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Feasibility Study of a Solar Power Plant Installation: A Case Study of Lake Burdur, Turkey

İbrahim KIRBAŞ[1*], Ahmet ÇİFCİ[2]

[1]Burdur Mehmet Akif Ersoy University, Department of Electrical and Energy, 15100 Burdur, Turkey
[2]Burdur Mehmet Akif Ersoy University, Department of Electrical-Electronics Engineering, 15030 Burdur, Turkey
ikirbas@mehmetakif.edu.tr

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Abstract: Continuous growth in the increase of energy consumption in the world has triggered the issue of energy demand. This has led to a shift towards renewable energy sources. Solar energy is one of the renewable energy sources that will be a leading renewable energy source for electricity generation in the future. Generation of electricity through solar power plant is clean, environment-friendly and reliable. This study is done to evaluate the feasibility of grid connected solar power plant for the vicinity of Lake Burdur, Burdur, Turkey (Latitude: 37° 45′ N, Longitude: 30° 12′ E). This power plant to be established will be able to generate 2.013.000.000 kWh of electricity each year. This means contributing approximately 1.5 billion TL to the national economy every year. With an installed capacity of 1220 MW, it will be the largest solar power plant in the country.

Keywords: Lake Burdur; photovoltaic; solar energy; solar power plant.

Bir Güneş Enerji Santrali Kurulumunun Yapılabilirlik Çalışması: Burdur Gölü, Türkiye Örneği

Öz: Dünyada enerji tüketimindeki artıştaki sürekli büyüme, enerji ihtiyacını tetiklemiştir. Bu da yenilenebilir enerji kaynaklarına yönelmeyi beraberinde getirmiştir. Yenilenebilir enerji kaynaklarından biri olan güneş enerjisi, gelecekte elektrik üretimi için lider bir yenilenebilir enerji kaynağı olacaktır. Güneş enerji santrali ile elektrik üretimi temiz, çevre dostu ve güvenilirdir. Bu çalışma, şebekeye bağlı güneş enerji santralinin Burdur Gölü çevresinde uygulanabilirliğini değerlendirmek için yapılmıştır (Enlem: 37° 45′ K, Boylam: 30° 12′ D). Kurulacak olan bu santral her yıl 2.013.000.000 kWh elektrik üretebilecektir. Bu da, her yıl ülke ekonomisine yaklaşık 1,5 milyar TL katkı sağlamak anlamına gelmektedir. 1220 MW kurulu güç ile ülkenin en büyük güneş enerji santrali olmaya aday olacaktır.

Anahtar Kelimeler: Burdur gölü; fotovoltaik; güneş enerjisi; güneş enerji santrali.

1. Introduction

The importance of renewable energy sources is increasing every day in Turkey in parallel to the world. Renewable energy sources are preferred due to less impact on the environment despite their negative characteristics such as high production and installation costs and low efficiency.

Solar energy in Turkey is used in many areas such as producing hot water, drying crops, heating buildings and generating electricity. Solar energy was realized as a renewable energy in the early 1960s [1]. With The Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (Law No. 5346), electricity has been sold to the national grid since

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2005. Starting from this year, solar power plants with an average capacity of 2 MW have been started to be built and operated in various regions. The fact that photovoltaic battery production is not made in our country and the lack of manpower with adequate knowledge has kept the initial investment costs high. But in recent years thanks to trained engineers and technicians, we have been able to build the solar power plant ourselves.

As of the first half of 2018, the installed capacity of our country has reached to 87,139 MW. By the end of the first half of 2018, the distribution of our installed power by resources; 32,0% hydraulic, 26,4% naturel gas, 21,4% coal, 7,7% wind, 5,4% solar, 1,3% geothermal and 5,8% other sources, as seen in Fig. 1. In addition, the number of electricity generation power plants in Turkey increased to 6.886 (including unlicensed plants) as of the end of the first half of 2018. The number of existing plants is as follows: 636 of hydroelectric, 41 of coal, 232 of wind, 40 of geothermal, 303 of natural gas, 5422 of solar, 212 of other power plants [2].

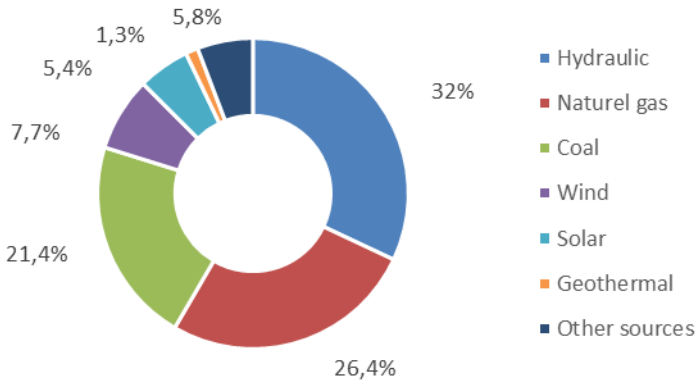

Figure 1. The installed power by various energy sources in Turkey

The total installed capacity of the PV solar power plant as of the end of June 2018 is 4726 MW, with 4703 MW unlicensed and 23 MW licensed. This corresponds to 5,4% of our installed capacity and 0,98% of our annual electricity demand [2]. Annual electrical energy is very low in terms of our need. In developed countries, this rate is above 20% [3]. In addition, while the feasibility studies of solar power plants are generally taken into account, they are generally built on agricultural land because of the sunbathing rate.

With the depletion of the spring water that feeds itself and the decrease in the amount of water that comes with the rainfall, Lake Burdur is rapidly drawn every day and leaves a dry land behind. Lake Burdur water is extremely alkaline, hard and salty. Due to the depletion of water, the remaining land is not suitable for agriculture. Growing plants such as capers and lavender is at research level [4].

Many research papers have been performed in order to evaluate the feasibility of a solar power plant. A techno-economic feasibility study for a grid connected solar photovoltaic system of 500 kW in Bangladesh was conducted by Mondal and Islam [5]. Chandel et al. [6] analyzed an economic viability study of solar photovoltaic power plant of 2,5 MW at Jaupur, India. Mandal and Panja [7] considered a 1 kWp (kilowatt peak) small scale grid connected solar photovoltaic system to evaluate the feasibility of rooftop solar photovoltaic system for School of Energy Studies Building at Jadavpur University, Kolkata, India. Kazem et al. [8] investigated the optimal configuration for a 1 MW grid connected solar photovoltaic plant in Adam City, Oman. A viability analysis of three small photovoltaic systems located in different cities of Peru was discussed by Espinoza et al. [9]. In the present study, it is aimed to investigate the feasibility of a solar power

plant installation in lands which are not suitable for agriculture, which is left behind by Lake Burdur water.

2. Study Location

Lake Burdur is one of the largest and deepest lakes of Turkey, located between Burdur and Isparta provinces at the Turkish Lake District (37° 43′ 351″ N, 30° 10′ 878″ E), as shown in Fig. 2. Catchment area is 6150 km^2. It has an area of 250 km^2 at 854 m elevation. The average lake area is 153 km^2 [10]. As it is understood from the geographical information above, there is an area of approximately 100 km^2 around the lake.

Figure 2. Lake Burdur

The available space for the solar power plant around the lake was calculated as 20.109.000 m^2 (20,10 km^2) as shown in Fig. 3. This area is located in the northeast of the lake. Although there are not such large flats in the remaining parts of the lake, it is considered to be an area of approximately 30 km^2.

Figure 3. The northeast side of the Lake Burdur

3. System Description and Results

In the borders of Isparta province, there is a solar power plant called Gökçekuyu which is approximately 12 km away from the region we selected for the study. The coordinates of

Gökçekuyu Solar Power Plant are 37°52′ N, 30°25′ E. This solar power plant was taken as a reference since it has the same climatic conditions as the proximity to the region and has the same sunbathing rate (Fig. 4).

Figure 4. The location and distance of Gökçekuyu Solar Power Plant

The specifications of Gökçekuyu Solar Power Plant are given in Table 1.

Table 1. Gökçekuyu Solar Power Plant specifications

Installed Capacity	1,98 MW ≈ 2 MW
Installed Area	32.790 m^2 = 0,033 km^2
Solar Panel Brand Name	Hanwha
Number of Solar Panel	7920 (Each one 270 W)
Electricity Generation in 2018	3.300.000 kWh
Financial Provision of Electricity Generation in 2018	2.344.252 TL[1]
Operating Company	Söyleyici Enerji
Installation Cost (2016 yılı)	3.872.625 TL

When settled as 0,033 km^2 parcels on an area of 20,10 km^2 in the vicinity of Lake Burdur, 610 solar power plants can be installed equivalent to the Gökçekuyu Solar Power Plant. The area of 10.000 m^2 was left for the administrative building, transformer and road. The electricity to be produced from the solar power plant will be increased to the medium voltage level with the transformer and connected to the nearest lines of the distribution company and transferred to the system. In addition, 610 solar power plants mean 1220 MW installed capacity. In Turkey, the electrical energy obtained from 5422 solar power plants is 4726 MW. This means that 25.81% of the electricity generated from the current installed 5422 solar power plants in Turkey will be obtained from a single solar power plant. A schematic representation of the solar power plant under study is shown in Fig. 5.

If one of the established power plants produces 3.300.000 kWh of electricity per year, 610 units of the solar power plant will be produced 2.013.000.000 kWh of electricity per year. The government offers 0.133 cent/$ payment amount per kWh. It is foreseen that this solar power plant will produce

[1] Indicative Exchange Rates Announced at 15:30 on 01/02/2019 by the Central Bank of Turkey (1 USD=5,3412 TL)

2.013.000.000 kwh of electricity per year. Thus, 267.729.000 dollars will be obtained. Taking into account that 1 dollar is 5,3264 TL[2], the first year provides a gain of 1.426.031.746 TL.

Figure 5. Schematic Diagram of the solar power plant under study

4. Conclusions

In order to expand the use of renewable energy sources for the purpose of electricity generation various arrangements are made in Turkey and in the world. The importance of this issue is emphasized by the laws. Solar energy generation is clean, environment-friendly and economical. A feasibility study of a solar power plant for the vicinity of Lake Burdur, Burdur, Turkey was carried out in order to encourage the use of solar power plant in Turkey based on the obtained results. The most striking feature of the region is that the lake basin is not suitable for agriculture. Therefore, there is no environmental problem for the solar power plant to be installed in these areas. The power plant will be able to generate 2.013.000.000 kWh of electricity per year as clean energy and a contribution of approximately 1,5 billion TL to the national economy every year. With this plant, which will be the largest solar power plant in the country with an installed capacity of 1220 MW, it will make a significant contribution to the installed capacity of the country's electricity generation.

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