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## SELECTED ASPECTS FROM GENERAL ENERGY PERSPECTIVE OF TURKEY

As known fossil fuels sustain its domination at energy sector at least up to 2030, carbon emissions are still in a trend of rise. Since the nuclear energy decreases carbon emissions at electricity production, it is being come up with its front. Renewable energy resources make supplements to energy sector by helps of new technologies. The present paper aims to illustrate the influence of the main factors which affect the of presence energy production and consuming in Turkey.

Keywords: **Energy consuming, energy demand, fossil fuel reserves**

### 1. Energy consuming, energy demand

By the end of 2005, the world has had the primary energy consuming as 11.430 billion tons equivalent petrol (TEP) which share petroleum is 28%, natural gas is 23%, nuclear energy is 6% and hydraulics is 7% at the primary energy consuming. The International Energy Agency informs that global energy demand will increase to the rate of 60% with a rate of 1.7% until to 2030 and the fossil fuel reserves will be able to meet to the demand. Fossil resources will continue to keep its vitality at the world's energy demand in the future as it keeps today (Table 1) [1].

Table 1. Consumption of fossil resources in the world

	Share of consumption (%)	Proven reserves	Duration to meet the need (year)
Petroleum	36	163.6 billion tons	40.6
Natural gas	23	179.83 trillion m <sup>3</sup>	65.1
Coal	28	1 trillion tons	200

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The petroleum will keep its feature that it is the most consumed energy at the period. The natural gas will become an energy resource in which it will have the most increase in demanding. The energy demand at past has been originated from the developed countries mostly. Nowadays, China and India also have participated to those countries.

While world's petroleum consumption was 84.7 million barrels, it is being expected that it would become 97 million barrels/days in 2015, and 118 million barrels/days in 20130. It is being expected that the production of natural gas of the year 2000 will be two folds of 2080 Mtep in 2030 by high demand of West Europe. Rapid industrialization and the increased environmental pollution have raised the demand to natural gas since the second half of 20th century. Nowadays, the world is in an addicted to natural gas. The estimated coal reserve is 1 billion; it is a kind of a hydrocarbon that its consumption has increased rapidly. World coal consumption has been 3177.5 MTEP in 2007. Total energy consumption which is obtained from hydraulic resources is 709.2 Mtep at the world. As of 2007, the 442 nuclear units are being operated worldwide, and total installed power is 370.000 MWs. Nuclear energy plants meet the needs of world electricity up to 15% [2].

It is being estimated that the world's primary energy supply would attain to 16.500 billion TEP in 2030. In this supply, it is being estimated that petroleum would take a share of 35%, natural gas would take a share of 24%, coal would take a share of 22%, renewable energy resources would take a share of 12%, nuclear would take a share of 5%, hydraulic resources would take a share of 2%. The Middle East has the biggest reserves at petroleum, the Middle East and Central Asian Countries have the biggest reserves amongst the fossil fuel reserves in the world. The Table 2 shows that periods of fossil fuel reserves to be used as years.

Table 2. Periods of world fossil fuel reserves to be used: (Year)

<b>Region</b>	<b>Petroleum</b>	<b>Natural</b>	<b>Coal</b>
North America	12	10	231
Central and South America	41	52	269
Europe and Eurasia	22	60	241
Middle East	81	100	399
Africa	32	88	270
Asia and Oceania	14	41	92
Total world	41	65	200

Energy consumption forces Turkey's industrial growing. Turkey is one of the leader country by means of the growing economy. As result of this Turkey's industry, business, and general economy are one of the highest growing in the world amongst the developing countries [8].

## 2. Energy needs of Turkey

The 72% of producible energy reserves of the world take places in geography close to Turkey. Our country is one important neighbor of the countries which have the proven petroleum and natural gas reserves in the world. Turkey keeps a natural energy corridor between Caspian, Central Asia, Middle East countries and consumer markets in Europe.

Turkey is a developing country and having the increased population. Turkey is also such a country which its energy and electricity consumptions increase rapidly. The 0.9% of world primary energy consumption is being consumed in Turkey solely. We cannot say that Turkey hasn't got yet significantly energy consumption worldwide. The primary energy consumption of our country has been realized as 27.4 million TEP in 2007. When we look at distribution of energy production based upon the resources, we see that the lignite has a share of 49%. Our primary energy consumption has been as 107.6 million TEP in 2007. The energy consumption has been realized as petroleum 31%, natural gas 31%, anthracite (pit coal) 15% and lignite 12% in 2007.

The figures below (a) shows the map of electricity grid of Turkey, (b) a picture of newly constructed hydroelectric dam and (c) a section which was taken from the national grid.



Fig. 1. (a) Turkey national grid map, (b) Caykara hydroelectric dam, (c) Towards to green energy lines

Our country's petroleum and natural gas reserves are extremely restricted, vice versa coal reserves are high as amount. Nevertheless most of our coal reserves are scattered as geographical, are removed from mines as low quality, high cost, and with environmental problems. Our hydraulic resources are not enough within a long-term. By means of those reasons, we can say that Turkey

is addicted to outside. Therefore, the money paid to energy import is being increased. This amount is increased to \$ 35 billion in 2008.

Energy sector is a sector that it requires an investment 130 billion dollars until to 2020. The needed investments will be made by the private sector as much as possible the legal arrangements are made.

### **3. Primary energy production and consumption in Turkey**

Though Turkey is not enough in terms of primary energy resources, our country has got important self-resources in terms of lignite and hydroelectricity. The most important energy resource of Turkey is the lignite reserves in Elbistan. Our country's coal reserve, geothermal and hydraulics potential are about 1% of world resource presence. The potential of 130.000 GWh/year at hydraulics energy is being used approximately 65%. The other renewable resources' share is 1% within total energy consumption [3].

The lignite has an important share amongst the energy resources which Turkey has. The 1.6% of world total lignite reserves are being obtained in our country. Unfortunately, the calorific value of 69% reserves are less than kCal/kg; the calorific value of % 29 reserves are in between 2000–4000 kCal/kg and % 2 reserves are 4000 kCal/kg. Since the calorific values our lignite reserves are low, the huge amount of them is being used as thermic plant's fuel.

The most important lignite areas are Afşin–Elbistan, Yatağan–Muğla, Soma–Manisa, Tunçbilek–Seyitömer–Kütahya, Beypazarı–Ankara and Sivas basins. The lignite production in 2007 has been realized as 72 million tons and its share in total energy consumption has been occurred as 12%. The installed power of thermic plant stations based upon lignite is 8211 MWs and this is corresponded to the 20% of total installed power according to data of 2007.

The anthracite reserve of our country is 1.33 billion tons. The rich coal resources (anthracite) of Turkey extend along the coastline from Ereğli to Amasya. It is known that there are coal reserves around Taurus and Diyarbakır too. In Turkey, 2.5 million tons of anthracite has been produced, 23 million tons has been imported in 2007. It is expected that production of anthracite would rise to 4.7 million tonnes, and anthracite import would become as 128 million tonnes in 2020. The anthracite are being consumed approximately 20% in iron-steel industry in Turkey.

Annual petroleum production of Turkey has been realized 2.2 million tons in 2007. Our country's petroleum consumption is about 32 million tons. It is expected that it would reach to 69 million tonnes in 2020. As far as the known petroleum regions concerned, it is considered that 41 million tons producible petroleum are waited for taking from the ground. Therefore, it is seen that petroleum import keeps a significant increase. Turkey imports petroleum from Saudi

Arabia, Iraq, Iran, Russia and Syria. Turkey operates two different pipe-lines between Iraq–Turkey and Baku–Tbilisi–Ceyhan.

The 2007 year's natural gas production of Turkey has been realized as 900 million m<sup>3</sup>. Since domestic production is not enough, Turkey imports natural gas from 1987 to the date, from Russia dominantly, and other countries as rising amounts. 36 billion m<sup>3</sup> natural gas have been imported in 2007. The 54% of the consumed natural gas was used in electricity plants, 23% of the consumed natural gas was used at homes, and 23% of the natural gas was used in industry. Since 1988, natural gas is being used in heating houses and for electricity production in industry, in Ankara; since 1992, it is being used in Istanbul, Bursa, Eskişehir and Izmit cities. At the end of 2009, using natural gas in our country is being expanded to all over Turkey, with extending 10.000 km natural gas distribution lines.

In our country there are several natural gas pipelines projects such as “Şahdeniz, Egypt–Turkey, Iraq – Turkey, Turkey–Greece, Turkey–Greece–Italy and Turkey–Austria”. Hence, it is being aimed that gas to be produced in resources of Caspian and Middle East would be moved to Central and West Europe countries together with transit countries.

As of the year 2007, Turkey's installed power is about 40.836 MWs. It is being expected that our country's electricity demand would become about 500 billion kWh in 2020. This needs to have a 96.000 MWs installed power as well. Turkey produced its electricity as 50% from natural gas, as 28% from coal, as 19% from hydraulics, and as 3% from liquid fuel in 2007. Turkey still needs to have new plant investments about \$ 17.7 billion until to 2020.

Turkey has a share of 1.53% hydroelectric potential at world. However hydroelectric production is beneath some countries such as Norway, France, Sweden and Italy, its economic potential comes at the second order after Norway. The hydroelectric energy met to 19% of total electricity energy of Turkey in 2007. As of the year 2007, Turkey's presence installed hydraulic power is 13.418 MWs, and there is still 34.000 MWs hydroelectric potential which waits for progressing.

As of the year 2020, the 85% of economic hydroelectric potential will be installed. It is being expected that Turkey's electricity energy demand would attain to 500 TWh, and at least 25% of this would produce by means of hydroelectric potential's progress in 2020.

#### **4. Other, ecological energy resources**

Bio-mass energy comes at beginning of resources which might be used for providing energy without environmental pollution. Corn, wheat, herb, grass, moss, sea algae, animal droppings, manure and industrial wastes (fruit and vegetable residues) are main resources for bio-mass. These resources compose 5% of

primary energy consumption and 35% of energy consumptions at houses. Bio-mass which is main origin of plants and live microorganisms generally stores sun energy by photo-synthesis. During energy producing from bio-mass, environment will be kept in terms of CO<sub>2</sub> release. Plants are not only food resource but also environment-friendly inexhaustible sources of energy. Turkey's bio-gas potential is 8.6 million TEP, 6 million TEP of this is being used for heating aims. Turkey's bio-gas production potential is being estimated as 1.5–2 billion m<sup>3</sup>/year. Turkey takes place within the countries which they are luckiness in terms of geothermal energy. Turkey has got more than 600 which their temperatures reach up to 100 °C.

House and green-house heating based upon geothermal energy in Turkey develops rapidly. According to datas of Research Institute of Mining Etude and Research (MTA), Turkey's proven thermal capacity 3.348 MWs. Our possible geothermal potential is 31.500 MWs. In 2007, supplement of geothermal energy to total primary energy resources supply has been 1 million TEP.

In Turkey, 20 firms got their licences for producing electricity from geothermal yet; 7 of these installed electricity production plant; the 16 new licence applications have been taken to examination as well. Turkey's installed power capacity is almost 465.69 MWe; 114.2 MWe power is being obtained from the geothermal plants which are at operations. When the 16 licence applications result, a 327.95 MWe power supply will emerge.

Our country is lucky one regarding to sun energy potential in terms of geographical position than the others. Turkey's technic sun energy potential is about 76 MTEP. It has been calculated that yearly total sunshine duration would become 2640 hours (daily 7.2 hours), sun energy density would become 3.6 kWh/m<sup>2</sup> according to studies made by Renewable Energy General Directorate of Turkey.

Sun energy collectors are being widely used for heating water at South and West regions of Turkey. There are already 12 million m<sup>2</sup> installed collector areas and it is being expected that these areas would increase up to 35 million m<sup>2</sup>.

Where the electricity transmitting isn't presence, there are photo voltaic applications bigger than 1500 kW. Increase at utilities of photo voltaics are being expected in Turkey by cost decrease and efficiency rise.

Wind speed must be 7 m/s or greater than this value for an economic wind energy plant. It has been identified that yearly mean value of wind speed for 50 meters height from sea level is 8.5 m/s and wind energy potential for the heights which are more than 50 meters is at least 4.800 MWs. It is being seen that the huge amounts have been made at wind energy investments in Turkey. Today, wind plant stations' installed power connected to the grid is over 400 MWs.

Hydrogen is the most basic and the most abundant element of the universe; it is colorless, odorless, 14.4 times lighter than air, and completely non-toxic gas. It is also fundamental energy resource of the universe. Hydrogen (H<sub>2</sub>) gas is

stored as liquefying at  $-253^{\circ}\text{C}$ . Hydrogen is found as in compounds at nature. Its most known compound is water.

Apart water vapors, none of gas which pollutes environment and increases green-house effect and harmful chemicals are not produced during obtaining energy from hydrogen. Even though hydrogen gas is obtained by different methods, it is able to be produced from wind, wave, and bio-mass as well.

There is a progress trend in fuel-cell technology in which hydrogen is used as fuel at world. Hydrogen fuel-cells are used not only for mobile applications such as portable computers, cell phones, but they are also suitable energy suppliers for electricity plant stations.

Last 2 decades, nuclear energy has been mostly discussed subjects at our country's energy sector. As of the year 2007, there are 442 nuclear power stations and the installed power meets the 15% of world electricity needs. There are almost 76 nuclear reactors in 11 countries which are located around Turkey.

Akkuyu Nuclear Power Stations will be constructed near to Mediterranean Coast in Mersin city. A contract regarding to constructing and operating a nuclear power station at Akkuyu region between Turkey Republic and Russia Federation Government has been signed on the 12th of May 2010 in Ankara. The power station consists of 4 power units which each of them has 1200 MWe. When Akkuyu NPS is constructed, it is planned that 35 billion kWh electricity energy would be produced approximately at 1 year. The Fig. 2 shows the nuclear power stations to be build in Turkey [6].



Fig. 2. Sinop and Akkuyu nuclear power stations

## 5. Energy efficiency

Energy efficiency means that it prevents energy losses, it valorizes or re-gain every waste, or it decreases energy consumption without declining quality and performance by using new technologies. Energy efficiency is a kind of tool that it represents the primary energy amount consumed per domestic gross product and it is used for persuading and comparing energy efficiencies at world. To

ensure energy efficiency; it is necessary to avoid the energy losses in gas, steam, heat, air, and electricity; to recycle, and to evaluate a variety of waste; to reduce energy demand and the need, to lower output by advanced technology. It is generally presented as consumed TEP amount per \$ 1.000 domestic gross product. The below Table 3 shows Turkey's electricity consuming between the years of 1999 to 2012.

Table 3. Periods of world fossil fuel reserves to be used: (Year)

Years	<b>1999</b>	2000	2001	2002	2003	<b>2004</b>	2005
Consumption (MWh)	<b>91.20</b>	98.30	97.07	102.95	111.77	<b>121.14</b>	130.26
	2006	2007	2008	<b>2009</b>	2010	2011	2012
	144.09	155.14	161.95	<b>156.89</b>	162.23	166.78	172.14

As seen from Table 3, Turkey's energy consumption has been realized as 91.20 MWh in year of 1999. In terms of 5 years periods, it has been seen as 121.14, and 156.89 respectively in 2004 and 2009. In the year of 2012, it is seen that the electrical consumption grow till to 172.14 MWh.

What energy efficiency is low in a country means that the consumed energy per domestic gross product is low, as result of this it is meant that energy is used as efficient [4]. Turkey's energy density is 2 fold of OECD average, and energy consumption per person is still around 1 over 4 of OECD average.

## 6. Conclusions

The energy density concept is the most reliable and accurate parameter in definition of the development. Development can be measured by creating more economic value with using less energy. The main indicator is to reduce energy density in using energy efficiently. Our country's average energy consumption per capita is about 1/5 of the ratio in OECD countries. Energy density is about two fold of the OECD average. Despite the works done, our country's energy density has not been declining trend. According to data from the International Energy Agency, the energy density of the developed countries is between 0,09 to 0,19 but our country is 0,38. To ensure efficient use of energy in Turkey, the Energy Efficiency Law No. 5627 came into force and published in Official Gazette dated May 2, 2007.

In our country, there is an energy savings potential of around 20-30% in the industries which use energy intensively. The goal is to reduce Turkey's energy density as of 15% until the year 2020. For this the various measures are taken for energy efficiency in the buildings' heating & cooling, lighting and appliances, household appliances, transportation and in the industrial sector.



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## WYBRANE ZAGADNIENIA DOTYCZĄCE PERSPEKTYW ENERGETYCZNYCH TURCJI

### Streszczenie

Jak wiadomo, paliwa kopalne utrzymać będą swoją dominację w sektorze energetycznym, co najmniej do roku 2030. Emisja dwutlenku węgla nadal, więc będzie posiadać tendencje wzrostowe. Zastosowanie energii jądrowej zmniejsza emisję dwutlenku węgla podczas produkcji energii elektrycznej, a zatem jej udział na rynku powinien się zwiększać. Dzięki wykorzystaniu nowych technologii źródła odnawialne mogą być uzupełnieniem w sektorze energetycznym. Niniejszy artykuł ma na celu przedstawienie głównych czynników wpływających w Turcji na produkcję i konsumpcję energii.

**Słowa kluczowe:** energochłonność, zapotrzebowanie na energię, rezerwy paliw kopalnych

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