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Article

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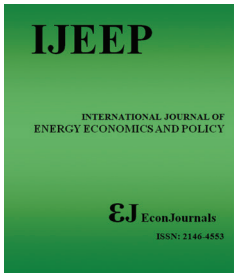
International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Tutar, Hasan/Atas, Mehmet (2022). A review on Turkey's renewable energy potential and its usage problems. In: International Journal of Energy Economics and Policy 12 (4), S. 1 - 9. https://econjournals.com/index.php/ijeep/article/download/12876/6803/31035. doi:10.32479/ijeep.12876.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2022, 12(4), 1-9.

A Review on Turkey's Renewable Energy Potential and its Usage Problems

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Received: 05 February 2022 **Accepted:** 23 May 2022 **DOI:** https://doi.org/10.32479/ijeep.12876

ABSTRACT

The need for energy resources in the world continues to increase day by day. Energy demand will increase in the coming years in parallel with population growth, industrialization and technological developments, especially in developing countries. The fact that fossil energy sources cause environmental problems, their reserves will be depleted shortly, dependence on source countries causes various political and economic problems, and price instability increases the interest in renewable energy sources. Especially in developed countries, renewable energy sources such as hydraulic, wind, geothermal, solar, biomass, wave, hydrogen etc. Energy sources are used in various ways, especially electricity production. As a developing country, Turkey's need for energy resources increases day by day in parallel with its increasing population and growing economy. Turkey, which is approximately 75% foreign-dependent in terms of its current energy structure, seems to be a necessity rather than a choice to reduce this dependency on renewable energy sources. In this study, Turkey's current renewable energy potential has been revealed, and various suggestions have been made by analyzing the renewable energy potential.

Keywords: Energy, Primary Energy, Secondary Energy, Fossil Fuels, Renewable Energy, The Energy Potential
JEL Classifications: O13, Q42, Q43, Q47

1. INTRODUCTION

Technological developments, industrialization, and the increase in the world population rapidly increase the energy demand. Energy, which is the basic input in production, is an essential element in the survival of societies. Energy, defined as the power behind doing work, can be found in different types such as mechanical (potential and kinetic), heat, electrical, chemical and nuclear, and can be transformed from one type to another by appropriate methods. Energy resources are generally classified according to their use and recyclability (Quaschning, 2005; Tanigawa, 2017; Singh et al., 2020). According to the classification made according to their use, energy resources are renewable and non-renewable; According to their recyclability, they are classified as primary and secondary energy sources. The main subject of this research is the possibility of benefiting from the current potential at the maximum level by emphasizing the renewable energy potential of Turkey. The research is important in the increasing demand for energy and the diversification of energy resources becoming an important issue.

Although the share of fossil fuels in the world's energy needs has decreased significantly in the last 50 years, it still meets 80% of the total energy need. Fossil energy sources have a high potential for environmental Pollution. While these resources are being extracted, they damage the environment, while consuming the energy produced from these resources harms the environment (Worldbank, 2020; Bhatia et al., 2018; Singh et al., 2020). Carbon dioxide is released when fossil fuels are used in a power generation facility or motor vehicles. The increase in the carbon dioxide level of the earth causes air pollution and causes global warming. Global warming causes problems such as rising seawater and

increasing the intensity of storms. Renewable energy sources, in addition to traditional fossil fuels and nuclear energy, renewable energy sources are gaining increasing importance. Until now, fossil fuels have been seen as the cheapest way to provide energy to all countries, but technological advances make it necessary to turn to renewable energy sources.

One of the issues emphasized in energy in recent years is renewable energy. Renewable energy is also important in terms of solving global warming. Wind generators, one of the main renewable energy sources in this area, create visual Pollution in nature but positively control global warming (Quaschning, 2005; Wendell et al., 2003). Another renewable energy source is geothermal energy. Geothermal energy can be used for heating purposes in residential, commercial and industrial sectors, drying fish, fruit, vegetables and timber products in agriculture, paper production and pasteurized milk production. Another renewable energy source is biomass or biowaste. Biomass and biowaste are flexible and pervasive energy sources adapted locally to meet local needs and goals (Ghosh, 2016; Tanigawa, 2017). In this research, Turkey's renewable energy potential has been evaluated in terms of wind energy, geothermal energy, hydraulic energy, biomass/biowaste, biogas, urban wastes, sea energy generation, wave energy, solar energy systems, photovoltaic systems and concentrated solar energy systems.

2. ENERGY SOURCES: AN OVERVIEW

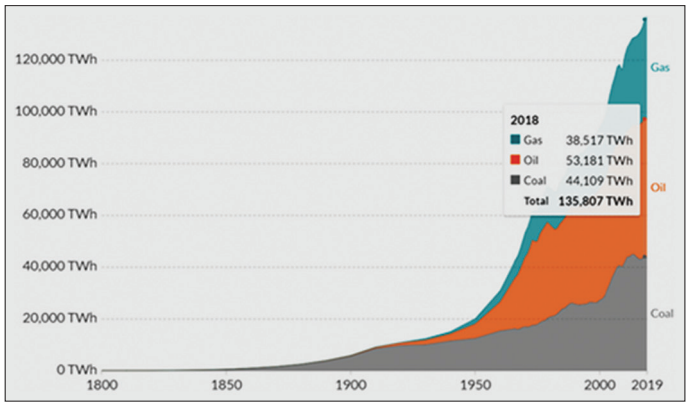
The form of energy that has not undergone any change or transformation is called primary energy. Primary energy sources are oil, coal, natural gas, nuclear, hydraulic, biomass, wave-tide, solar and wind. The energy obtained from the conversion of primary energy is secondary energy. Electricity, gasoline, diesel, diesel, coke, secondary coal, hair gas and liquefied petroleum gas (L.P.G.) are secondary energy sources. Another classification frequently used today is the classification made by considering energy resources' consumable or renewability characteristics at the end of use. According to this classification, renewable energy resources are the energy resources that can remain the same in a natural cycle process, do not decrease despite being used, and are not exhausted; Energy sources that cannot renew themselves once used are known as non-renewable energy sources. Non-renewable energy sources are divided into two as fossil sources and core sources. Coal, oil and natural gas are fossil-based non-renewable energy sources. On the other hand, Uranium and thorium are in the core sourced non-renewable energy source group. Hydro, solar, wind, geothermal, biomass, wave tide, hydrogen are renewable energy sources (Koç and Şenel, 2013; Şenel, 2012).

The use of fossil fuels to generate energy began at the start of the Industrial Revolution, but fossil fuel consumption has increased significantly over the last half-century, nearly eightfold since 1950 and doubling after 1980. There has been a trend in energy use from coal to oil, and then back to natural gas. Today, while coal consumption is decreasing in many parts of the world, oil and gas consumption increases rapidly (Smil, 2019). As a result of crude oil processing in refineries, products such as diesel, gasoline, L.P.G. and fuel oil are obtained. The remaining parts of these products can be used in asphalt production, drug and fertilizer production and polyester production. However, the main function of oil is to be used as an energy source, as stated above. However, petroleum as a type of fossil fuel poses a significant threat to the environment in terms of high CO_2 emissions, unlike non-fossil fuels (Shields-Menard et al., 2018; Mujtaba et al., 2020).

Another type of fossil fuel is coal, a sedimentary rock composed of carbon and hydrocarbons. Coal is a non-renewable source of energy; it takes millions of years to form. Coal is used for industrial purposes as a source of energy used for electricity or heat generation and in metal refineries. Coal is one of the largest sources of anthropogenic carbon dioxide emissions. The use of coal for electricity generation is not independent of environmental impacts and causes several environmental challenges, especially air emissions (El Safty and Siha, 2013). Another fossil fuel is natural gas, and it is an environmentally friendly fossil fuel with the lowest CO2 emissions. It is clean and efficient energy for industry and electricity departments compared to coal and oil. In recent years, natural gas demand has increased significantly due to urban population growth, the gradually improved natural gas pipeline network, and the implementation of pollution control policy (Chen et al., 2020). The power of natural gas is due to its abundant resources, including unconventional gases, its ability to be transported through pipelines, the stability of L.N.G. supply and its environmental advantages (Koyama, 2017). Fossil fuels are the most widely used energy source today. In this field, petroleum and its derivatives have a dominant role with electricity production of 53 TWh (Figure 1).

Another type of energy source is nuclear energy. Nuclear power can be achieved by utilizing only a small amount of natural Uranium in thermal nuclear reactors to produce high energy levels. It is observed that an increasing number of countries are opting for nuclear energy to help meet their future energy needs. The demand for reliable electricity that does not pollute the air in China and India's rising, industrial and fast-growing world markets increases nuclear energy investments. In 2018, electricity production of 2563 TWh was realized with nuclear energy. Although this production level is still low compared to fossil energy sources, it is important. The highest usage level of nuclear energy is in Europe (811.4 TWh) and North America (915 TWh). Compared to the previous year, the biggest increase was in southeast Asia (38 GWe) (World Nuclear Association, 2019).

Figure 1: Global fossil fuel consumption (TWh)



Source: Smil, 2017

Despite the risks of nuclear accidents (Fukushima) today, nuclear power generation by fission is still considered an option in many countries. The main reasons for this are; The cost of electricity produced is generally cheap, nuclear is energy does not contain CO2 throughout its entire life cycle, and renewable sources.

As mentioned earlier, energy resources are divided into three categories. These are fossil fuels, nuclear resources and renewable resources (Demirbaş, 2000). Renewable energy sources are seen as an energy sources that will play an important role in the future of the world, thanks to their advantages. Unlike other energy sources, renewable energy sources; are sources that can be used to produce energy repeatedly, such as solar energy, wind energy, biomass energy, geothermal energy. For this reason, renewable energy is often called an alternative energy source (Rathore and Panwar, 2007). Renewable energy sources are derived from natural processes constantly renewed by the International Energy Agency (IEA) and can renew themselves faster than their consumption. Wind energy, solar energy, biomass, geothermal, hydraulic and marine resources are renewable energy sources. These resources are environmentally friendly, clean, energy-safe and cost-effective for the national economy (IEA, 2020a). Renewable Energy Sources can be produced directly from the sun, such as thermal, photochemical and photoelectric energy.

Another form of renewable energy generation is energy sources such as wind, hydropower or photosynthetic energy stored in biomass, which can be produced from the indirect use of the sun or nature's tides and geothermal mechanisms. Renewable energy has some features that distinguish it from fossil energy. First of all, renewable energy sources have unlimited reserves. In other words, renewable energy sources are virtually inexhaustible, but fossil fuel stocks are limited. Another feature of renewable energy sources is that they are environmentally friendly. Therefore, as renewable energy increases, dependence on fossil fuels will decrease. Another feature of renewable energy resources is domestic and natural resources (Ellabban, Abu-Rub and Blaabjerg 2014; Çelikkaya 2017). Using renewable energy sources increases supply diversity, reduces risks arising from oil price volatility and increases supply security. This also contributes to the country's economy by reducing the foreign exchange output to fossil fuels.

The most used renewable energy sources are hydraulic, wind and solar energy. In addition, electricity is produced from many other renewable energy sources such as marine, geothermal, biofuel, waste, biogas. It is observed that approximately 6.5 million GWh of electricity is produced from renewable energy sources today (IRENA, 2020a). Renewable energy sources that meet domestic energy requirements can provide energy services with virtually zero air pollutants and greenhouse gases emissions. Renewable energy system development makes it possible to solve the most important problems for countries, such as ensuring energy supply security and improving the organic fuel economy. Renewable energy sources; It can be said that it contributes to solving local energy and water supply problems, increasing the living standard and employment level of the population, ensuring sustainable development of remote areas in desert and mountainous regions, contributing to energy security and protecting the environment (Zakhidov, 2008; Bergmann, 2008). Developing and implementing renewable energy projects in rural areas can create job opportunities and reduce migration to urban areas.

3. TYPES OF RENEWABLE ENERGY SOURCES AND TURKEY'S POSITION

Fossil energy sources, such as oil, coal, natural gas, created by nature over millions of years, are depleted. The continuous and increasing use of these energy sources also causes many environmental problems locally and globally. Nuclear energy, which is being used as an alternative to fossil fuels, cannot solve humanity's energy and environmental problems. Uranium, which is nuclear fuel, is also limited and decreasing globally. Besides the risks of accidents and radiation to the environment and humanity, nuclear energy also brings the problem of nuclear waste, which will remain a threat to future generations for thousands of years. Renewable energy applications are the way to meet humanity's energy needs in harmony with nature without causing environmental risks. Today, energy production from renewable sources has become economically competitive with fossil and nuclear sources production. Energy production from renewable sources is a method that does not consume natural resources and does not waste (Yanar and Kerimoğlu, 2011).

Turkey is one of the countries with the fastest-growing energy demand globally. Energy consumption increased by 8.9% in 2010, twice the OECD average. Turkey meets its ever-increasing energy needs through imports. Turkey imports more than 70% of the total energy it uses, and the most important reason for Turkey's current account deficit is this high energy import (Yanar and Kerimoğlu, 2011). Energy production from renewable sources is in a continuous and systematic increase trend. While Turkey, as a candidate country for the European Union, has to adapt to E.U. policies and practices, it is the opposite of the European Union in terms of renewable energy. On the other hand, the share of energy obtained by Turkey from renewable sources in total energy consumption is constantly decreasing. Due to the increase in modern renewable energy sources such as wind turbines and photovoltaic electricity generation, renewable energy in total is increasing (Kurucu, 2017). Although nearly all countries have renewable energy potential, Turkey has some advantages in terms of renewable energy potential. Turkey has significant advantages in terms of renewable energy sources such as wind energy, geothermal energy, hydraulic energy, biomass/biowaste, biogas, urban wastes, energy generation from the sea, wave energy, solar energy systems, photovoltaic systems and concentrated solar energy systems. Types of renewable energy sources and Turkey's advantages in this area have been evaluated in the following general terms.

3.1. Wind Power

Wind energy is an indirect form of energy. Sun rays cause temperature differences and winds on the earth. Wind can achieve much higher power densities than solar radiation. This context can produce more than 10 kW/m2 during a severe storm and over 25 kW/m2 during a hurricane, compared to about 1 kW/m2

of maximum terrestrial solar radiation (Quaschning, 2005). The wind energy sector is the fastest-growing energy sub-sector in the world. Wind Power Plants can be installed wherever there is sufficient wind flow due to the advantages of not needing any raw material source, no pollutant effect, and no need for cooling liquid. The rapid development of wind turbine technology generates more electrical energy with lower wind force (IEA, 2020b). Turkey's high altitude and the abundance of windy days and regions make Turkey advantageous in wind energy. Wind energy is one of the most important technologies to stop global warming. It is estimated that 5 M.W. wind power plants per square kilometer can be established in regions with a wind speed of 7.5 m/s and 50 meters above sea level in Turkey, and a wind power plant can be established in an area equivalent to 1.3% of Turkey's surface area. In the light of these data, the wind energy potential in Turkey can be determined as 48,000 MW. Looking at the IRENA data, it is seen that Turkey had wind energy installed power capacity of 7,591.19 MW in 2019 and a total wind energy production of 24,703 GW in 2020 (IRENA, energy.gov.tr)

3.2. Geothermal Energy

Geothermal energy is based on hot water, steam and gases found under the earth's crust. Earth's core maintains a temperature of 5000 oC due to the gradual radioactive decay of elements. Heat energy constantly flows from the hot core to the crust, and volcanic activities carry this hot material from the crust to the near-surface below the earth's crust, and thermal energy in the form of hot water, steam or gas is stored under the earth's crust. Geothermal systems use this energy to generate electricity or heating (Öztürk and Yüksel, 2016).

Geothermal energy projects are generally clean and renewable with low environmental impacts such as greenhouse gas emissions, air quality, land use and water quality. Figure 2 shows the global geothermal potential. America, Africa and North Asia have the highest geothermal potential. Turkey has especially high geothermal potential (Saibi et al., 2013). The most common method used to generate electricity from geothermal is steam produced from hot water extracted from the earth's crust to drive a turbine (Wendell et al., 2003). While Turkey ranks first in Europe in terms of geothermal potential, it ranks fourth in the world in terms of installed power capacity after the U.S.A., Indonesia and the Philippines. While the probable geothermal heat potential of Turkey is estimated as 35,500 MW, the electricity generation potential is estimated as 2000 M.W. It is seen that Turkey has geothermal energy installed power capacity of 1,613.22 MW in 2020, and the total geothermal energy production in 2020 is 9,929 GW (IRENA, energy.gov.tr)

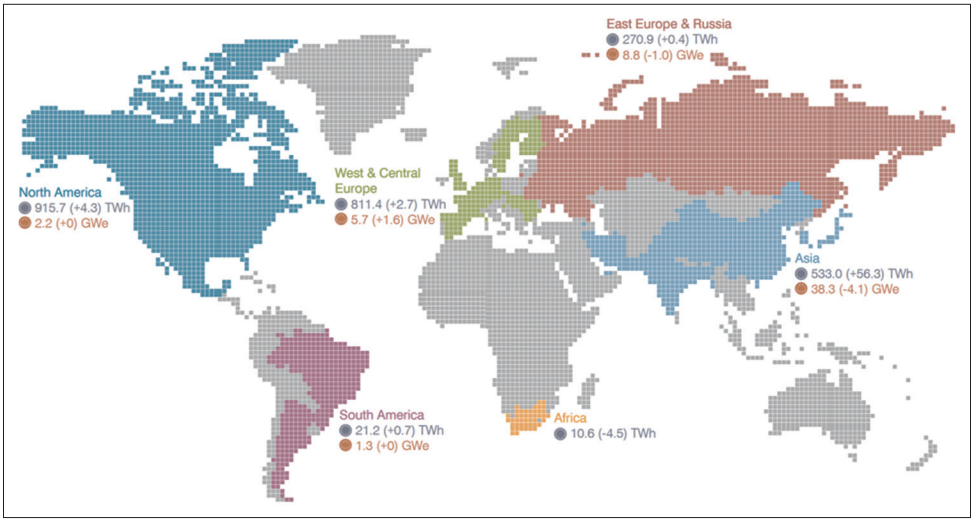
3.3. Hydraulic Energy

Hydraulic energy can be defined as the energy obtained using the energy of mobile water, or it can be defined as the energy obtained by converting the potential energy of the water into kinetic energy. The hydraulic energy potential varies depending on the precipitation regime. It is known that people have benefited from the energy of water since ancient times. While the energy of water was initially used in water mills, today, electricity is produced from the energy of water. Hydroelectric energy is a clean, renewable and highly efficient electricity source with enormous improvement and expansion potential ((Ellabban et al., 2014; Yang et al., 2014; Dorji and Ghomashchi, 2014). Turkey is 1% of the world's potential hydroelectric theoretical potential. Turkey's technical hydroelectric potential is estimated to be 216 million M.W., while its economic hydroelectric potential is 160 million M.W. Turkey's hydroelectric power capacity was 30,983.89 MW in 2020. It is seen that the total hydroelectric power generation will be 78,119 GW in 2020 (IRENA, energy.gov.tr)

3.4. Biomass/Biowaste

Bioenergy is renewable energy obtained from biological sources. Biomass is living or dead organisms and the by-products of these organisms, plants or animals. Biomass is often used for plant material grown for non-food use as a fuel source. Most plant materials used as energy sources are forest residues, animal manure and municipal solid waste, and by-products of agro-industrial processing such as pulp (Gadde et al., 2009; Ghosh, 2016). It is estimated that Turkey's biomass/biowaste potential is equivalent to approximately 6.6 million tons of oil. Turkey had a bioenergy

Figure 2: World nuclear energy map



Source: World Nuclear Association, 2019

installed capacity of 348.80 MW in 2020, and the total bioenergy production in 2020 is 1,321 GW (IRENA, energy.gov.tr).

3.5. Biogas

Biogas is produced after organic materials such as plants and bacteria break down animal products in an oxygen-free environment; this process is called anaerobic digestion. Biogas systems use anaerobic digestion to recycle organic materials and convert them into gaseous energy and biogas containing valuable soil products. Anaerobic digestion is already occurring in nature, landfills, and livestock manure management systems. Biogas contains roughly 50-70% methane, 30-40% carbon dioxide and traces of other gases (Tanigawa, 2017; USDA, 2014). Mixing multiple wastes in the same digester, called co-digestion, can help increase biogas yield. Once biogas is created, it can generate heat and electricity in engines, microturbines and fuel cells. Biogas can be upgraded to biomethane, also called renewable natural gas, injected into natural gas pipelines or stored and used as vehicle fuel (Tanigawa, 2017; Meek, 2017; Han et al., 2011). It is estimated that Turkey's biogas energy potential is equivalent to approximately 2 million tons of oil. It is seen that Turkey has biogas energy installed power capacity of 748 MW in 2020, and the total biogas energy production in 2020 is 3.032 GW (IRENA, energy.gov.tr).

3.6. Urban Waste

Waste-to-energy conversion technologies are promising technologies for converting waste into a usable form of energy, especially for developing countries. Waste-to-energy technologies are also important in reducing global warming. These technologies are generally classified as biological treatment technologies or biochemical treatment and heat treatment technologies (Di Matteo et al., 2017; Korai et al., 2017). Today, world economies are driven by consumer-based lifestyles, where waste generation is the most obvious and inconvenient resource-intensive by-product. Depending on economic development, climate, culture and energy sources, the municipal solid waste composition varies from one country to another. Low-income countries have the highest proportion of organic waste, while in high-income countries, municipal solid waste is predominantly composed of inorganic materials (Trang et al., 2017). According to World Bank data, it is claimed that 1.3 billion tons of waste are produced annually all over the world, and it is estimated that this amount will increase to 2.2 billion tons per year by 2025 (Hoornweg and Bhada-Tata, 2012; Guerrero et al., 2013). Urban wastes in Turkey are under biomass energy. Turkey's potential municipal waste energy generation, which produces a significant amount of urban waste with a population of 84 million, is not clear. However, in recent years, especially in Turkey, energy production from urban waste has started under the leadership of municipalities. It is seen that energy production from urban wastes is 14 G.W. in 2020 (IRENA, energy.gov.tr).

3.7. Generating Energy From The Sea

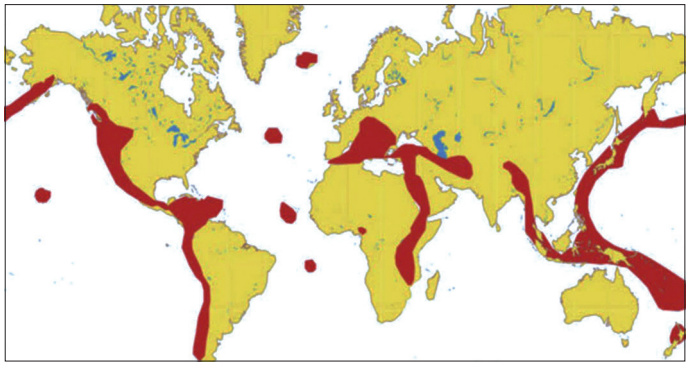
Ocean energy has many forms, including tides, surface waves, ocean circulation, salinity, and thermal gradients. Mechanical forms of ocean energy are important potential energy sources in certain parts of the world. Some countries harness this energy today, but it has limited application due to low efficiencies and high costs. Technology has changed the terms for this type of renewable energy in recent years. More and more countries are funding research and development. There is increasing worldwide interest in using wave energy and sea currents (tidal flow) for electrical power generation. Wave energy is less predictable and is derived from wind energy (Bahaj et al., 2011). Energy production from the sea is achieved in the following ways: Energy production from the sea also has great potential in terms of renewable energy sources. Wave energy and tidal movements should be counted within this framework. As seen in Figure 3, the areas where energy production from the sea is generally the ocean coasts. As Turkey is not connected to the oceans due to its location, the potential to generate energy from the sea is economically very low (Figure 4).

Sea/ocean power generation tidal power plants use the undulating daily movements of the tides. Various devices use this motion to turn turbines and generate electrical energy. Tidal energy involves creating a dam in the tidal basin. A weir is used to divert water into the basin. As the ocean level drops, water can flow back into the ocean. Traditional hydroelectric technologies are used to generate electricity with diverted water. Floating or launching devices, the most well-known method of generating energy from tidal movements, generate electricity from the act of rocking (USDE, 2014, p.213).

3.8. Solar Energy Systems

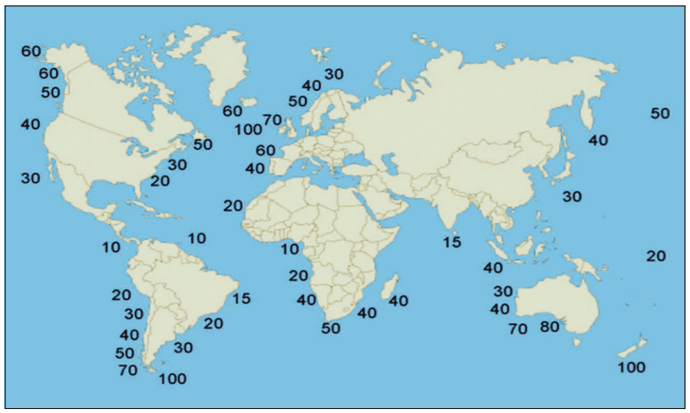
Solar energy systems are based on the principle of generating electricity in photovoltaic (Photovoltaic-PV) cells by the radiation

Figure 3: World geothermal regions



Source: Saibi et al., 2013, p. 1023

Figure 4: Wave energy potential areas in the world.



Source: Waters, 2008, p. 20

emitted from the sun or generating electricity with steam power obtained from heat transfer fluids (Machinda et al., 2011; Romero et al., 2007). These systems can be installed on large fields and the facades of buildings and generate electricity for individual consumption and distribution to networks. The electrical energy obtained can be transferred to the city grids. In addition, individually installed systems can supply electricity to houses or buildings. Solar markets have gained momentum since 2000, with remarkable growth recently. The total installed capacity of solar power generation was almost negligible in the early nineties, and the global cumulative installed solar P.V. capacity has grown from less than 2.6 gigawatts in 2003 to about 509 gigawatts in 2018. China, Japan, Germany and the United States have emerged as the most important markets for solar P.V. installations (Sönnichsen, 2020). Concentrated solar technologies such as solar antenna, parabolic trough, linear Fresnel reflectors and power tower are also gaining momentum for large-scale solar power generation using power loops/motors.

3.8.1. Photovoltaic systems

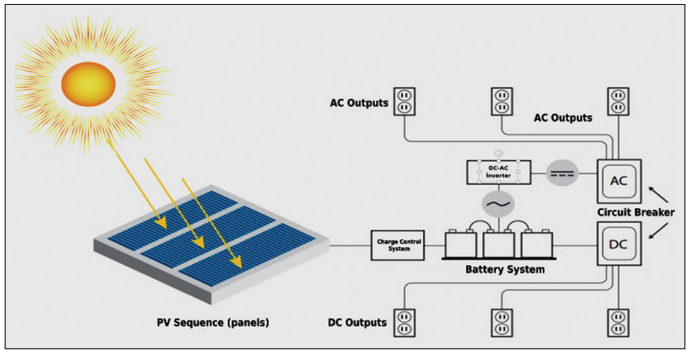
Solar power generation systems consist of panels (P.V. modules), batteries and converter and control systems. There are several types of solar cells used in these systems. Thin-film solar cells can be produced at a lower cost in large production quantities. Therefore, their market share will likely increase in the future. However, they show lower efficiency than wafer-based silicon solar cells (Figure 5).

3.8.2. Concentrated solar energy systems

In Concentrated solar power (C.S.P.) technology, the direct normal radiation of the sun condenses into the heat transfer fluid. It then passes through a series of heat exchangers to produce superheated steam. Steam is converted into electrical energy in a conventional steam turbine (Machinda et al., 2011; Romero et al., 2007). Solar P.V. system can cover up to 10m² of roof area, while only 3m² - 4m² space is required for the concentrated solar energy system. Concentrated solar energy can convert about 90% of solar radiation into heat, while the efficiency of solar P.V. is between 15% and 20% (Noor et al., 2009, p. 1) (Figure 6).

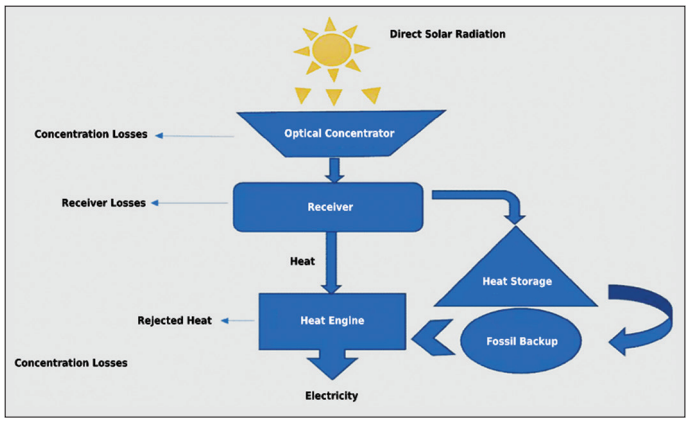
Since solar energy systems are powered by solar energy, they cannot provide sufficient efficiency, which causes a reduction in energy production or energy production. This system has some disadvantages, such as that half the amount of energy can be produced in winter compared to summer and there is no energy production at night. In order to maximize efficiency, the solar energy system should be placed on a flat surface in an optimum position so that it receives maximum sunlight and does not cast shadows on it (Boztepe, 2017; Nfaoui and El-Hami, 2018). In terms of the total solar energy capacity of the countries, China ranks first with 176 GW, followed by the U.S.A. with 62.4 GW. Japan, Germany, India and Italy also have significant solar power generation capacity (Statista, 2020). Turkey has a high solar energy potential due to its geographical location at 32-42 degrees north latitude. Turkey's average annual sunshine duration is 2,741.07 h/year, while the average annual total radiation intensity is 1.527.46 kWh/m2-year. It is seen that Turkey had an installed solar power capacity of 6,667.11 MW in 2020, and the total solar energy production in 2020 is 11,265 GW (IRENA, energy.gov.tr).

Figure 5: P.V. System solar energy generation model



Source: E.C., 2019, p. 6

Figure 6: Concentrated solar energy system solar power generation model

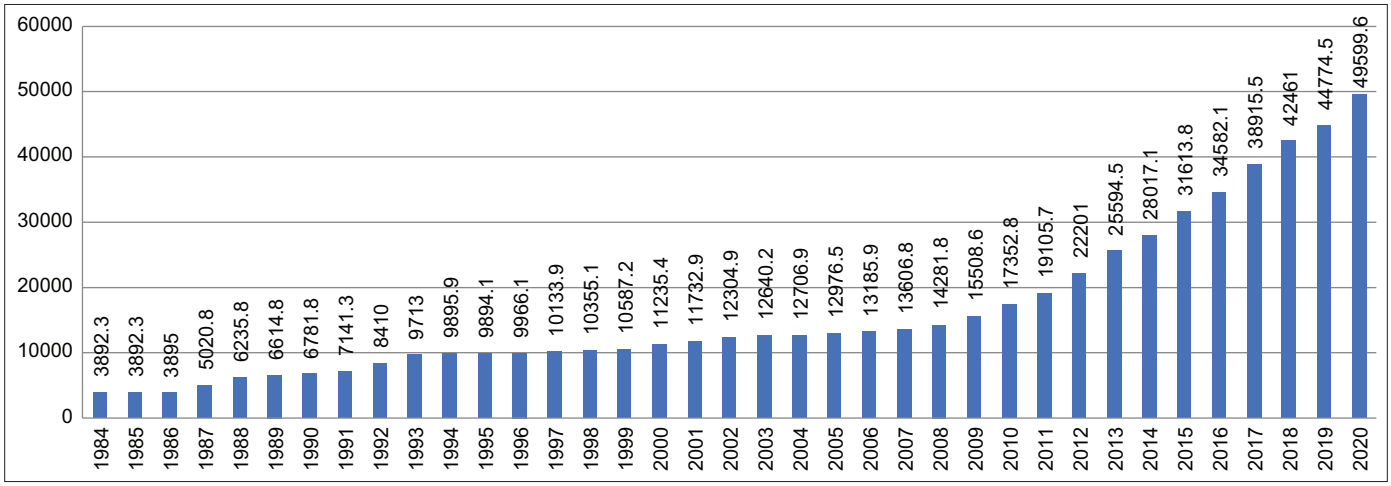


Source: Romero et al., 2007

Turkey's geographical location and climatic conditions are favorable compared to many countries regarding solar energy potential. Turkey's average annual sunshine duration is 2640 hours, which is equivalent to a total of 7.2 hours per day. The region that receives the most sunshine in Turkey is the Southeastern Anatolia Region, followed by the Mediterranean Region (İnce, 2016). Considering the usage areas of solar energy in Turkey, it is seen that it is mostly used in heating greenhouses and buildings, lighting in parks, gardens and parking lots, drying of agricultural products and recently in electricity generation in homes. Generally, Turkey evaluates the advantage of sunbathing to obtain hot water from solar energy rather than obtain electrical energy. The solar collector area installed in Turkey is approximately 12 million m², and the annual production volume is 750 thousand m². Solar energy's annual heat energy production is around 420 thousand T.E.P. (Ton Equivalent Petroleum). In line with these results, Turkey is among the world's leading solar collector manufacturers and users (Alaçakır, 2016) (Figure 7).

Considering the installed power rates of solar energy in the world by country, although the number of sunny days is higher than in other countries, Turkey has a potential of 2,246 MW in installed power capacity as of November 2017 and ranks 15th. Countries that give importance to the use of solar energy, such as China, Japan, and Germany, share the top 3 places in terms of installed power potential (Enerji Atlas, 2017). Turkey's official energy policy is to reduce the country's dependence on external resources until 2023

Figure 7: Current renewable energy installed power capacity (M.W.) in Turkey



Source: IRENA, 2022

and make maximum use of domestic resources by reducing the cost of natural resources. This framework aims to supply 30% of the total electricity production from renewable sources in 2023. When we looked at the distribution of TEİAŞ by resources in Turkey's electricity generation in 2016, natural gas leads the way in electricity generation with a rate of 32%. However, the energy produced from hydroelectric power plants is about 18%, even surpassing imported coal and lignite. The share of wind energy approached 6% (5.65%), while the share of solar energy (0.38%) remained low compared to other energy sources.

4. DISCUSSION AND CONCLUSION

In this study, the current situation of energy resources and renewable energy in the world and Turkey has been evaluated. Turkey has a high potential in renewable energy sources in terms of solar energy, wind energy, geothermal energy, hydropower, biogas energy, biowaste energy and urban waste energy. Since renewable energy sources other than hydropower are relatively new, these energy sources cannot be utilized sufficiently in Turkey. The fact that energy production costs from renewable energy sources are relatively higher than fossil fuels and energy production costs and that these technologies have not yet reached maturity level pose significant risks for companies that will make energy investments. Energy investments in this field pose various risks due to Turkey's insufficient legal regulations regarding renewable energy production. Despite Turkey's widespread use of renewable energy, most of its current energy needs are met from fossil fuels. Recently, energy production in Turkey has shown a trend towards renewable energy. Legal regulations are needed to use renewable energy sources other than hydroelectric energy more effectively. In case studies are carried out to reduce the high investment costs in the installation phase of renewable energy power plants, it can become an alternative energy source with the highest efficiency and availability for the future of Turkey.

Turkey, which is suitable for the use of renewable energy in terms of climate and geography, needs to turn to renewable energy sources due to the increasing energy need in recent years, the risks brought by climate change and the high cost of foreign dependence on energy. In terms of being environmentally friendly and reliable, renewable energy offers an important opportunity for Turkey. World countries are turning to renewable energy sources by considering the unsustainability of fossil fuels and the greenhouse gas emissions they spread to the environment. Considering that a country like Germany, whose climatic conditions are not as favorable as Turkey's, meets a significant part of its electricity needs from renewable energy, Turkey should not waste time to benefit from this potential. The strategy that can be followed is to increase investors' incentives for installing clean power plants.

In research on the effect of solar energy incentive programs on profitability in Turkey, it has been determined that the Hatay Karaağaç region is suitable for solar power plant investment (Keser, 2010). In another study on the financing of renewable energy resources, the technical and financial analyses of a wind power plant producing electrical energy and a hydroelectric power plant were compared. As a result of the study, it has been determined that renewable energy sources have shown remarkable development in recent years, but their share in current energy production and consumption remains quite low (Albayrak, 2011). This research has also determined that as the demand for energy production increases, loans provided to the sector also increase. In another study, to examine the applicability of P.V. systems in Turkey, the solar radiation values received on the surface and annual energy production levels on solar radiation and financial investment techniques were emphasized. Based on the radiation rates and average sunshine hours of the selected regions, various suggestions were made by determining how many panels are needed to provide the calculated amount of energy produced.

As a result, Turkey has big wind and solar energy potential. With its new and innovative energy applications, Turkey can provide all the energy it needs and even more from its own local and renewable resources within the framework of the European Union's clean development principles and water framework directives. The energy potential of Turkey's river resources is one-quarter of the wind potential and one-fifth of the solar potential. In order to benefit from renewable energy, significant studies are required on

solar energy financing, appropriate financing, compulsory access and renewable energy portfolio standards. In order to benefit from renewable energy at a higher level in the long term, necessary legal arrangements should be made to pave the way for customer investments, group shares and third-party agreements. Various uncertain factors such as non-renewable energy cost, carbon price, renewable energy cost and price subsidy all need to be evaluated in a model and a renewable energy action plan needs to be prepared and put into practice.

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