

TURKEY'S APPLICATIONS ON RENEWABLE ENERGY POLICY

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ABSTRACT

The energy sector holds a crucial strategic importance for development and for the sustainability of the development. However, the reserves in our country are beginning to be insufficient for the fast increasing energy demand. The gap between energy production and consumption is growing and it is becoming insufficient. Due to this reason, the need for alternative energy sources has come into light. The fact that fossil fuels used in energy production will be exhausted and their environmental effects has made it inevitable for the world to use renewable energy. In Turkey, in order to produce electrical energy mostly thermic sources such as hydraulic sources and brown coal, natural gas, coal and fuel oil are used. Production of electricity with the usage of renewable energy sources, in which we hold a great potential, has shown a great development in the world for the past few years and is used little if any in our country. In this study information regarding the dispersion of the available electric energy in Turkey according to the sources and its development will be analyzed in order to determine the necessary technical substructure to make renewable energy appealing. This study has examined and made suggestions in terms of renewable energy source productions and the effective usage of these sources and the policies which has been used in terms of the sources owned by Turkey.

Keywords: Renewable Energy Sources, Renewable Energy Policies, Energy Potential.

1. INTRODUCTION

There several developments, improvements, and variations are met in the generation and usage areas of energy depending to the nations' developments. The increments on required energy rates directed people to make researches for alternative energy sources. The period that is started with the 1974 petrol crisis showed that petrol is not an eternal source, and cheaper and easier electricity generation researchers are extensively discussed in that years.

The reality of that the fossil-based energy sources would be lacking, the increments on petrol prices, and environmental problems make the people to pay much attention on sustainable energy generation and sustainable development issues. The energy policies are updated according

S. G. Gök / Nevşehir Hacı Bektaş Veli Üniversitesi Sosyal Bilimler Enstitüsü Dergisi
 3 (2013) 66-77
S. G. Gök / Nevşehir Hacı Bektaş Veli University Journal of Social Sciences 3
 (2013) 66-77

to renewable energy source usages, increasing the efficiency, alternative sources, and environmental friendly technologies.

The renewable energy sources have importance for the energy deficient and depended countries. Therefore, there are several legal regulations and governmental encouragements are offered for researches and entrepreneurs. However, the renewable energy sources cannot meet the desired costs and requirements at this period. It is not estimated that the renewable energy sources will tackle this matter in a short while. This situation makes the efficiency searches of conventional sources as important as renewable energy sources.

This study aims to analyse the energy sources of Turkey such as hydraulic, biomass, solar, geothermal, and tidal waves besides their potentials, usage rates, and alternative positions to conventional sources. Furthermore, their role on meeting the energy requirement and decreasing the abroad dependency on energy subjects of Turkey are discussed in the left part of the paper.

2. THE RENEWABLE ENERGY SOURCES OF TURKEY

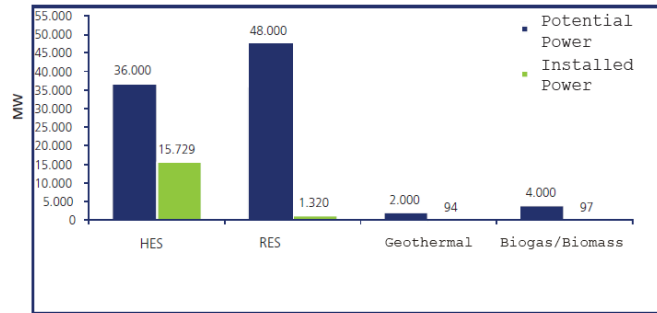
The renewable energy means “the energy source that is available on the next day according to natural circulation itself” (Uyar, 2006). Since the limited reservations and destructive effects of fossil fuels that meet almost all the energy requirement of the World, alternative energy sources that are renewable, more secure, environmental, and eternal are extensively researched.

The main difference of renewable and fossil-based sources is that the fossil fuels cannot be recycled after their usage while the renewable energy sources can be assumed eternal and can be converted in the next cycle of nature. Most of the countries pay much attention to renewable sources to retard the climate changes and Greenhouse gases (Kuban and Uyar, 2007). International Energy Agency predicts the CO₂ emission increases at 6% according to 2020 scenario. In order to prevent this increment, there 430 billion\$ additional investment should be done on energy efficient and low carbon technology (IEA, 2009). The globalised world requires alternative energy sources to sustain its improvement. The renewable energy sources are seen as the alternative to increased population’s energy demand in an ecologic and secure way. In 2000, the renewable energy sources covered 11% percent of all in Turkey. This share is decreased to 7% in 2010 because of the applied regulations. While Turkey meets the 36% of the consumed energy with its own sources, it is assumed that it will decreased to 20% in 2023.<http://www.emo.org.tr/modules.php>

Table 1. Turkey's renewable energy resources potentials

Renewable Energy Type	Type of Energy Use	Natural Potential	Technical Potential	Economic Potential
Solar Energy	Elec. En. (billion Wh)	977000	6105	305
Hydraulic Energy	Heat (MTEP)	80000	500	25
Wind Energy	Terrestrial Elec. En. (billion Wh)	430	215	124.5
	Marine Elec. En. (billion Wh)	400	110	50
	Sea wave energy. Elec. En. (billion Wh)	-	180	-
Geothermal Energy	(billion Wh)	150	18	-
	Elec. En. (billion Wh)	-	-	1.4
	Heat (MTEP)	31500	7500	2843
	Fuel Modern (MTEP)	90	40	25

Turkey's renewable energy resources potentials. Resource: EİE

**Figure 1.** Example of a figure caption. (figure caption)**Table 2.** Turkey's renewable energy resources potentials

Resource Type	Targeted Development
Wind	Removal of 20,000 MW of wind energy installed capacity until 2023
Geothermal	All known geothermal potential of 600 MW by the year 2023 to be operational
Sun	Promote the use of solar energy for electricity generation., assessment of the potential of the country to ensure to the maximum extent, encouraging result of studies initiated for this purpose.
Other	Technological developments and potential developments in the use of other renewable energy legislation, regulations, depending on the preparation of production plans, taking into account
Hydroelectric	Until 2023 to be evaluated technically and economically viable hydroelectric potential of all

2.1. Geothermal Energy

Geothermal is the heat energy generated by terrasphere and includes increased mineral, salt, and gases according to terrestrial waters that are over the average temperature of natural waters. Turkey is the 7th country in the world according to geothermal sources. It is detected that the 8% of the global geothermal energy potential is located in Turkey (Özçep and Karabulut, 2008).

Since the unit cost of geothermal energy is cheaper than others and causes to minor environmental effects, it is assumed as a more advantageous and cleaner energy source. The latest analyses showed that there is a geothermal potential of 650 MWh in Turkey. It is predicted that all the defined potential may be integrated to electricity grid up to 2020. The installed electricity potential of geothermal stations in Turkey is around 942 MWh at its current state. It is also predicted that the potential geothermal energy used in thermal tourism and heating energy is around 31500 MWh.

This potential is equal to heating energy required for 5 million houses. The cost of this heating is lower than 100 times of electricity, 50 times of fuel-oil, 40 times of natural gas, and 32 times of coal. In addition to cost, geothermal energy systems are more secure and more flexible according to others. The efficiency of geothermal may increases up to 97% and it can be measured as continuously in each period of a year. Another important advantage of the geothermal stations is minimum building period (Özçep and Karabulut, 2008).

The main reasons of lacking in geothermal energy can be explained with technical, financial, and management problems. The technical problems are occurred due to lower enthalpy, calcite sedimentation in reservoirs, and environmental problems. Another prohibitive issue on geothermal is that there is not any investment done for a long period in Turkey. The projects and applications of residential heating, greenhouses, and industrial plants with lower enthalpy geothermal sources are realised with support of local authorities or individuals instead of governmental policies (Solmaz and Solmaz, 2001).

2.2. Wind power

Wind energy from the renewable energy resources is considered as future energy resources because of its being natural, eatable, clean, continuous power and origin of the sun. The Modern wind energy technology is known for being clean, its adaptation to nature, producing electric energy economically. On producing wind energy, fossil fuels are consumed; hence, it results to atmospheric pollution and dangerous waste problem. Besides, on growing wind industry and being suggested bigger, more enumerable wind field, interested will be collected on regional environmental effects. Wind energy becomes most-preferred choice for

developing countries because it is the features of technology, however, developed countries want to achieve the level of carbon emissions and to decrease effect of greenhouse, in other words, its aim is to decrease emissions derived from the produced electric duration and to give opportunity of achieving attempts in a cheaper way (Çukurçayır and Sağır, 2007).

Despite traditional fuels, being a resource, which does not have any risk of long-term fuel prices and fuel costs and remove the dependence to other countries in terms of politic, economic, and procuration risks raise interest to wind energy [Http://Www.Deloitte.Com](http://Www.Deloitte.Com).

Potential in wind energy that is announced by ministry in the light of 2008 datas is totally 48GW as about 8GW of it is effective and 40GW is moderately effective. Ministry of Energy and Natural Resources has an aim of installed wind energy power to be increased to 10000 MTW till 2015 in strategic plan of 2010-2014 and to be reached at 20 GW installed wind energy power in Electric Energy Submission Security Strategy Document till 2023. Turkey, which starts to take benefit from its wind potential lately, has almost 900 MW RES installed power at the end of 2009 and in 2010 it is 1300 MW totally.

Also, it concludes some negatives that its foundation cost is more than nonnuclear fuel station and it leads to noise pollution when turbine number increase much, lastly it does not contribute to producing energy so much. Our potential is almost twice times more than current electric production. Turkey aims to invest in 20 thousand megawatt (MW) wind energy until 2020.

Comparing to wind turbine with fossil fuel station, it makes more economic production because it costs nothing (zero). According to OECD resources, there is a possibility to get about two times more of the produced electric in Turkey per a year from wind.

The usage of renewable energy sources and technologies is being increased in Turkey. Especially the renewable energy law that is announced in 2007 encouraged renewable energy sources utilization in electricity generation. The positive effect of the mentioned law increased the installed wind energy potential of Turkey from 18 MW to 1300 MW in seven years. The licence applications made to the Energy Market Regulatory Authority (EMRA) show that the installed capacity may increase up to a few times of accurate potential. This situation showed that Turkey is passed an important turning point on renewable energy sources. There a similar expectation is directed to solar energy in the next 10 year projection.

S. G. Gök / Nevşehir Hacı Bektaş Veli Üniversitesi Sosyal Bilimler Enstitüsü Dergisi
3 (2013) 66-77
S. G. Gök / Nevşehir Hacı Bektaş Veli University Journal of Social Sciences 3
(2013) 66-77

2.3. Solar energy

Solar energy is a technology that is depended to harvesting energy from solar irradiation. The conversion of solar irradiation to electricity is performed with solar cells that are collected in a solar panel. Solar cells are depended to semiconductor technology. Furthermore, the solar energy can be stored as electricity with batteries or as heat with solar collectors. The direct and diffused radiations that arrives to the Earth from sun varies according to atmospheric situations as humidity, dust particles, and cloudiness the most sunny places of the World are located around 35°N and S of Ecuador. Turkey is a country that is geographically located in the solar line and annual insulation increases up to 2906 hours that is around 30% of a year (Atılğan, 2000).

It is expected that the solar cell usage will increase in Turkey with the decrements seen in prices. The solar energy potential atlas of Turkey shows that there 380 billion kWh/year solar energy is available in Turkey. <http://www.enerji.gov.tr>

The solar energy will probably be more important in the energy future of Turkey. This is not only valid for Turkey but also for lots of the countries in the near future. Although the solar energy is widely used as a water heater in Turkey, it does not cover the 5% of the whole potential currently. The usage of solar energy in electricity generation is one of the most important targets of Turkish energy policy. The minor application of solar energy such as illumination, traffic lights, warning boards are rapidly increased. The latest few years can be summarised as main attention is paid to energy efficiency and renewable energies, especially solar and wind energy.

The solar energy applications are used in the most of the systems in 2010s. The next 10-15 years are predicted as the solar energy will spread all over the country with solar roofs, solar buildings, industrial applications and their integration to national grid.

2.4. Biomass

Biomass is a matter mass which does not possess a biological fossil root. It's main components; all natural matter which has plant or animal roots with carbon-hydrate components, the obtained energy from these resources is defined as biomass energy. Biomass is also defined as all organic matter which can regenerate within less than a period of 100 years, plants which grow on land and water, animal wastes and forestry products. In other words, plants, by withholding the carbon of the carbon dioxide they receive during photosynthesis, form biomass and discharge the oxygen. It is possible to burn the plants and send out again into the atmosphere carbon dioxide (Taşyürek and Acaroğlu).

The use of biomass energy can be grouped into two; traditional and contemporary use. Traditionally, biomass energy is the woods obtained from the woods in the forests, it consists of plants and animal wastes which are used for fuel. The basic specification of biomass energy is the fact that until its basic primitive development, with various burning tools, energy is obtained directly by burning the biomass product. It is very common in industrial rural regions. Contemporary biomass sources are; energy forestry products and wood industry wastes, energy agriculture products, plant-animal wastes of agriculture sector, urban wastes and agricultural industrial wastes. The biomass products in question are processed and are converted to solid, liquid and gas fuels. The variety of biomass fuels vary from wooden briquettes to synthetic raw petrol. In order to produce biomass fuel; pyrolysis, hydro gasification, hydrogenation and divisive distillation acid hydrolysis techniques are used. It is also possible to use a mixture of biomass fuels and fossil fuels (Dikmen, 2009).

It is possible to obtain electrical energy from raising fast growing plants and burning them from forests which are called energy forests. Pilot applications regarding this matter have begun in our country. 138 In addition, regarding the energy obtained from the urban wastes; it has been accepted that the methane gas naturally formed in the dump sites of Turkey, which is more than 2000, is 650million m³. This is approximately equivalent to 8 billion kWh¹³⁹. The methane gas accumulated in the wastes is pumped directly into the energy production centers and by treatment the methane gas is separated and burned. This method of electricity production is still applied in the waste areas in Istanbul (Kemerburgaz) and Ankara (Mamak and Sincan)¹⁴⁰. On the other hand, it should also be mentioned that it is more expensive to provide biomass sources than fossil sources. However, because biomass is a recyclable source, it is an important element of the sustainable global energy next to fossil energy which is running out. <http://www.eie.gov.tr>

Ministry of Natural Sources' data claims that waste potential of Turkey is approximately 8.6 million TEP and their 70 percent are used for warming. At the same time it is announced that productable biogas quantity was measured as 1.5- 2 million TEP. What's more, it is known that bioethanol power is equal to 0.73 percent of total liquid fuel in Turkey with the rate of 160.000 tones. With the Renewable Energy Law, biogas included in range of biomass and 13.3 Dolarcent/kWh proper price warranty was given to all electric generation facilities which produces biomass, including landfill gas. This price is the highest encouraged class with production facilities based on the sun.

S. G. Gök / Nevşehir Hacı Bektaş Veli Üniversitesi Sosyal Bilimler Enstitüsü Dergisi
 3 (2013) 66-77
S. G. Gök / Nevşehir Hacı Bektaş Veli University Journal of Social Sciences 3
 (2013) 66-77

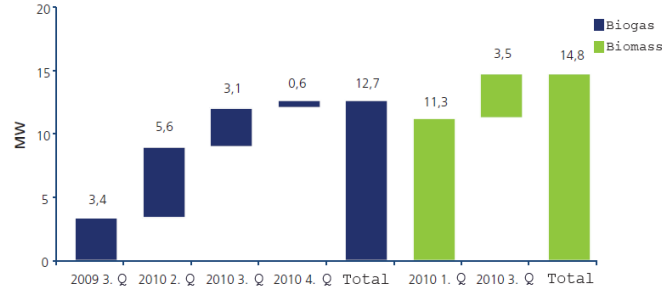


Figure 2. Biomass and biogas over the years on the representation of a quarter of the installed power (MW)

2.5. Hydraulic energy

Hydraulic energy is obtained in dams, by turning the static energy of water into kinetic energy. The hydroelectric power plants turn the power of the flowing water into electricity. Producing energy from hydraulic power is a clean, productive and effective method. The initial investment of hydraulic power plants is very high. In addition, the fact that the areas in range, even some residential areas and historical sites will be drowned and that during drought, electricity production will decrease is other disadvantages.

However, hydraulic power plants, just like thermal power plants do not cause air and environmental pollution. Even developing half of the world's economically feasible hydroelectric production potential will cause a decrease of 13% in greenhouse gas emission. Also, the ponds which are formed with time behind the dams will cause the climate of the surroundings to soften. Besides these, hydraulic power plants also have the advantages of preventing floods and submersions, regulating irrigation works, developing fishing, providing forestation and easing transport. (www.dsi.gov.tr).

Hydraulic energy constitutes the most important source of usable renewable energy in Turkey. The theoretical hydro electrical potential in Turkey can be evaluated as 433 billion kWh, technically the evaluable potential is 216 billion kWh, as for the technical and economical potential; it was calculated as 127 billion kWh. As of today, there are 135 functioning hydro electric power plants in Turkey. These plants have 12631 MW installed power and an annual production capacity of 45325 GW which is 36% of the total potential. Approximately 45% of this amount is produced within the scope of the GAP project.

In the past few years the share of the electricity produced in hydraulic centrals has decreased due to the spreading usage of natural gas in Turkey. With the spread of natural gas more natural gas cycle power plants

have been established. As a result of this, the share of hydraulic power plants in the production of electricity is decreasing. Even though the initial investment is higher than the natural gas power plant, the fact that they are domestic resources and that they have no fuel cost is very important for Turkey (Altun, 1996).

2.6. Tidal energy

One of the used methods in the production of electricity is based on taking advantage of the difference between a high tide and a low tide (ideally 5 meters). According to this; by building a dam at the back of gulfs or bays enables the rising water to go directly into the dam; then, the power which is caused when the tide pulls back is turned into electrical energy by means of a turbine system. Another method is, benefiting from the flow speed during low tide and high tide without filling the water (a dam is available); electrical energy will be produced by placing a turbine in front of the areas where the flow occurs. The method in question has a similar process to the electrical energy production from sea/ocean current (flows) (Olah, Goeppert and Prakash, 2006).

Although there is no electric generation license from powers of waves, tides, currents in Turkey currently, it is known that there are investors who want to generate electricity especially from massive currents of Bosphorus and Dardanelles straits. It is said in the statement by TBMM Energy Commission in June 2009 that currents in Bosphorus and Dardanelles straits have 450 MW energy potential. This high cost facilities, which will be built on the underground rivers, are supposed to be built detailed by means of feasibility both economically and environmentally and investors are supposed to make right decisions about that feasibility results. In the strategic document of Ministry of Energy and Natural Sources, it can be assumed that due to there is no action about these three energy source, other renewable sources are paid attention to and it will be like this. In the renewable power law there is no accurate price is concluded.

It is possible to benefit from wave energies which occur in big water masses such as oceans and seas. It is one of the renewable energy forms.

The studies which have been made regarding producing energy from waves are generally concentrated on electrical energy. The basic systems used in this field are divided into two: "fixed devices" and "floating devices".

Fixed devices are installed on a rather solid foundation, in front of breakwaters which are installed through the shores or also on a fixed sea based off shore. The most developed wave energy plants are designed according to this system. In spite of this, the floating systems are systems which move on the surface of the water just like a boat and are connected to

S. G. Gök / Nevşehir Hacı Bektaş Veli Üniversitesi Sosyal Bilimler Enstitüsü Dergisi
3 (2013) 66-77
S. G. Gök / Nevşehir Hacı Bektaş Veli University Journal of Social Sciences 3
(2013) 66-77

the shore with high voltage cables. Electricity production from these systems, whose research and development are still ongoing, is made through water chambers. As the waves which are taken into the water chambers move, the air in the chamber is compressed and mechanical energy is obtained. This system is similar to a classical pump system (suction and force) and the transformation from mechanical energy into electrical energy is made through turbines (IEA, 2006).

As a result, obtaining electrical energy by benefiting from oceans or seas is a rather new resource when compared to the other renewable energy methods and its share within all of the renewable energies is below 0.1%. In the forecasts made by IEA, it has been noted that by the year 2030 it will not pass 1%207. I the event that the cost level of the use technology is dropped and the fact that water ecology can be ruined, it is possible to obtain positive results in the long run (IEA, 2006).

3. RESULTS AND SUGGESTIONS

The biggest obstacle of renewable energy sources seems to be high costs. However, when we consider the fact that the main sources of energy in Turkey are met through import and that a serious source is reserved for this purpose, the investments made for renewable energy sources will bring positive results in the long run. Also, the costs of renewable energy are decreasing daily. Due to this reason, by following the developing technologies in Turkey daily it is inevitable to incline towards the popularization of these technologies.

By using the renewable energy sources of the energy policies, the most important tool is to use energy effectively. It is not sufficient to produce policies which will just meet the energy demands in the field of energy. According to the energy density, which is one of the most important indicators regarding energy proficiency, Turkey is below the world average. As a result of the widely scoped policies which will be formed, energy productivity investments will decrease energy demand and thus decrease energy import and decrease the investment costs made for new energy investments.

When creating the energy policies, it is very important that one does not ignore the environmental factor. The use of energy and its relation with the environment has gained a lot of importance throughout the world as well as in Turkey. While the environmental policies in Turkey insure a sustainable development, the basic target should be to protect the natural balance and leave the world to the generations to come with the least damage possible. Due to this reason, in order to provide a developing sustainable

economy, the development targets and policies should be considered within the scope of environmental issues.

In the sense of renewable energy potential, the EU offers an important opportunity, which is over average, in order to increase the usage of renewable energy sources in Turkey, however, the fact that the issue is not “internalized” by the political powers and related branches of the government is also a problematic approach to the issue. Due to this reason, in order to solve many problems which stand in front of the development of renewable energy in Turkey and accelerating the frozen investments for renewable energy sources, the basic starting point is for the related governmental departments and political powers to have a systematic and scientific approach to the issue. Also, the joint studies which will be made by the related person, institution and organizations regarding renewable energy should be supported by a political will; if we form a renewable energy policy which is convenient to the facts of the national realities and suitable with international developments and take into consideration all economical, social, political and environmental aspects, it should immediately be put into force.

Table 3. Primary Energy Production Targets of Turkey from 2005 to 2030

	2005	2010	2015	2020	2025	2030
Hardcoal and lignite	21259	28522	31820	39385	42732	45954
Oil and natural gas	2127	1735	1516	1604	1505	1465
Central heating	495	884	1336	2018	2427	2758
Hydropower	5845	7520	8873	9454	10002	10465
Wood and waste	6760	6446	6029	5681	5498	5413
Geothermal	1380	3760	4860	4860	5400	5430
Nuclear	0	3657	9143	18286	26988	29600
Solar	459	907	1508	2294	2845	3268
Wind	250	620	980	1440	1786	2154

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