

Wind Energy in Turkey: Potential and Development

Eylem YILMAZ ULU
Pamukkale University

Omer Altan DOMBAYCI
Pamukkale University

Abstract: According to the scenarios, despite the relatively low share of fossil fuels in the period until 2040, these fuels will continue to be dominant sources. It is estimated that the share of nuclear energy in primary energy sources will increase and the share of renewable energy sources will be 16.1 percent in 2040. According to the current policies scenario, global electricity demand is expected to increase by an average of 2.3 percent each year and increase by 80 percent from its present value by 2040. In order to meet this increase the share of renewable energy sources like solar, wind, geothermal, etc. in energy production needs to be increased. Turkey's wind energy potential is estimated to be 48 GW, i.e. 120 billion kWh. The number of power plants that generate electricity based on wind energy is increasing every year, and according to the current data, there are 155 licensed power plant with the value of 6437.9 MW and 39 unlicensed wind power plant with the value of 28.48 MW. In this study, development and potential of wind energy in Turkey has been examined with the latest data.

Keywords: Wind energy, Wind energy power plants, Wind turbine, Energy strategies, Turkey

Introduction

Turkey is located in a very important region in which a large portion of the world's oil and gas reserves are located due to its geographical location. Due to its important geographical position Turkey has a great role like being an energy bridge between east and west, between south and north. But Turkey's aim is not only to be a bridge also produce its own energy. Because a large amount of Turkey's energy needs are met from imported sources. Nearly seventy-five percent of Turkey's demand is met by imported fossil fuels. And this situation damages our economy and environmental health.

Our country is working intensively to meet the increasing energy demand with the importance given to investments in the field of energy and with the importance given to the energy relations with other countries in order to provide energy supply and demand security. Since the beginning of the year 2000, wind-based power generation plants have been established in our country and since 2014 solar-based power generation plants have started to be established and thus the usage rate of fossil energy resources that create environmental pollution has been reduced. It is better understood how the right decision to move to domestic, clean and renewable energy sources when considering the damage done to the country's economy by the imported fossil energy sources, the environmental pollution that may be caused and the energy shortage that may arise in the event of any disagreement on the energy relations. In our country, the number of geothermal and sun-based power generation plants, especially wind, is increasing by day.

Wind Energy Situation in Turkey

The wind is caused by the solar radiation. The different warming of the earth surface causes the movement of the air. Approximately 2% of the solar energy that reaches the earth is converted into wind energy (Web 1).

There are some disadvantages of wind power generation applications;

- The initial investment cost is high,

- This is an Open Access article distributed under the terms of the Creative Commons Attribution-Noncommercial 4.0 Unported License, permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

- Low capacity factors,
- Variable energy production.

Besides the disadvantages, there are also advantages;

- Renewable, clean and eco-friendly,
- Reliable, continuous and cost-effective resource,
- Maintenance and operating costs low,
- Facility technology and operation is simple,
- Commissioning time is very short.

In line with this information, it is seen that electricity generation from wind energy is much cleaner and economical compared to fossil fuels.

Turkey is situated between 36-42⁰ north latitude and between 26-45⁰ east longitude. In Turkey, 50 m above ground level and wind speeds of over 7.5 m/s, 5 MW of wind power plants can be established per km areas as seen in Figure 1. In line with these assumptions, the Potential Wind Energy Map (PWEM), which contains wind resource information generated using medium-sized digital weather forecasting model and micro-scale wind flow model, was prepared by the Ministry of Energy and Natural Resources. The wind energy potential of Turkey has been estimated as 48,000 MW. The total area which is equivalent to this potential is just 1.30% of the total surface area of Turkey (Web 1).

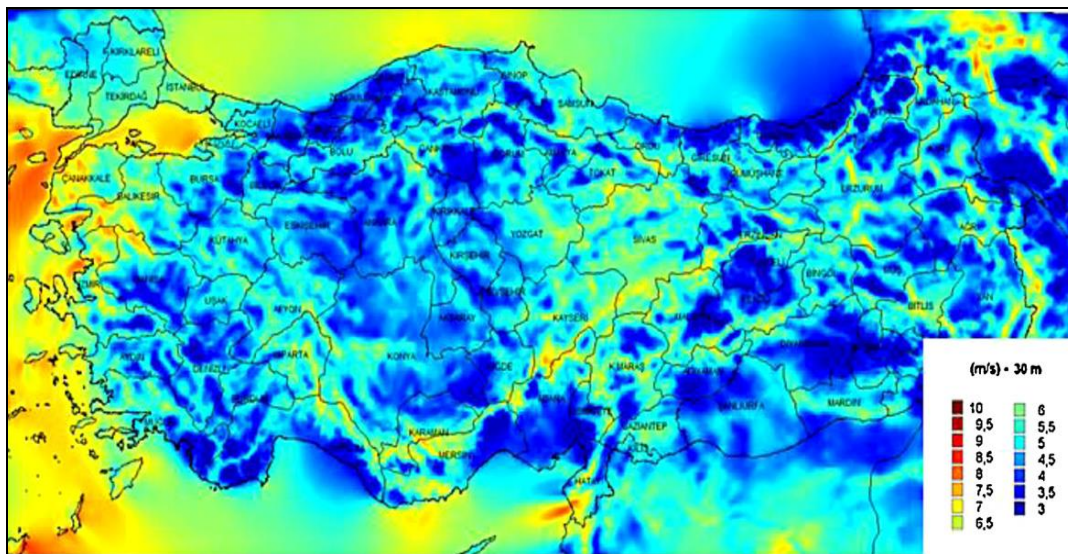


Figure 1. Wind velocity distribution in 30 m high in Turkey

Turkey has large amount of wind potential, but the cumulative installed power capacity is 7.012,75 MW as seen in the Figure 2 (Web 2), (TWEA, 2018).

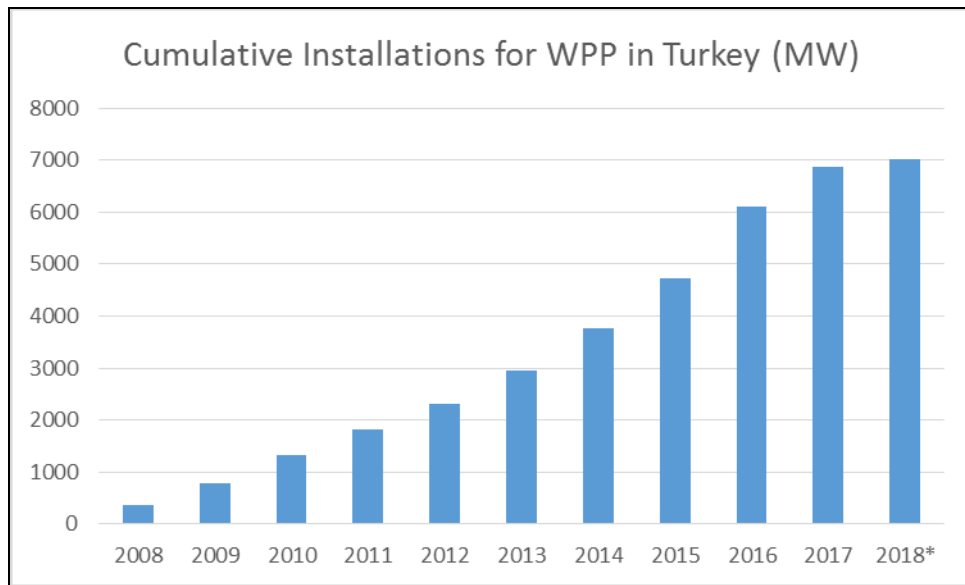


Figure 2. Cumulative Installations for wind power plants(WPP) in Turkey (MW)

Today, approximately 6% of the energy consumed by wind meets our country's first wind power plant was established in 1985 in Çeşme with the capacity of 55 kW. In 1998 the second wind energy power plant was established in Alaçatı with the capacity of 1.5 MW. Against in 1998 another wind energy power plant which consists of 12 turbines was established in Alaçatı with the capacity of 7.2 MW. The third wind farm in Turkey which had a capacity of 10.2 MW was established in 2000, in Bozcaada and 17 wind turbines which have a power of 600 kW (Kenisarın et. al., 2006, Kaygusuz et. al. 2002, Akkaya et.al. 2007). Since the beginning of 2000, the installation of power plants based on wind energy has increased and continued to date. Annual growth of wind power plants installation in Turkey shown in Figure 3 (TWEA, 2018).

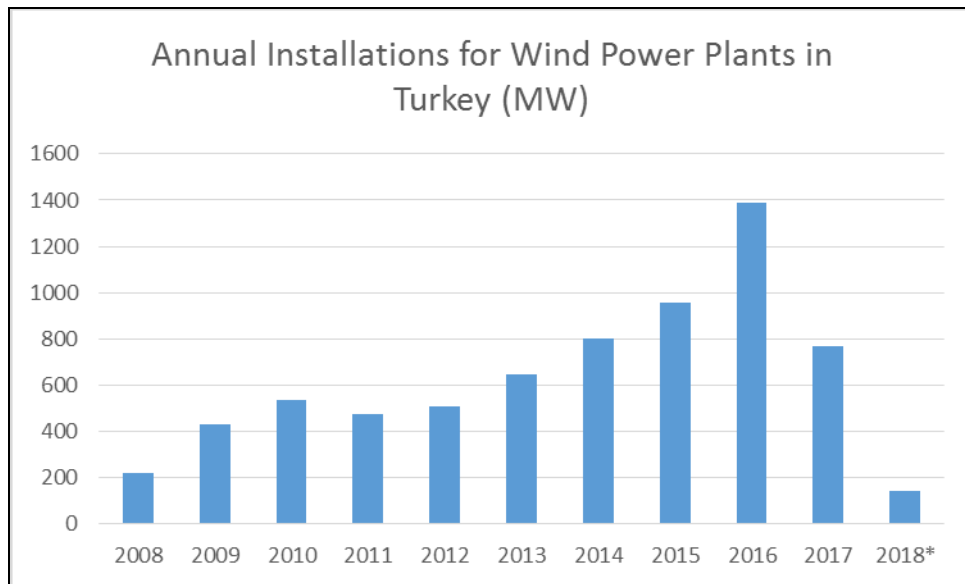


Figure 3. Annual Installations for Wind Power Plants in Turkey (MW)

Annual average wind energy density(W/m^2) and wind speed (m/s) values of Turkey are shown in Table 1 according to regions. Relating to high wind power densities, wind speeds take high values at Marmara, Aegean and South-East Anatolia. The Marmara region appears to be the region with the highest wind speed values. The annual average wind speeds take the value of 3.29 m/s in the Marmara region. Therefore, wind power plants are mainly established in Marmara, Aegean and South-East Anatolia regions where wind speed is high. Operational Wind Power Plants According to Regions in Turkey shown in Figure 4. (TWEA, 2018)

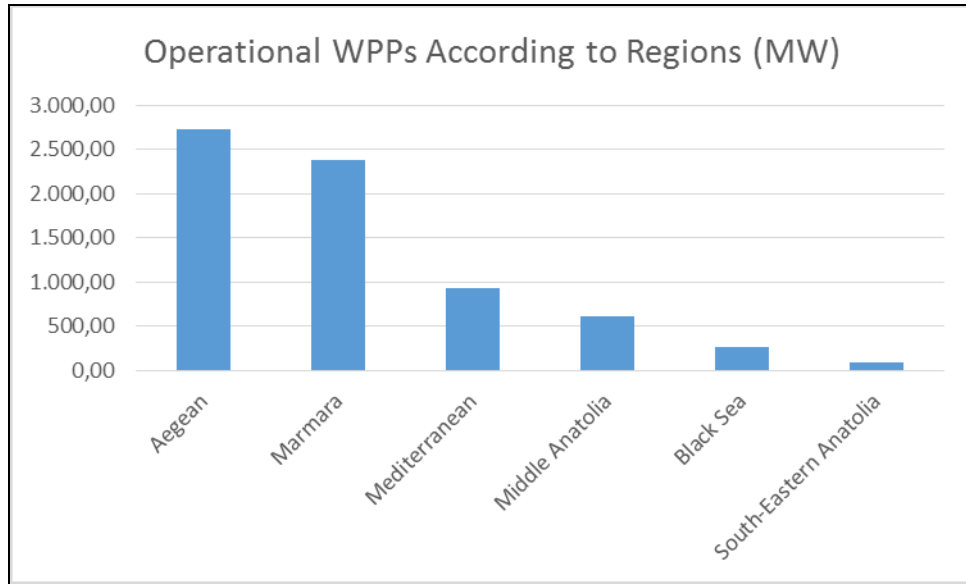


Figure 3. Operational wind power plants (WPPs) according to regions (MW)

According to the data from the General Directorate of State Meteorological Studies, Turkey's annual mean wind speed is 2.58 m/s and wind power density is 25.82 W/m². Wind energy potential of Turkey over various regions are listed in Table 1 (İlkiliç 2012), (Web 1) .

Table 1. Wind energy potential of Turkey over various regions (Hepbaslı et al. 2001, Cumali 2012)

Region	Annual average wind density (W/m ²)	Annual average wind speed (m/s)
Eastern Anatolia region	13.19	2.12
Middle Anatolia region	20.14	2.46
Black Sea region	21.31	2.38
Mediterranean region	21.36	2.45
Aegean region	23.47	2.65
South-Eastern Anatolia region	29.33	2.69
Marmara region	51.91	3.29
Average	25.82	2.58

Conclusion

This research has been carried out to show the richness of Turkey's renewable energy resources in terms of wind energy and the steps taken from past to present in terms of wind energy. Turkey is a rich country in terms of wind energy potential. Aegean Sea and the Sea of Marmara coast regions are rich in wind energy in Turkey. As a result of these measurements, it has been determined that the regions of South-eastern Anatolia and Eastern Mediterranean regions are also rich in wind in Turkey. Investments to be made in this field in Turkey, which are rich in wind energy potential as a result of researches and measurements, have been determined to increase in the coming years.

Turkey is located in a very special point because of its geographical position between the largest natural resources of the world in the east and ever-increasing demand in the west. According to the data of the Ministry

of Energy and Natural Resources, energy demand in our country will increase by approximately 7 percent on average per year until 2023.

According to the plans of the Ministry of Energy and Natural Resources, the share of renewable energy resources will increase gradually and exceed %30. And the targets of the Turkish government for renewables by 2023 are:

- Increasing energy efficiency
- Ensuring energy supply security
- Increasing the fight against climate change
- Increasing the share of renewables to %30
- Increasing the use of hydropower
- Increasing the installed capacity of geothermal power to 5,000 MW
- Increasing the installed capacity of geothermal power to 1,000 MW
- Increasing the installed capacity of solar power to 5,000 MW
- Increasing the installed capacity of wind power to 20,000 MW

And when these objectives occur, Turkey's energy future will move forward with more robust steps.

References

- Akkaya, S. and Gencer, C., Türkiye'de rüzgar enerjisi projelerinin son durumu, 3e Electrotech Rewiev 2007 in Turkey, 154, 154-157, 2007.
- Demirbas, A., (2006). Turkey's renewable energy facilities in the near future, Energy Sources, 28, 527– 536. EIE (General Directorate of Electrical Power Resources Administration). http://www.eie.gov.tr/turkce/YEK/ruzgar/RGI_AYLIK_HIZLAR.xlsS; 2001.
- Gunes ve Rüzgar Enerjisi (2009), Devlet Meteoroloji İşleri Genel Müdürlüğü Araştırma ve Geliştirme Çalışmaları; <http://www.meteor.gov.tr/webler/arge/argealt25.htmS>.
- Gençer Ç, Akkaya S, Gürkan S (2009), Wind Energy Potential In Turkey And Case Study Of Three Projects, 5th International Advanced Technologies Symposium (IATS'09), May 13-15, Karabük, Turkey
- Hepbaşlı, A., Ozdamar, A. and Ozalp, N. (2001), Present status and potential of renewable energy sources in Turkey. Energy Source, 23(7), 631–48.
- İkiliç, C (2012), Wind energy and assessment of wind energy potential in Turkey, Renewable and Sustainable Energy Reviews 16, 1165– 1173.
- Kaygusuz, K. and Kaygusuz, A. (2002), Renewable energy and sustainable development in Turkey. Renewable Energy, 25, 431-453.
- Kenisarin, M., Karsli, V.M. ve Caglar, M. (2006), Wind power engineering in the world and perspectives of its development in Turkey, Renewable and Sustainable Energy Reviews, 10 (4), 341-369.
- Ozerdem, B., Ozer, S. and Tosun, M. (2006), Feasibility of wind Farms: A Case study for Izmir, Turkey, Journal Of Wind Engineering and Industrial Aerodynamics, 94, 725-743.
- Ozgener, O. (2006), A Small wind turbine system (SWTS) application and its performance analysis, Energy Conversion and Management, 47, 1326-1337.
- Web 1 : <http://www.enerji.gov.tr/en-US/Pages/Wind>
- Web 2 : http://www.ritm.gov.tr/root/index_eng.php
- TWEA Turkish Wind Energy Association, 2018, Available from https://www.tureb.com.tr/files/tureb_sayfa/duyurular/2018/08/istatistik_raporu_temmuz_2018.pdf

Author Information

Eylem Yılmaz Ulu

Pamukkale University
Technology Faculty
Automotive Eng. Dep.
Denizli-TURKEY
Contact E-mail: eyilmaz@pau.edu.tr

Omer Altan Dombayci

Pamukkale University
Technology Faculty
Metallurgical and Materials Eng. Dep.
Denizli-TURKEY
