

OVERVIEW OF SOLAR ENERGY CONVERSION IN TURKEY

İsmail KARALI¹, Mehmet Ali ÖZÇELİK^{2}, Ahmet KABUL³*

^{1,2} Gaziantep University, Technical Sciences, Department of Electricity and Energy, Turkey

³Süleyman Demirel University, Department of Energy Systems Engineering, Isparta, Turkey

*Corresponding author; ozcelik@gantep.edu.tr

Abstract

According to global energy statistics, the amount of energy consumed increased from 8557 Million Tons of Equivalent oil (mtep) in 1990 to 13509 mtep in 2016. Research has shown that life span of 200 years of coal, 40 years of oil and 60 years of natural gas. Therefore, it is foreseen that fossil fuels will not be able to respond to the increase in energy needs and will fall behind energy consumption. because of this reason, it has been considered important to search for new energy sources to prevent future energy crises. Today, it can be said that this searching mostly focuses on renewable energy sources.

Research suggests that renewable energy will constitute approximately 40% of total energy in the future. Although the importance of hydroelectric and wind energy from renewable energy sources has been understood much earlier, it is seen that the importance of solar energy has been realized in recent years. It is estimated that the highest increase in renewable energy sources between 2018 and 2050 in electricity generation will be in solar energy. Based on the years 2010 and 2018, while in 2010 was obtained 40,871 MW energy from the solar and 180,854 MW energy from the wind, but in 2018 was obtained 485,826 MW energy from the solar and 563,726 MW energy from the wind. According to these results, the energy obtained from the solar has increased approximately 12 times in the last nine years, while the energy obtained from the wind has increased approximately 4 times.

Keywords: *Solar energy and its potential, Renewable Energy, Energy conversion*

1. Introduction

Energy is the ability to do business briefly. Therefore, countries also need energy to do business and to have an independent future. But, beside the increase in demand for energy increases day by day, energy costs increase, environmental factors and scarcity of resources bring about energy concerns.

According to the global energy statistics, the amount of energy consumed worldwide increased from 8557 million tons of oil (mtep) in 1990 to 13509 million tons of oil (mtep) in 2016 [1]. Research shows that fossil resources will be insufficient to respond to the increase in energy needs. These researches show that there is a life span of coal of 200 years, oil of 40 years and natural gas of 60 years. In addition, this study reveals that fossil fuel formation around the world lags behind energy consumption [2]. In parallel with the increase in the world population, the current level of energy use is foreseen to increase by 50-60% in the future [3]. In this context, the search for new energy sources is inevitable. The main criteria of this energy search are continuity, environmentalism, accessible and cheaper energy [4].

It is a well-known fact that renewable energy sources are accepted by the broader community in which they overlap with the above mentioned criteria. International energy companies anticipate that the share of renewable energy in total energy production will increase around 40% in the future [5]. Although the importance of hydroelectric and wind energy from renewable energy sources has been understood much earlier, it is seen that the importance of solar energy has been realized in recent years. It is estimated that the highest increase in renewable energy sources between 2012-2040 to electricity generation will be solar energy [6]. Figure 1 shows the distribution of all countries' investments in renewable energy sources by years.

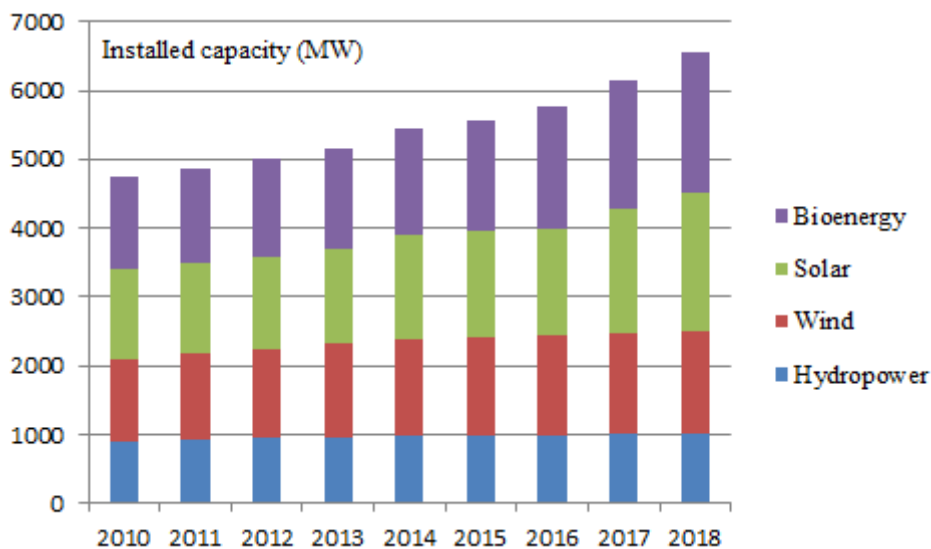


Figure 1. Renewable Energy Installed Power Capacity in World[16].

It can be seen from the graph that while the high capacity increase is seen in the solar and wind energy, the capacity increase in other renewable energy sources is lower. Based on the years 2010 and 2018, while in 2010 was obtained 40,871 MW energy from the solar and 180,854 MW energy from

the wind, but in 2018 was obtained 485,826 MW energy from the solar and 563,726 MW energy from the wind. According to these results, the energy obtained from the solar has increased approximately 12 times in the last nine years, while the energy obtained from the wind has increased approximately 4 times. In the light of these values, it is seen that the investments made in solar energy in recent years are much more than the investments made in other renewable energy sources and therefore the importance given to solar energy has increased. According to the estimates of the International Energy Agency (IEA), investments in solar energy are expected to reach an installed power capacity of 1721 GW by 2030, not to slow down in the near future [7].

2. Solar Energy Installed Power Capacity of European Union Countries

One of the most important reasons for the interest in renewable energy sources is the harmful emissions resulting from the combustion of fossil fuels. European Union countries and other countries that want to reduce their emissions value think that the solution of the problem is in solar and other renewable energy sources. At this point, EU countries plan to increase the share of renewable energy to 34 percent by 2030, according to the values of the report of 2016 which published by the International Renewable Energy Agency IRENA in Brussels [8]. In this way, it is thought that the targeted emission values will be achieved and in addition to the emergence of new business areas, it will contribute positively to the revival of the national economies. Figure 2 shows the distribution of investment in renewable energy sources of the European Union countries by years.

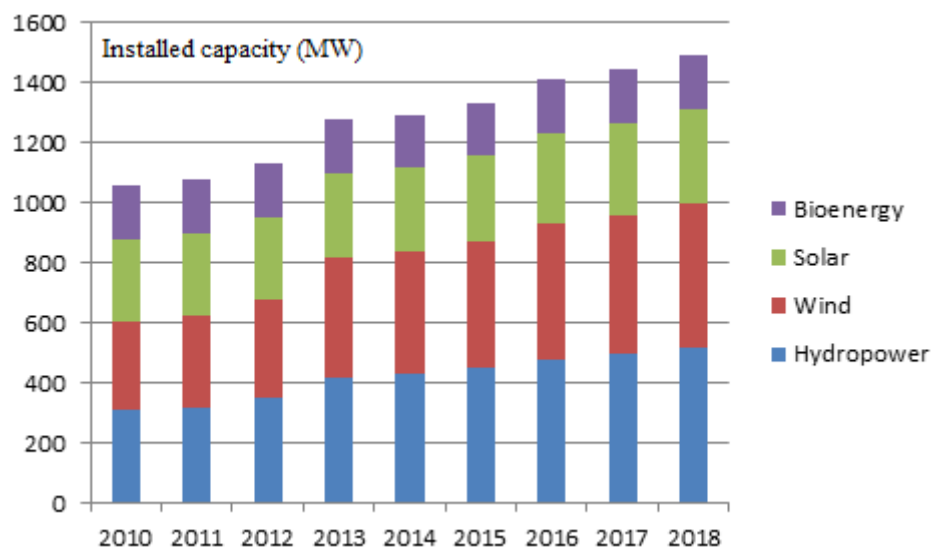


Figure 2. Renewable Energy Installed Power Capacity Across European Union Countries[16].

While the high capacity increase in the European Union is observed in solar and wind energy, it is observed that the capacity increase in other renewable energy sources is much lower. Considering the last nine-year process in EU countries, while in 2010 was obtained 30,857 MW energy from the solar and 84,922 MW energy from the wind, but in 2018 was obtained 121,692 MW energy from the

solar and 182,491 MW energy from the wind. According to these results, while the energy obtained from the sun increased by 4 times in nine years, the energy obtained from the wind increased by 2 times. Although the European Union's investment in solar energy showed a rapid increase, it remained below the rate of increase in the world average. Reason of this can be attributed to the fact that other EU countries except Germany and Italy do not invest enough in solar energy, and in addition, China's high investment in solar energy raises the world average.

3. Germany's Solar Power Installed Power Capacity

Germany ranks first in the world in terms of PV system power per capita [6]. When Compared to other countries of the EU, Germany has shown rapid growth in solar and other renewable energy investments and is the leading country in the European Union. Germany, which is expected to invest more than 200 billion euros in renewable energy sources, is expected to provide jobs to about 500,000 people by 2020 [9]. Figure 3 shows the distribution of Germany's investment in solar energy by years.

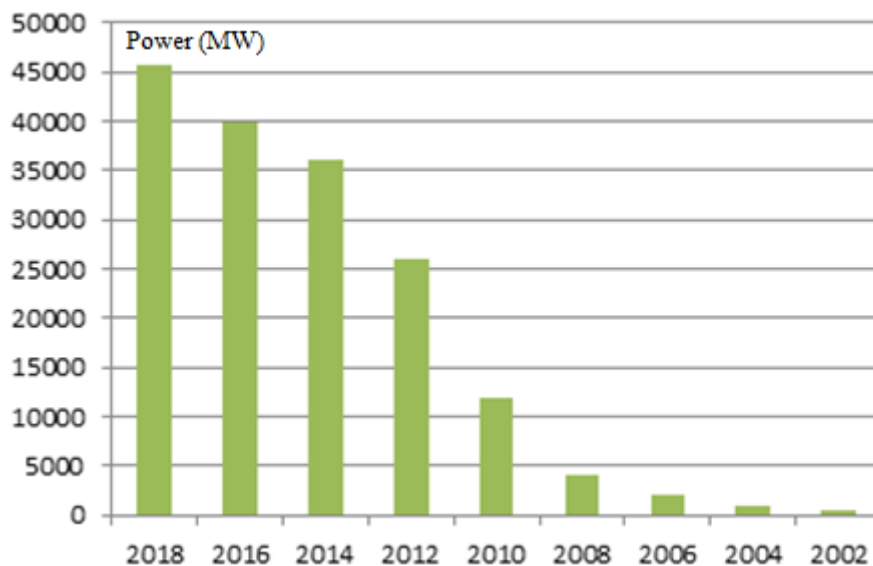


Figure 3. Germany's solar power installed power capacity [17].

As it is seen in the graph, Although The Germany have worse climate than Turkey in particular by making the necessary investments in solar energy in recent years has become a leader in the region and because of this reason has been a role model to many countries. The power which Germany generated 47,780 MW from the solar energy is approximately 38% of the power which European Union obtained from solar energy.

4. China's Solar Power Installed Power Capacity

China, which has surpassed success of Germany in solar energy investment, has the largest solar panel fields in the world and is the leading country in this field with the technologies which they have developed in this field. As of 2018, China alone produced about 1.5 times the total PV power

produced by all European countries (121,692 MW). Moreover, China which produced approximately 36% of the power generated by all countries (485,826 MW) with 174,630 MW of solar power, It is expected that by 2030 it will increase its solar energy investment capacity to 200 GW [10]. But, considering the year-end gains of 2018, it can be foreseen that this country will reach its 2030 targets much earlier. China, which is also the world's largest producer of solar panels, produces more than 60 percent of total panel production, according to data from the International Energy Agency (IEA) [11]. This situation has created a serious business area in China with the increasing interest in solar energy in recent years [11]. According to the International Energy Agency (IEA) data, China reached their targets of 2020 three years ago in 2017. Table 1 shows the distribution of China's solar power over the years.

Table 1. China's Solar Power Installed Power Capacity [18]

SOLAR POWER INSTALLED POWER / MW										
YEAR	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
INSTALLED POWER/ YEAR	160	500	2.50	5.00	9.50	10.560	15.130	34.540	52.830	44.38
TOTAL CAPACITY	300	800	3.30	8.30	17.8	28.199	43.180	77.420	130.25	174.6

As can be seen from the graph, China has made a very rapid development in investments of solar power in recent years. Of course, the increase in industrial production in China and the increase in oil prices in recent years can be said to be the reasons for this rapid development.

5. Turkey's Solar Power Installed Power Capacity

In particular, China, Germany and other developed countries have shown their successful breakthrough in solar energy also can serve as a positive example for Turkey's renewable energy policy. Turkey has a very high solar energy potential due to its geographical location is located. According to Solar Energy Potential Atlas to (GEPA), Turkey's total annual sunshine duration of 2,741 hours, 7.5 hours per day and an annual total incoming solar energy 1,527 kWh / m².year, the daily average is 4.18 kWh / m².day [12]. In 2017, total solar collectors area in Turkey reached to 20.000.000 m² and 823.000 tons of petroleum heat energy was obtained [12]. In 2017, in addition that, 2.9 billion kWh of electricity was generated from solar energy [12]. According to the researches of the Vienna technical University - Energy Economics Group, the distribution of the Solar Energy Technical Potential according to European countries is shown in Figure 4.

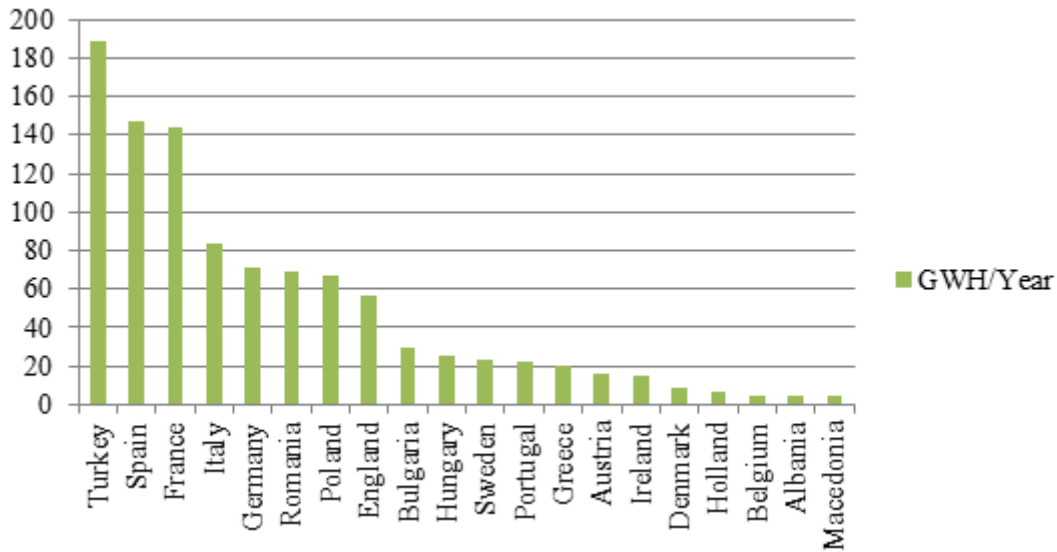


Figure 4. Distribution Of Solar Energy Technical Potential By European Countries (GWh/Year) [19]

As shown in the figure, Turkey, which has 189 GWh / year solar energy potential is in first place in Europe. Result of this information, solar energy potential of Turkey is greater than about 2.5 times the solar energy potential possessed by Germany.

Total installed capacity of solar power in Turkey is planned 5 thousand MW as target of 2023 [13]. But, as shown in Table 3, in the end of 2018. Turkey 4.981 MW unlicensed and 81 MW licensed solar PV power has an installed capacity of 5.062 MW in totaly. In this informations light, Turkey have reach in 2018 for target of 2023. Turkey has increased investment in solar energy in recently. Table 2 shows the total installed capacity of solar energy in 2018 and the total installed capacity of solar energy until 2018 on a global scale.

Table 2. Top 10 Countries in World By 2018 And Total Solar Power Installed Capacity Power [20]

	Investment for 2018			Total investment including Year 2018	
1	China	45.0 GW	1	China	176.1 GW
2	India	10.8 GW	2	India	62.2 GW
3	American	10.6 GW	3	American	56.0 GW
4	Japan	6.5 GW	4	Japan	45.4 GW
5	Australia	3.8 GW	5	Australia	32.9 GW
6	Germany	3.0 GW	6	Germany	20.1 GW
7	Mexico	2.7 GW	7	Mexico	13.0 GW
8	Korea	2.0 GW	8	Korea	11.3 GW
9	Turkey	1.6 GW	9	Turkey	9.0 GW
10	Netherlands	1.3 GW	10	Netherlands	7.9 GW

As can be seen in the Table 2, Although Turkey has in recent years invested in solar energy and has entered into the top 10 countries in recent years, it could not enter into the top 10 countries in total.

In this context, when we look at the gains of the top 10 countries as a result of the investments they have made, it can be said that we are still far from the target. As shown in Table 3, investments in solar energy have increased. However, Turkey needs more energy because of the growing economy and increasing production. Therefore, Turkey should be increase much more investments of solar energy.

Table 3. Turkey's Solar Power Installed Power Capacity[21]

SOLAR POWER INSTALLED POWER / MW		
RESOURCES	AS OF END OF 2018	AS OF END OF 31 JANUARY 2019
Solar Energy(Unlicensed))	4.981,20	5.098,50
Solar Energy	81,7	81,7
Wind Energy	6.942,30	6.946,80
Wind Energy (Unlicensed)	63,1	63,1
Hydropower (Dam)	20.536,10	20.567,50
Hydropower (Streaming)	7.747,10	7.783,70
Geothermal	1.282,50	1.302,50

The investments made in Turkey in 2017 and 2018 has increased significantly compared to previous years. As of the end of 2007, was obtained 3 MW from solar energy, up to 250 MW in 2015 and up to 5,062 GW by the end of 2018 [16]. It is now and also coming century, solar energy will continue to take important role in terms of energy resources [22]-[23].

6. Conclusion

In particular, the rise in energy costs in recent years, the difficulties in supplying energy and political pressures over energy have made the value of energy quite important today. Turkey have not high potential in terms of energy resources and especially fossil resource. In this reason, Turkey dependent on foreign countries, the use of all domestic resources and the assessment of all possibilities are necessary to break addiction. The fossil fuels of the country should be used such as coal. Moreover, in the medium term, it should increase its energy diversity by completing nuclear power plants in order to reduce or eliminate energy dependence with other countries. However, the general projection that the energy future is in renewable energy sources in the long term should not be ignored. Because of this and the case of China and Germany examples, Turkey needs to energy much more should be investment from renewable energy sources and primarily solar energy. Developing more technology in this direction are high importance for Turkey.

Countries like China and Germany did not produce energy only in solar power. Thanks to the experience gained in these countries, they have also produced and exported the technology needed for the installation and operation of solar energy systems. China produces 60% of PV panels produced worldwide [11]. Similarly, according to 2010 data in Germany there are approximately 10 thousand companies, including assembly and suppliers, and more than 200 companies producing PV cells and modules, it is explained that the number of full-time workers in these companies is about 133

thousand [9]. However, If considering that Germany has increased its investments in solar energy more than doubled from 2010 to 2018, it can be estimated that the number of workers working in the same period has increased approximately fourth period. Therefore, both countries have created an important business area for the citizen of the country and contributed to the economy.

As of the end of December 2018, total installed power of 4981 MW unlicensed and 81 MW licensed solar power plant in Turkey has been increased to 5,062 GW. Turkey has an aboriginal rate of more than 50 percent on PV panel basis and more than 75 percent on solar energy system basis [14]. Currently, panels, Transformers, cutters, steel structures and cables are manufactured in the country. However, cell production, which is the most important part of solar energy systems, has still not been indigenized as of 2018[14]. Taking into account the unemployment and current account deficit problems experienced in the country, it will be an important opportunity all parts needed in solar energy systems to be produced immediately in our country.

Orientation to solar energy systems on a global scale is fast, moreover it is estimated that it will reach 1721 GW by 2030 [7]. As a result of this rapid development, the PV panels, which are known to have a useful life of 25-30 years, are projected to generate 9.57 million tons of waste by 2050[15]. As a result, it is already foreseeable that PV panels and other parts used in solar energy systems will pose a waste problem in the near future. Therefore, in order to prevent future environmental problems due to these wastes and to turn this problem into an opportunity, the necessary studies should be carried out at the point of recycling of wastes occurring in part of solar energy systems.

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