common choice by 2025. Natural Gas import amounts will be increasing. Finally, this situation will cause to serious economic problems.

Oil and Gas together account for more than 60% of the growth in energy demand between now and 2025.

Vehicles & Fuels by 2006

1. Total Vehicles Amount is 6.415.908
2. Total Petrol Consumption is 3.500.000 m^3
3. Total Diesel Oil Consumption is 13.500.000 m^3
4. Total LPG Consumption is 1.436.000 tons

The prediction amounts of vehicles & fuels by 2025

1. Total Vehicles Amount is 11.150.624
2. Total Petrol Consumption is 150.000 m^3
3. Total Diesel Oil Consumption is 21.688.000 m^3
4. Total LPG Consumption is 2.073.000 tons

Natural Gas Needs by 2006

Total Natural Gas Needs are 1.448 10^9 cubic feets

The prediction amounts of natural gas by 2025

Total Natural Gas Needs are 6.175 10^9 cubic feets

Total requirement – Domestic Production Differences is increasing. Thus, energy deficit is inevitable. It will reach to 310 Mtep by 2025.

Some serious energy needs problems wait Turkey like Oil, Natural Gas and Electricity. In Turkey, especially increasing vehicle amount will cause to oil and oil products crisis. Also, some electricty crisis will come quickly. Because, unconsciously using is increasing. It can be met with alternative energy sources like wind energy, solar energy and bio energy. Renewable Energy Sources will be most common choice by 2025.

The government should; Take all necessary steps as soon as possible to implement the new competitive power market.

In particular; Seperate TEAŞ vertically as soon as possible. Unbundle distributors accounts for distribution and retailing, and separate DSİ's accounts for hydro power activities from irrigation activities, to enhance cost transparency. Establish an independent regulator and independent system operators. Prevent any delays in the introduction of competition. Take measures to ensure a smooth transitional period. Seperate the competitive market from the captive market during the transition period.

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