THE IMPORTANCE OF RENEWABLE ENERGY SOURCES IN TURKEY

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Abstract

Turkey is rapidly growing in terms of both its industrial production and population. Parallel to this, its demand for energy is amounting fast. Energy is one of Turkey's most important development preferences. Today, Turkey's energy necessity is fundamentally dependent on oil, natural gas, and electricity. On the other hand, Turkey's energy production meets only 30% of its total energy consumption and thereby is an energy importing country. On the other hand, Turkey has a large potential for renewable energies. The renewable sources in Turkey are solar, wind, biomass, hydro, solar and geothermal.

Most of Turkey's production facilities are based on fossil fuels. However, every year, Turkey has to meet a great burden to meet the costs of importing fossil fules and the costs of the damages that occur in the environment by the utilization of fossil fules and their byproducts which is environmetal degredation. Besides, Turkey is an abundant country with respect to renewable energy sources and could benefit considerably by the utilization of this green type enrgy. Moreover, the implementation of renewable energy technologies can lower the current national and global environmental problems as well as secure energy necessities of Turkey associated with the production and use of fossil energies. Therefore, the objective of this study is to present the energy situation and potential of the renewable energy sources in Turkey as well as associate these factors with the environmental issues.

Keywords: *Energy, Renewable Energy Sources, Turkey.*

JEL Classification: **O-13, Q-20, Q-27, Q-43.**

1. INTRODUCTION

People have been presented only a choice between conventional fossil fuels and nuclear power. This, however, is a false choice. Renewable energy can reliably generate as much energy as conventional fuels, and can do so without producing carbon emissions or radioactive waste.

By definition, renewable energy is abundant and constantly replenished. It includes energy from the sun, earth and wind. Most renewable energy comes either directly or indirectly from the sun. Sunlight intercepted by the earth provides renewable solar energy that can be used to generate electricity, provide heat and light. The sun's heat also drives the earth's winds. The earth's rotation and topography combine to produce predictable wind patterns that can be used by large wind

turbines to generate electricity. Biomass is defined as any plant or animal matter used to produce electricity, heat or transportation fuels. Hydropower relies on capturing the energy in flowing water, which is linked to the sun through the hydrological cycle- water evaporation from the oceans turns into clouds and later condenses, falling as rain. The ocean itself can produce energy from the action of the waves and tides, based on the gravitational pull of the sun and moon. Geothermal energy uses the internal heat of the earth to generate electricity, as well as more direct uses such as spas and greenhouses.

When we analyze the situation with respect to Turkey, Turkey's renewable energy sources are plentiful and extensive and represent the second-largest domestic energy source after coal. Primary renewable energy resources in Turkey are: hydro, biomass, wind, biogas, geothermal and solar. Similar to other industrializing countries, with the increases in energy consumption and economical growth, energy related environmental problems are rapidly growing in Turkey. In 2003, it is estimated that 36 % of CO2 emissions occurred due to energy, 34 % due to industry, 15 % due to transportation and 14 % due to other sectors such as housing, agriculture and forestry and in 2020 40 % will occur due to energy, 35 % due to industry, 14 % due to transportation and 11 % due to other sectors. To control these problems for sustainable development, energy related policy should be well determined (Koyun, 2007). The aim of this paper is to present the energy situation and potential of the renewable energy sources in Turkey as well as associate these factors with the economy and environment.

2. RENEWABLE ENERGY

Renewable energy is derived from resources that, for all practical purposes, cannot be depleted and produce fewer pollutants. This makes renewable energy fundamentally different from fossil fuels and has prompted many countries, including Turkey, to promote its use through incentive and subsidy schemes.

The benefit from greater exploitation of these sources would be enormous: (i) reduced reliance on imported fuels (increased energy security); (ii) decreased environmental impact compared to fossil fuel and nuclear power plants (i.e. no greenhouse gas emissions (except biomass and biogas) or toxic waste); (iii) competitive costs (which are still decreasing) compared to many conventional technologies; and (iv) no fuel costs (except biomass and biogas) and virtually inexhaustible fuel sources(Guner Law Office, 2008).

Renewable energy which stems from natural sources such as sun light, wind, rain, wave, water and geothermal heat sustains itself and does not contaminate the environment. When we look at the kinds of renewable energy, we see that solar energy, wind energy, biomass energy and moving water in generally.

In fact, sunlight is an excellent source of heat and electricity, the two most important forms of energy we consume. Solar energy is becoming increasingly popular for remote power needs such as telecommunication towers, agricultural applications (irrigation and pasture management), in tropical countries that are not connected to an electrical grid, for heating swimming pools, and many other applications around the world. Wind energy is really just another form of solar energy. Sunlight falling on oceans and continents causes air to warm and rise, which in turn generates surface winds. More recently, wind has been harnessed as a clean, safe source of electricity. The term "biomass" refers to any form of plant or animal tissue. In the energy industry, biomass refers

to wood, straw, biological waste products such as manure, and other natural materials that contain stored energy. The energy stored in biomass can be released by burning the material directly, or by feeding it to micro-organisms that use it to make biogas, a form of natural gas. Energy from biomass is still used around the world, for everything from cooking and heating to generating electricity. Today, the energy of falling water is used mainly to drive electrical generators at hydroelectric dams. As long as snow and rainfall can fill the streams and rivers, moving water can be a renewable source of energy.

In recent years, we have seen large fluctuations in the cost of natural gas, oil, and electricity due to global economics, market deregulation, and political events in some parts of the world. Renewable energy is not subject to sharp price changes because it comes from sources such as sunshine, flowing water, wind, and biological waste, all of which are free. This gives people greater certainty about the cost of energy, which is good for society and the economy. By comparison, fossil fuels are limited in their supply, and their price will increase as they become scarcer.

When fossil fuels are burned, they release carbon dioxide. This gas acts like an invisible blanket, trapping more of the sun's energy in the atmosphere, causing the Earth to warm up little by little. Carbon dioxide is building up in the atmosphere as more and more fossil fuels are used in homes, factories, and automobiles. If this continues, most scientists think our planet is likely to become significantly warmer, which could cause many serious problems around the world.

The importance of energy in economic development has been recognized almost universally; the historical data attest to a strong relationship between the availability of energy and economic activity. During the past two decades the risk and reality of environmental degradation have become more apparent. Growing evidence of environmental problems is due to a combination of several factors; the environmental impact of human activities has grown dramatically because of the sheer increase of world population, consumption, industrial activity, etc. Achieving solutions to the environmental problems that are faced today requires long-term potential actions for sustainable development. In this regard, renewable energy resources appear to be one of the most efficient and effective solutions, which is why there is an intimate connection between renewable energy and sustainable development (Dincer, 2004).

3. RENEWABLE ENERGY IN TURKEY

Currently electricity is mainly generated in Turkey using thermal power plants which consume coal, lignite, natural gas and fuel oil, geothermal energy and hydro power plants. Turkey has no large oil and gas reserves. The main indigenous energy resources are lignite, hydro and biomass. Accordingly, Turkey has to adopt new, long-term energy strategies to reduce the proportion of fossil fuels in primary energy consumption. Turkey has also taken another recent step which is consistent with its current long-term energy strategies by announcing that it will sign up to the Kyoto Protocol. By doing so, Turkey will commit to cut greenhouse gas emissions, demonstrating its commitment to "clean" technology The development and use of renewable energy sources and technologies is increasingly becoming vital for the sustainable economic development of Turkey. The most significant developments in renewable production have been observed in wind, hydropower and geothermal energy production.

Turkey's demand for energy and electricity is increasing rapidly and heavily dependent on expensive imported energy resources that place a big burden on the economy. As would be

expected, the rapid expansion of energy production and consumption has brought with a wide range of environmental issues at local, regional and global levels. Air pollution, for example, is becoming a great environmental concern in the country. With respect to global environmental issues, Turkey's carbon dioxide emissions have grown along with its energy consumption. States have played a leading role in protecting the environment by reducing emissions of greenhouse gases (GHGs). In this regard, renewable energy resources appear to be the one of the most efficient and effective solutions for clean and sustainable energy development in Turkey. Turkey's geographical location has several advantages for extensive use of most of these renewable energy sources (Kaygusuz, 2007).

Turkey is a rich country from the point of variety and potential of renewable energy resources. It has the 8 % of the geothermal energy potential in the world which does not exist in most countries. In addition, the solar energy is abundant due to its geographical place in the world. Turkey is also one of the countries in the world with has a high amount of hydroenergy potential. Wind energy potential in Turkey is estimated as 160 TWh. As well known, cost of these renewable energy resources is not high (Gençoglu, 2004).

Turkey is an energy importing country; almost 70% of the energy requirement has been supplied by imports. Due to the diversification efforts of energy sources, use of natural gas that was newly introduced into Turkish economy, has been growing rapidly. On the other hand, Turkey, with its young population and growing energy demand per person, its fast growing urbanization, and its economic development, has been one of the fast growing power markets of the world for the last two decades. Oil has the biggest share in total primary energy consumption. But it is expected that natural gas consumption will be higher than oil in future.

Energy is one of Turkey's most important development priorities. Turkey has a large potential for renewable energies. The most important renewable sources for Turkey's energy sector are solar in its various forms, wind, biomass, hydro and geothermal. Turkey's geographic location has several advantages for extensive use of most of the renewable energy sources. The amount of annual biomass potential of Turkey is approximately 32 mtoe. Turkey has a gross annual hydro potential of 433,000 GWh, which is almost 1% of world total potential. Currently, wind power capacity in Turkey is around 19 MW, with units located all over the country. Turkey's solar energy potential has estimated to be 26.4 million toes as thermal and 8.8 million toes as electricity and geothermal potential is about 38,000 MW (http://turkey-electricity.com/page.html).

Table 1 depicts the historical and projected relationship between population, economic output and energy demand. The population projections signal the slowing down of population growth. At the same time the GNP is expected to nearly double every ten years. A similar relationship between population, per capita energy demand and total energy demand is projected. The implication of these figures is that energy intensity of the Turkish economy will substantially improve over time, going from 81 Mtoe/GNP/capita in 1973 to 40 Mtoe/GNP/capita in 2000 to 33 Mtoe/GNP/capita in 2020 (Table 1).

Table 1: Population, economy and energy

Years	Populations (000s)	GNP/capita	Total GNP	Total energy demand (Mtoe)	Energy/capita (Kep)	Energy intensity
1973	38,072	1994	75,915,568	24.6	646	81
1990	56,098	2674	150,006,052	53.7	957	50
1995	62,171	2861	177,871,231	64.6	1,039	44
2000	67,618	3303	223,342,254	82.6	1,218	40
2010	78,459	5366	421,010,994	153.9	1,962	35
2020	87,759	9261	812,736,099	282.2	3,216	33

Kaynak: TÜBİTAK (2008).

In 2005, primary energy production and consumption has reached 34 and 130 million tons of oil equivalent (mtoe), respectively (Table 2 and Table 3). The most significant developments in production are observed in hydropower, geothermal, solar energy and coal production. Turkey's use of hydropower, geothermal and solar thermal energy has increased since 1990. However, the total share of renewables in total primary energy supply (TPES) has declined, owing to the declining use of non-commercial biomass and the growing role of natural gas in the system.

Table 2: Present and future total final energy production in Turkey (mtoe)

Energy sources	1990	2000	2005	2010	2020	2030
Coal and lignite	12.41	13.29	20.69	26.15	32.36	35.13
Oil	3.61	2.73	1.66	1.13	0.49	0.17
Gas	0.18	0.53	0.16	0.17	0.14	0.10
Com. renewables and wastes[a]	7.21	6.56	5.33	4.42	3.93	3.75
Nuclear	—	—	—	—	7.30	14.60
Hydropower	1.99	2.66	4.16	5.34	10.00	10.00
Geothermal	0.43	0.68	0.70	0.98	1.71	3.64
Solar/wind/other	0.03	0.27	0.22	1.05	2.27	4.28
Total production	25.86	26.71	34.12	39.22	58.20	71.68

[a]Comprises solid biomass, biogas, industrial waste and municipal waste.

Kaynak: IEA, 2005; MENR, 2005 (http://www.enerji.gov.tr).

Table 3: Present and future total final energy consumption in Turkey (mtoe)

Energy sources	1990	2000	2005	2010	2020	2030
Coal and lignite	16.94	23.32	35.46	39.70	107.57	198.34
Oil	23.61	31.08	40.01	51.17	71.89	102.38
Gas	2.86	12.63	42.21	49.58	74.51	126.25
Com. renewables and wastes[a]	7.21	6.56	5.33	4.42	3.93	3.75
Nuclear	—	—	—	—	7.30	14.60
Hydropower	1.99	2.66	4.16	5.34	10.00	10.00
Geothermal	0.43	0.68	1.89	0.97	1.71	3.64
Solar/wind/other	0.03	0.27	0.22	1.05	2.27	4.28
Total primary energy consumption	53.01	77.49	129.63	152.22	279.18	463.24

[a]Comprises solid biomass, biogas, industrial waste and municipal waste.

Kaynak: IEA, 2005. MENR, 2005 (http://www.enerji.gov.tr).

Turkey is among the first five leader countries in its geothermal direct use applications (Demir, 2002). Turkey is ranked as fifth biggest geothermal energy user for heating and hot spring purposes after China, Japan, USA and Island (SIS, 2005). In Turkey, the district heating system applications were started with large scale, city based geothermal district heating systems. The investigations on geothermal energy in the country gained speed in the 1970s. However, the utilization of geothermal energy could not become widespread sufficiently due to scaling problems up to the early 1980s. Since then, important developments have been recorded in geothermal energy utilization. Recently, geothermal direct use applications have reached up to 52,000 residences equivalence of geothermal heating, and engineering design of nearly 300,000 residences equivalence geothermal district heating has been completed. Parallel to the development of geothermal energy utilization in Turkey, it is projected that by the years 2010 and 2020, the total installed capacity will increase to 3500 MWt (500,000 residences equivalent, which is about 30% of the total residences in the country) and 8300 MWt (1,250,000 residences equivalent) for space heating and to 500 MWe and 1000 MWe for power production, respectively (Serpen, Aksoy, Öngür, 2010).

Turkey's technical wind energy potential is 88,000 MW and its economic wind energy potential is 10,000 MW. 40 new wind farm projects (totaling approximately 1400 MW) have already obtained licences and 751 licence applications (totaling approximately 78,000 MW) are still awaiting approval. Some cities in Turkey have relatively high wind speeds. These have been classified into six wind regions. The most attractive sites are the Marmara Sea Region, the Mediterranean Coast and the Aegean Sea Coast (Guner Law Office, 2008). The amount of solar collectors installed in Turkey was 7.7 million m2 in 2000, but in 2006 the amount was increased to 11.5 million m2 (IEA, 2008). In Turkey, installed solar cell capacity which is used mostly in public bodies for supplying small amounts of power and for research purposes, has reached 1 MW (http://www.enerji.gov.tr). Turkey has a huge hydropower potential. Turkey is the second richest country after Norway in Europe for its gross hydroelectric potential which is 440 TWh/year. Turkey has constructed 618 dams by 2007, which are in operation. Of these 618 dams, 230 facilities have been constructed as large dams and 388 as small dams. Total supply of energy was 13,064 MW in 2006 (DSI, 2008).

The main objectives of Turkey's current energy policy, including renewable energy considerations are: to meet demand using domestic energy resources as the highest priority, in the medium and long term, this is to occur through a mix of public, private, and foreign capital; to develop existing sources while accelerating the penetration of new and renewable sources; to diversify energy sources and to avoid dependence on energy imports from a single source or country; to encourage private-sector investment and to accelerate capacity construction and privatization in the power industry, preparations are to be made for the introduction of nuclear power; to improve the reliability of electricity supply through upgrades in the power transmission and distribution grid; to improve energy efficiency in end-use and transformation, e.g. through reduction of losses in energy production, transmission, and consumption; to protect the environment and public health (Budak, 2009).

4. RESULT

Turkey's demand for energy and electricity is increasing rapidly and heavily dependent on expensive imported energy resources that place a big burden on the economy. As would be expected, the rapid expansion of energy production and consumption has brought with it a wide

range of environmental issues at local, regional and global levels. Air pollution, for example, is becoming a great environmental concern in the country. With respect to global environmental issues, Turkey's carbon dioxide emissions have grown along with its energy consumption. States have played a leading role in protecting the environment by reducing emissions of greenhouse gases (GHGs). In this regard, renewable energy resources appear to be the one of the most efficient and effective solutions for clean and sustainable energy development in Turkey. Turkey's geographical location has several advantages for extensive use of most of these renewable energy sources. This article presents a review of the sustainable energy policies, potential and utilization of the renewable energy sources in Turkey.

Turkey has great potential for renewable energy and is willing to reduce its dependence on fossil fuels by increasing its use of renewable energy resources. Turkey is interested in renewable energy resources and gives effort to provide the sustainability of using these energy resources. The state encouraged the municipalities in respect of the geothermal energy and gave them the permission to behave self-governing. For a sustainable development of renewable energy resources and settling to the Mediterranean strategy, ground sourced and water sourced heat pump systems, wind and solar energy power plants have to be kept unobstructed always. The renewable energy technologies and the energy quantities which are necessary for production per unit have to be kept always in the journal and policy of the country. Legal regulations have to be performed and the State has to give effort to make the public assimilate these regulations highly.

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