

Energy Resources and Their Effects on Environment

İSMAİL BOZKURT

Vocational School of Technical Studies Electrical Programme

Marmara University

Göztepe Kampüsü, Kadıköy 34722 İstanbul

TURKEY

Abstract: - The World Energy Committee states that there exists no risk free energy resource and for this reason, while choosing the energy resources, cost factors must be considered with environmental effects. Today, prevention of environment pollution and conservation of environment have a dimension exceeding national borders. The risks that result from using of fossil fuels increasingly (petroleum, coal, gas) must be decreased (air pollution, thinning of ozone layer, acid rains etc). To decrease such risks, besides to increasing of energy productivity, energy resources that emit less sera gas in the atmosphere (like Carbon-dioxide (CO₂)) must be preferred. Otherwise, destruction of ecological balance and disasters in future will be inevitable. The negative effects of renewable energy resources on environment are lesser than the conventional energy resources. Costs of renewable energy resources are lesser than the fossil origin fuels. They never consume as they are renewable and in contrary to the conventional fuels, they do not exhibit a significant threat for environment and human health. In this study, effects of energy resources on environment are considered in detail. Especially, effects of renewable energy resources on environment and criteria that must be observed in energy production to prevent environment pollution are examined.

Key-Words: - Energy, fossil fuels, nuclear power plants, renewable energy, environment, global warming

1 Introduction

One of the most important elements to meet the essential needs of modern life is the use of electric energy. This feature makes the electric energy a sector that gives input to almost all sections in economy. Besides, as production, transmission, distribution and marketing of the electric energy are an individual investment area, it may be considered as an economical output.

One of our most important needs of which consumption increases continuously and will definitely continue to increase in future is undoubtedly the energy. Rapid development in technology and industry in recent years causes increase in environmental problems. Today, negative effects of solid wastes on nature that increase rapidly in respect to both content and quantity in parallel to technological development, industrialization and urbanization have been an important environmental problem.

The solid matters and refining mud that are desired to be disposed in the cheapest and easiest manner by manufacturers and must be regularly removed for comfort of society and conservation of environment are called as solid waste. The main problems resulting from solid wastes that are not

removed regularly are: epidemic diseases, spreading of unpleasant odors, reproduction of pests like flies, rats etc, pollution of underground and surface waters and air pollution contributing the sera event [1-4]. For this reason, European policy objectives to reduce greenhouse gas emissions by 20% and ensure 20% of renewable energy sources in the European Union (EU) energy mix; to reduce EU primary energy use by 20% at the end of 2020 [5].

2 Energy Resources

The energy need of world rapidly grows by consuming all the stock of energy resources in nature. When the effects of the petroleum crises in 1970's and the gulf war in 1991 on petroleum reserves are considered, it is clear that there is not any other option for all the world to use the reserves in hand in the best way and direct towards to new energy resources.

If we also consider the effects of fuels on environment after they are processed, to get benefit from the energy resources in the best and most effective ways in a manner to produce the least waste becomes very important [6, 7].

3 Fossil Fuels

Fossil fuels are also known as mineral fuels. They are the natural energy resources like coal, petroleum and natural gas that contain hydrocarbon. Fossil fuels are widely used in the industrial area. In electric production, the energy that comes out through combustion of fossil fuel is transmitted to a turbine as power. In former generators, the vapor obtained by combusting a fuel was used to rotate the turbine but in new energy power plants, the obtained gases directly rotate the gas turbine.

The economical growth of industrialized modern societies depends on energy benefiting base they obtained from fossil fuels. At present, 80% of the world's energy need is met from fossil fuels like coal, petroleum or natural gas. These resources that are intensive in some definite areas of world exist in various forms. The human being has learned to take out such resources in different methods and obtained the energy they desire. As fossil fuels can be stored and transported easily, they are considered as a perfect fuel.

The fossil fuels are widely used in houses, commercial and industrial sectors, heat production and production of electric energy. In transportation sector, mostly petroleum products (gasoline, diesel oil, jet fuel etc) are preferred. The heat production, space heating, is used for cooking, hot water, vapor production, direct heating or drying of many industrial products. For these purposes, three kinds of fossil fuels can be used. While very small amount of electric energy is produced in hydro or nuclear power plants, mostly coal and natural gas is preferred. Usage of fossil fuels in such high rates begins to create destructive results.

The cleanest fossil fuel, natural gas, is used in electric production, as a raw material in industry and process electric energy. Why the fossil fuels like coal, petroleum and natural gas cause climate change is that sera gases such as CO₂ and methane resulting from the combustion process keep heat in their structure. The sun gives heat and radiation in atmosphere from sunrise to sunset. For continuance of the natural cycle, this heat must be retransferred to the space. However, sera gases resulting from the fossil fuels cause keeping of some part of the heat in atmosphere. In this manner, the world begins to heat and change the climate. In Table 1, the effects of sera gases on global warming are given in percentages [1, 8].

Table 1 Greenhouse gases and global warming effects

Greenhouse Gas	Global Warming Effects [%]
Carbondioxide (CO ₂)	50
Chlorofluorocarbons (CHF)	22
Methane (CH ₄)	13
Nitrogen Oxides (NO _x)	5
Ozone (O ₃)	7
Water Vapor (H ₂ O)	3

4 Energy Resources

4.1 Effects of Hydroelectric Power Plants on Environment

The water power is considered as an energy resource related to the geographical location. As we all know, electric is produced in barrages by using the water force. Collecting water in barrages does not negatively effect the environment and the turbines used in hydro power plants (like Kaplan turbines) produce electric without negatively effecting the environment. These plants can be defined as development and usage of water resources including their energy production purpose. In other words, hydroelectric energy ensures converting of potential energy of water to kinetic energy.

The hydroelectric power plants have climatic, hydroelectric, ecological, socio-economical and cultural effects. The water collecting part of a hydroelectric power plant (reservoir) creates environmental effect when it is in operation. As the surface area of a reservoir is wider than a river and as the vaporizing increases, climatic effects occur. In this manner, humid rate in air increases, air movements change and temperature, raining and wind events differ. The flora and animal living both on land and in water of the region enter into sudden changing and animal species that can adapt themselves in such an environment can survive. The hydrological effects result from flowing regime of stream and changing of physico-chemical parameters. To convert rivers to reservoirs cause vaporizing of water and increasing of quantity of salt and other minerals in water. In transition from stream to lake, natural cleaning capacity decreases depending on decrease in water speed diffusion and oxygen taking capacity and the lake enters into

mortification process. Changes in water quality of lake cause alterations in hygrophilous living.

Blocking of migration ways both on land and in water, living areas remaining under water and annihilation of some important species cause occurring of ecological effects. Dissolution of air azoth in excessive saturation level because of falling off waters is fatal for the fish.

On the other hand, the social-economical and cultural effects are felt negatively and positively since construction phase of barrage. As a result of the expropriation made depending on size and quality of the land under water, internal and external migration events are experienced and value of land changes. However, because of the manpower movement during construction phase, the regional economy enlivens and infrastructure services and social services (school, health facilities, etc) cause positive effects especially in integrated projects. The barrage lake is a resource for recreation and production of water products. However, unless the natural resources and historical assets in the region are protected, cultural values may disappear [1, 7, 9].

4.2 Effects of Thermal Power Plants on Environment

The thermoelectric power production is made generally by using coal, petroleum and natural gas fuels. Only 30-40% of the energy produced in thermal power plants can be converted to electric energy. The remaining part is called as "fault energy" and comes from its boiler with radiation or discarded from funnel together with funnel gas. One of the most important environmental effects of thermal power plants is related to cooling water and the cooling water need of thermal power plants is great. For this reason, thermal power plants are generally constructed near resources like lake or sea where cooling water can be used. Disposing of wastes in sea and scattering on land is the feckless wasting method known since old days.

The gases that come out from funnel of thermal power plants and greatly affect the flora are dioxide and azoth oxides. The organ of plants mostly sensitive to such gases is their leaves. Such gases that enter into leaves by means of stomas destroy the structure of chlorophylls in leaves. Damages on plants are seen in three different dimensions. These are acute, chronicle and hidden damages. Plants expose to acute damage die immediately. Though the chronicle damage is not vital, it greatly destroys the quality of plants. The hidden damage occurs in a time [1, 10]. The environmental effects resulting

from the energy resources used in thermal plant plants are as follows;

1. Air pollution
2. Water pollution
3. Soil pollution
4. Effects of thermal power plants on living beings.
5. Their effects on land use.

4.3 Effects of Nuclear Power Plants on Environment

Though the Nuclear Energy Power Plants (NEPS) that leaves its mark of "atom era" on this century is a clear, reliable and settled technology in electric production, it takes reactions by the public in many countries.

The effects of nuclear plants on environment appear during taking out of uranium and thorium, preparation of fuel, production, enriching, re-treatment of fuel, storing and detaching of reactors. The biggest effect of nuclear plants on environment is emission of a radioactive matter in environment as a result of an accident. Gases and liquid radioactive wastes from nuclear plants cause significant environmental effects. However, the effects of radiation on environment vary depending on power of accident, type of reactor and security system out of reactor. If various radioisotopes disperse to environment as a result of the accident, radiation contaminated to water, soil and air taking medium effects the environment and human health. Here the important thing is that well conditioned storing and keeping of high level radiating wastes after the fuel completes its usage life.

With contributions of countries like Canada, South Korea, Taiwan, France and Belgium that increased their nuclear capacities, it is observed that other sera gases (greenhouse) and poisonous aside rains have decreased in great extent.

The radioactive effects reach to environment and all living beings including humans by means of two different ways. The first way: transportation of emissions arising from funnels in the atmosphere and their reaching to the earth and living beings on earth. The second way: reaching of liquid and solid wastes arising from power plants to rivers, lakes and seas and their effect on living beings and under ground waters. Because of the circulation of natural life, the human beings and animals living on earth can effect from the radioactivity arising from nuclear power plants by means of both ways. [1, 7, 10, 11,].

4.4 Effects of renewable energy sources on environment

Today, the top priority resources in the world's energy production are the renewable energy resources like petroleum, natural gas and coal. Especially, as natural gas pollutes the environment less than the other resources, its share in energy production increases day by day. As it can be seen in Figure 1, the energy resource most commonly used in the world is petroleum. The mine coal of which usage increasingly decrease takes place in the second row and natural gas of which production and consumption rapidly increase in the third row. In different periods, a definite energy resource was used dominantly. Petroleum took the place of coal and in next years, natural gas has become important. In future years, alternative energy resources will become important.

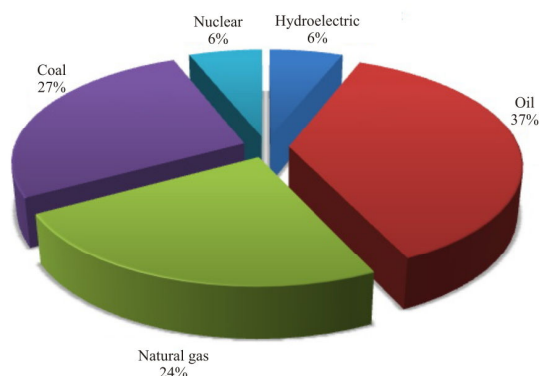


Figure 1 Commonly used energy sources in the world

Table 2 Number of units and produced electrical energy from alternative energy sources

Countries	Number of units (2004)	Produced electrical energy [TWh], (2002)
USA	104	708.1
France	59	414.9
Japan	54	295.1
Germany	18	156.8
Russia	30	134
England	23	83.6
Switzerland	5	25.9
China	9	23.5

The EU prepares the document entitled "The White Paper" which states out the future directives for the member countries (differentiated by each country's non-polluting energy potential)

consequently that until 2022, about 15% of the energetic requirements to be contended by non-polluting renewable resources [12]. The alternative energy resources being used in the world and their usage rates are given in Table 2 [13].

4.4.1 Geothermal Energy

It is defined as hot water, vapor and gases arising from the heat accumulated in various depths of the earth crust and of which temperatures are above the atmospheric temperature. The geothermal energy is the heat potential accumulated extraordinarily in accessible depths of the earth crust that can be benefited economically. This energy is a clean renewable energy.

By aid of the energy transformation technologies, electric production is realized from hot water and vapor or they are directly used for purpose of heat energy. The waste fluid of which energy is benefited is re-injected to underground because of its negative environmental effects. As many countries that use geothermal energy apply re-injection, geothermal energy is considered the most positive energy resource in respect to environment. When geothermal energy is used in electric production, it comes before fossil fuels with its almost zero waste even though it is only evaluated with sulfide emissions. In geothermal power plants, azoth oxide emissions have much lower values than the power plants that use fossil fuels. For this reason, geothermal power plants are considered as a clean energy resource as they are classified risk free in respect to its effect on ozone layer and health.

27% of total electric production in Philippines and 7% in California State are being covered from geothermal plants and 56MWe -capacity geothermal electric energy production is made in Papua New Guinea. 75% of energy need of gold mining is covered from geothermal. 86% of total heat energy (city heating) in Iceland is covered from geothermal.

Among the advantages of geothermal energy there are; it is environment friendly, it does not need fossil energy to heat and vaporize water and it uses natural resources. One of the disadvantages of geothermal energy is that it requires re-injection because of emission of gases like hydrogen sulfide and carbon dioxide. In Figure 2, usage areas and rates of geothermal energy other than electric production are given [1, 13-16]

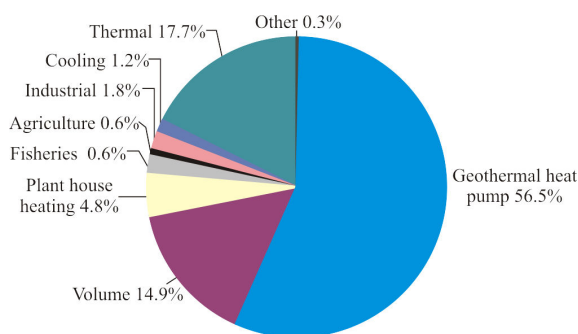


Figure 2 Direct using of geothermal in the world (non-electrical)

4.4.2 The Wind Energy

The wind energy is a clean energy resource that may contribute to the usual energy production as an energy resource under suitable conditions. There has been esteemed that until year 2017, the windmills installed capacity, should cover up about 10% of the planet's electrical energy needs.

Energy to be obtained from wind completely depends on the speed of wind and blowing period. The wind is a reliable, continuous and determinant resource. The wind plants may require a wide area for turbines. They are noisy and cause bird deaths and make parasites on radio and TV receivers. For this reason, in many European countries, mainly in England, the wind turbines are banned to be installed within boundaries of national parks or nearby to them because of their environmental effects. The wind energy is one of the clean energy resources and has positive effects on environment. A 500kW wind turbine realizes the CO₂ cleaning process equal to 57000 trees. In Figure 3, the wind potential distribution in the world is given [10, 14, 17].

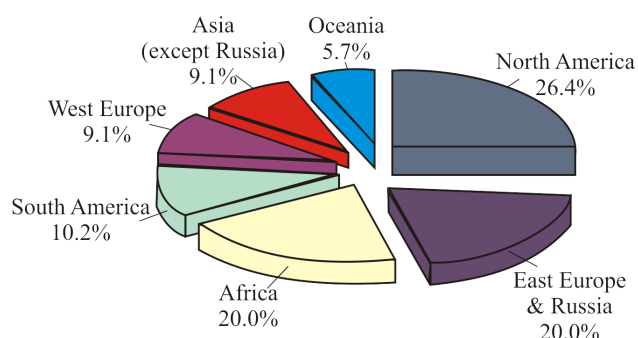


Figure 3 Technical potential distribution of the wind energy in the world [17].

4.4.3 Solar energy

It is an energy resource that comes from the sun, has a fixed force out of the atmosphere of world (1370 W/m^2) and varies between the values of $0\text{-}1100 \text{ W/m}^2$ on earth. The solar energy is clean, costless and limitless. Firstly, the solar energy was used as

heat energy but in recent years, it is also being used as an electric energy together with the developed technology. The electric energy is being obtained by means of solar panels and photovoltaic (PV) cells with decreasing costs day by day. The conventional PV generation systems have two big problems that the efficiency of PV system is very low, especially under low irradiation states and the output available power of PV system is always changing with weather conditions, i.e., the intensity of the solar radiation (irradiation) and ambient temperature. In order to extract as much energy as possible from a PV system, it is important to have an efficient maximum power point tracking algorithm. In developing nations, the PV generate system is expected to play an important role in total electrical energy demand, and solar photovoltaic energy has gained a lot of attention because it is renewable, friendly to the environment, and flexible for installation [18].

The solar energy is inconsumable energy resource that does not cause environment pollution. Because of the increase in fuel prices experienced in recent years, the solar energy that was not considered economical a few years ago has become very economical in some usage areas. The solar energy, alternative to energy resources like petroleum and coal, is highly promising.

Among the advantages of solar energy, there are; it uses solar energy, prevents unnecessary and excessive commercial energy consumptions of buildings by using the natural heating and cooling systems, uses natural and harmless materials, meets the energy need in areas lack of electric network, is continuous, economical and not foreign dependent. The disadvantages of solar energy are; its first investment cost is very high and PV cells operating in low output. The environmental problems created by technologies that ensure using of solar energy are unimportant when compared to other technologies. Effect of planar collector systems on environment is in negligible level. However, in some conditions, there may be dangerous situations in respect to health because of high temperatures and poisonous heat transformation fluids. On the other hand, during the production of solar cells, workers expose to poisonous matters [1, 13, 14, 19, 20].

According to the report of International Energy Agency (IEA)-Photovoltaic Power Systems Program (PVPS), Japan realized 22% of the world's PV cell production in 2007. PV cell production of 1905MW in 2006 raise to 2401MW in 2007 and the increase in rate of 21% in a year was realized in PVPS countries. The biggest increase was recorded by Germany with 328MW and by USA with

64MW. Japan realized photovoltaic cell production in power of 923MW in 2007 and it continues its leadership (Figure 4).

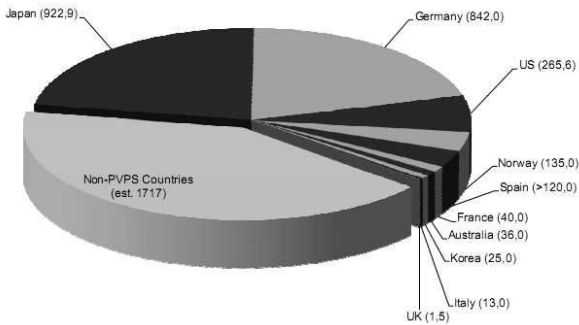


Figure 4 PV cell production (MW) by country in 2007

While in first years of installation of PV cell systems, mostly stand-alone systems were in demand, today grid connected systems are being preferred (Figure 5 and Figure 6) [21].

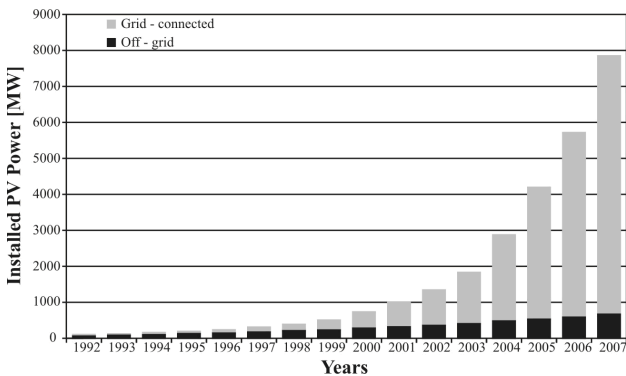


Figure 5 Cumulative installed grid-connected and off-grid PV power in the reporting countries

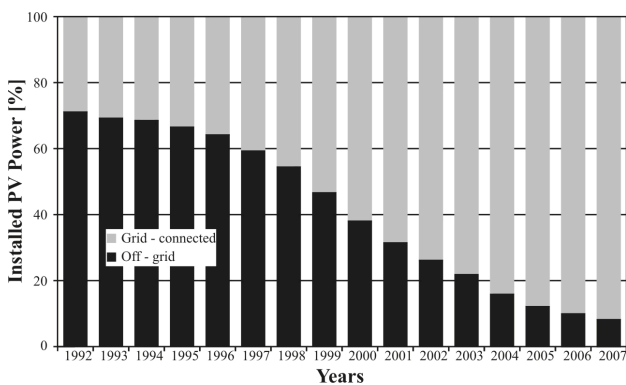


Figure 6 Percentages of grid-connected and off-grid PV power in the reporting countries [21].

5 Conclusions

The nature has resources and opportunities sufficient enough enabling people to live in balance without giving damage to the environment and even, to obtain comfortable life level by being industrialized. Unless we destroy the natural balance by giving as much as we take to the nature, if we give back what we take from environment under same conditions, give opportunity and time for reestablishment of natural balance, the nature will renew itself and compensate its lacking component. The renewable energy use is an option that increases variety in energy resources, may be replaced to fossil resources, decreases foreign dependency in fossil fuels as it is domestic, important in electric supply in rural areas and solves the air pollution-sera gas problems by being used in place of fossil fuels.

Whatever its kind is, the energy production systems have an effect on environment. The solar and wind energies that do not have any negative effect on environment is hoped to be used economically in production of electric energy in long-term. The hydroelectric energy potential that does not have any negative environmental effect, except the agricultural lands staying under water, must be re-determined in a realistic manner by considering the new technologies.

Consumptions of fossil fuels in energy production and other applications continue in its today's speed, it is clear that the ecological balance of world will be destroyed. According to the study of Frankfurt University Meteorology Institute on sera effect, it is forecasted that there will be temperature changes until 2040; 10°C in Pacific, 8°C in the Bering Gulf, 6°C in Japan, 4°C in Siberia and Antarctica and -2°C in West Africa. While restricting the use of fossil fuel energy resources, the clean energy technologies that pollute the environment less or have no polluting effect must be considered and developed. Otherwise, it will be impossible to prevent degeneration of ecological balance and arising of some disasters to be experienced by people.

On the other hand, to give up energy consumption as it causes environmental pollution is to abandon the benefits of economical development. The important thing is to find optimum solution by considering the positive and negative sides of resources. For this purpose, the environmental priorities must be considered in research and development studies, selection of technologies and energy planning, their determination must be made correctly and be in a manner to realize the determined targets in long-term. Besides,

development of alternative energy resources that may make contribution in solution of environmental problems created by energy in recent years and especially, may decrease the consumption of fossil fuels must be given priority.

The following criteria to minimize the environmental pollution must be paid attention;

1. To minimize the usage of fossil fuels,
2. To maximize the reliability of nuclear fuel technology and rapidly substitute new and renewable energy resources in place of that energy.
3. To benefit from the resources generally used limitedly like hydraulic geothermal energy, mainly the solar and wind energies, as much as possible.
4. Put the vegetable energy resources into operation as much as possible with a rational method,
5. To develop and apply the energy usage systems and methods,
6. To avoid from extravagancy in energy use as much as possible and try to find saving ways.

References

- [1] S., Kadioğlu, Z., Tellioglu, Using of Energy Sources and Environmental Effects, *TMMOB 1st Energy Symposium*, Ankara, Turkey, November, 1996.
- [2] İ., Bozkurt, Energy and Environment, *Journal of 3E Electrotech*, Vol.184, 2009, pp.188-191.
- [3] A., Akdoğan, G., Sevcan, Solid Waste Management and a Case Study on Municipalities, *Journal of Turkey and the Middle East Public Administration*, Vol.14, No.4, 2005, pp.51-78.
- [4] İ., Bozkurt, Hydroelectrical potential of Turkey, *Journal of 3E Electrotech* Vol.168, 2008, pp.134.
- [5] M., Grigoriu, Basis of Energy Efficiency Economical and Ecological Approach Method for Pumping Equipments and Systems, *WSEAS Transactions on Environment and Development*, Vol.5, No.1, 2008, pp.1-12.
- [6] F., Aköz, B., Üstün, Ö., Çakır, Effects on Environmental Pollution and Energy Saving of Thermal Insulation of Buildings, *TMMOB Insulation Conference*, Eskişehir, Turkey, 2001.
- [7] G., Öner, Lignite and Air Pollution, *Environment86 Symposium*, İzmir, Turkey, 1986.
- [8] Ö., Ünal, S., Karagöz, G., Ülger, E., Yüce, S., Erkul, How Expensive the Global Warming, *2nd International Economics Conference*, Eskişehir, Turkey, 2008.
- [9] G., Atagündüz, Clean Energy Technologies, *Journal of Ecology, Ege University, Solar Energy Institute*, Vol.3, 1992.
- [10] M., Eral, M.A.A., Aslan, S., Akyıl, Nuclear Energy and Environment, *Journal of Ege University Nuclear Energy Institute*, Vol.24, 1997.
- [11] IAEA, *Radiation in Everyday Life*, Information Series Division of Public Information, 1996, pp165-180.
- [12] I., Szeidert, O., Prostean, N., Budisan, I., Filip, V.E., Balas, G., Prostean, Actual Situation and Perspectives on Wind Energy Usage in Banat Region, *WSEAS Transactions on Systems and Control*, Vol. 8, No.4, 2009, pp.369-378.
- [13] A., Şenpınar, T.M., Gençoğlu, *Comparison of Renewable Energy Sources in terms of Environmental Effects*, Firat University East Anatolian Researches, 2006, pp.49-54.
- [14] H., Christopher, H., Armstead, *Lectures on Geothermal Energy*, Publication of UNU Geothermal Training Programme, Reykjavik, 1997.
- [15] Z., Demirel, Geothermal Energy, *3rd National Environment Engineering Conference*, Mersin, Turkey, 1999.
- [16] M., Özyurt, G., Dönmez, Assesment of Environmental Effects of Alternative Energy Sources, *Proceedings of the 3rd National Renewable Energy Sources Conference*, , Mersin, Turkey, 2005, pp.39-42.
- [17] İ., Bozkurt, Electrical Energy Consumption and Wind Energy Potential of Turkey, *Journal of Technology Education*, Vol.6, 2008 pp.53-55.
- [18] L., Liqun, W., Zhixin, A Variable Voltage MPPT Control Method for Photovoltaic Generation System, *WSEAS Transactions on Circuits and Systems*, Vol.8, No.4, 2009, pp.335-349.

- [19] M.T., Gençoğlu, Water Pumping System Feeding Solar Energy, *Journal of 3E Electrotech*, Vol.168, 2008, pp.94-97.
- [20] A., Şenpınar, *Computer Control of Stand-Alone PV Systems*, PhD. Thesis, Firat University, Institute of Pure and Applied Sciences, Turkey, 2006.
- [21] İ., Güney, N. Onat, Technological Status and Market Trends of Photovoltaic Cell Industry, *WSEAS Transactions on Electronics*, Vol.5, No.7, 2008, pp.303-312.