



Turkey's Wind Potential and Global Usage

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Received date: November 2015

Accepted date: December 2015

Abstract

The increasing need for energy and global warming clean energy has become the most popular topic spoken today. Currently 85% of the total energy is provided by fossil fuels around the world. This shows how serious the situation is in terms of global warming. These days, the world's governments are planning to make significant investments to increase usage of clean energy sources. All the world's governments are coming together to discuss global warming more frequently in these days. Wind energy is the most popular among all the renewable energy sources. Global wind potential is approximately 72 TW and only benefiting 0.5 TW (0.007%) by 2015. Turkey overall wind potential is approximately 50,000 MW and only harnessed 10 % by 2015. Only if we think the global wind energy potential as one part of clean energy, it is enough to meet the Energy needs at the national and international level. In this study, the use of wind potential in Turkey and targets were investigated. In addition, the share of the global wind potential is discussed.

Keywords: Renewable energy, wind power, wind energy potential and utilization

1. Introduction

Turkey has a considerably high level of renewable energy resources that can be utilized to satisfy a part of the total energy demand in the country [1]. One of the harvestable renewable energy resources is wind energy. Turkey is one of the richest countries in terms of wind energy potential. It is possible to make economic investment of wind energy at 48000 MW in power in Turkey [2]. Wind energy has many advantages such as it is free and clean but disadvantages are very few. Therefore, further studies on wind energy are very important to make it widespread.

Many studies on wind energy potential and utilization have been done. Kose [3] investigated the usage of wind energy to produce electricity and the possibility of electrical energy production from wind energy in the region of Kutahya. Onat and Ersoz [4] studied a detailed wind potential analysis by using two computer software programs for Samandag (Mediterranean region), Amasra (West Black Sea region) and Guney (interior Aegean region). Yaniktepe et. al. [5] investigated on the current state, potential, and development of wind energy systems in Turkey. Ilkilic and Turkbay [6] investigated assessments of the wind characteristics and wind power potential and wind energy conversion systems in Turkey for 2009. This research about wind energy shows that wind power is one of the most important energy sources for Turkey. Akpinar [7] studied wind energy potentiality along coastal locations at the North Eastern of Turkey.

For this purpose, his study were statistically analyzed wind power potentials and wind characteristics from six meteorological stations (Sinop, Samsun, Ordu, Giresun, Trabzon, and Hopa) at 10 m height

during 9 years. Dursun and Gokcol [8] investigated wind energy potential and today's and future's wind energy projects of Turkey and presented in detail. Furthermore, Renewable energy law released at the date of May 2005 was analyzed in detail because after that time wind energy movement in Turkey has shown a considerable increase. Yaniktepe et. al. [9] studied the use of wind energy to produce electricity and the possibility of electrical energy production from wind energy in Osmaniye. The wind energy potential and utilization for the various regions was investigated by many researchers [10-12].

In this study, we evaluated the wind energy potential and utilization in Turkey and around the world. The recent wind energy statistical data for Turkey and around the world was obtained from Global Wind Energy Council (GWEC), European Wind Energy Association (EWEA) and Turkish Wind Energy Association (TWEA).

2. Wind energy potential and utilization in Turkey

Turkey is rich in wind energy due to the geographic location. Fig. 1 shows wind speed distribution in Turkey. As seen in Fig. 1, it is understood that there are adequate wind currents for energy production on Marmara, Aegean, Black Sea and Mediterranean coasts. Wind flow is formed due to geographic structure in the interior region of Turkey. In these regions, a potential for wind power generation is available. Fig. 2 shows the total instalable wind power capacity according to the wind speed. As seen in Fig. 2, total installable wind power capacity at 7.0-7.5, 7.5-8.0, 8.0-9.0 and >9.0 m/s constitutes 61.15 %, 27.16 %, 11.29 % and 0.41 % of total capacity, respectively.

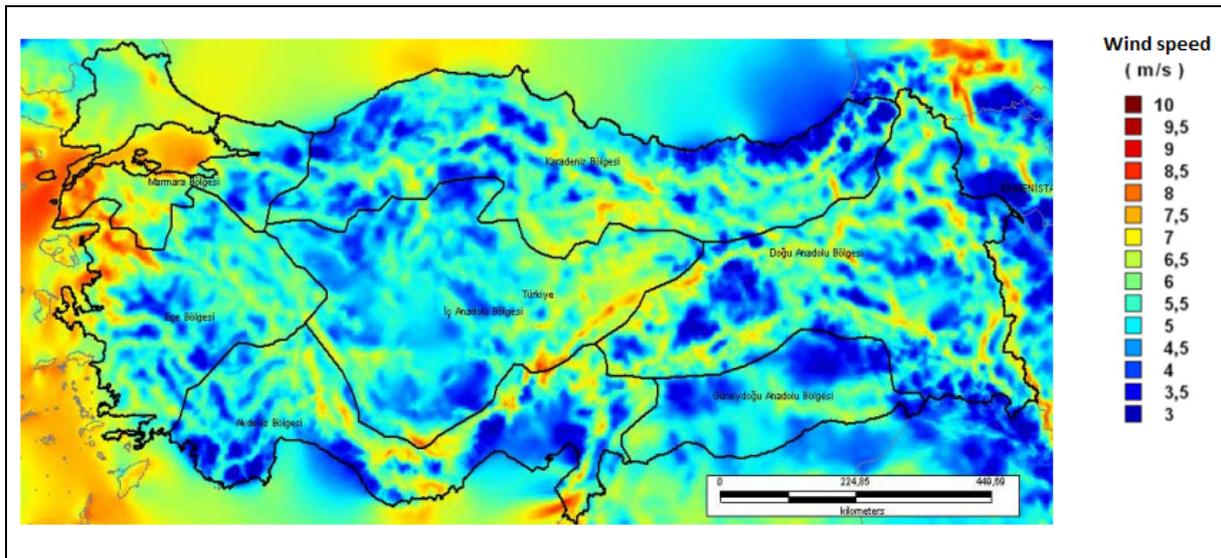


Figure 1: Wind map of Turkey [14]

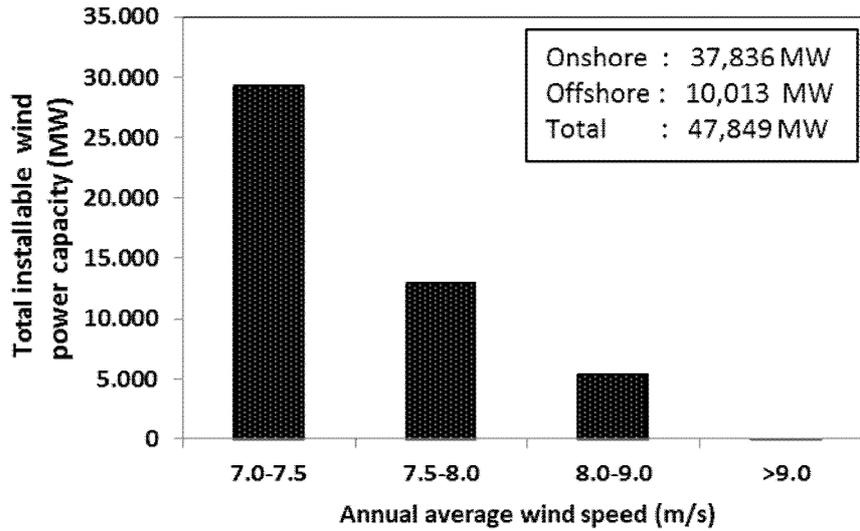


Figure 2: Total installable wind power capacity according to the wind speed [14]

Fig. 3 shows cumulative installations for wind power plants in Turkey. As seen in Fig. 3, there is almost no wind power installation in Turkey until 2005. Installed capacity of wind power has rapidly increased with government incentives after 2005. Installed wind power was reached 3762.10 MW by the end of 2014. The capacity of the wind power plants under construction is 1210.20 MW [13]. Wind energy potential of Turkey is 47849 MW for 7.5 m/s and higher speeds [14]. 7.86 % of the total wind power potential had installed by the end of 2014 in Turkey. This implies that we are at the beginning of the road in the field of wind energy.

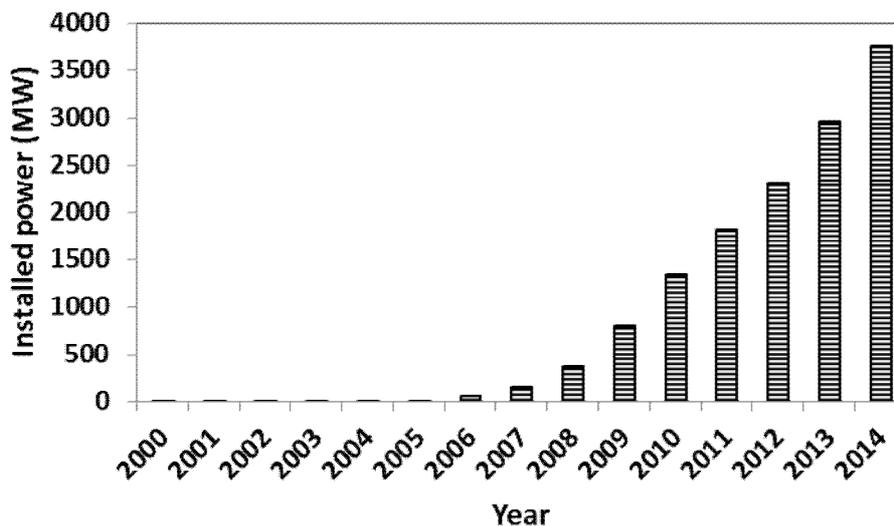


Figure 3: Cumulative installed wind power capacity in Turkey [13]

3. Wind energy potential and utilization around the world

Demand for renewable energy sources is increasing with the increasing need for energy. One of the renewable energy sources is wind energy. Wind energy has many advantages according to the other

sources. Therefore wind energy utilization is rapidly increasing around the world. Fig. 4 shows global cumulative installed wind power capacity. As seen in Fig. 4, cumulative installed wind power capacity is rapidly increasing after 2000. Installed wind power had reached 369553 MW by the end of 2014. Global wind energy potential for class 3 (5.1 - 5.6 m/s for 10 m elevation, 6.4 - 7 m/s for 50 m elevation and 6.9 - 7.5 m/s for 80 m elevation) and over is calculated as 72 TW. If only 20 % of this were used, it would be sufficient for covering the entire energy demand of the world [15].

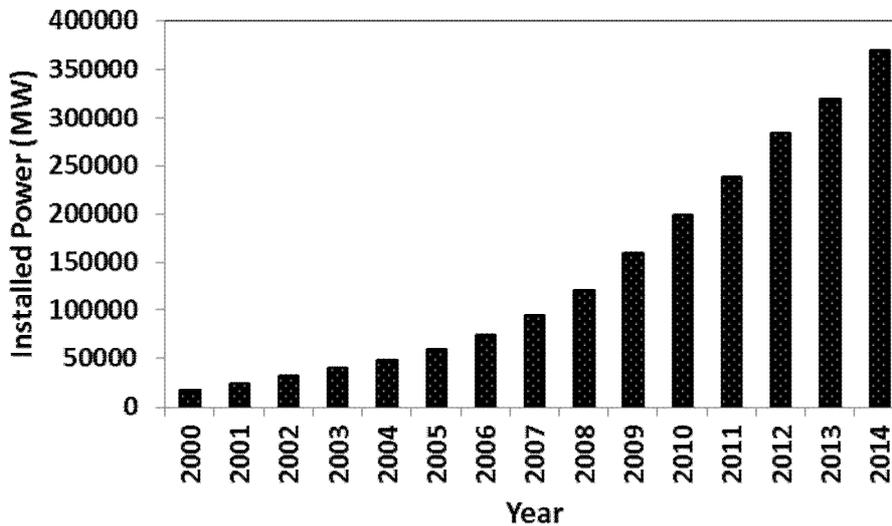


Figure 4: Global cumulative installed wind power capacity (GWEC)

Fig. 5 shows cumulative installed wind power capacity for top 10 countries. As seen in Fig. 5, China has the most installed wind power. The top 10 countries accounted for 84.2 % of the total installed wind power capacity (GWEC).

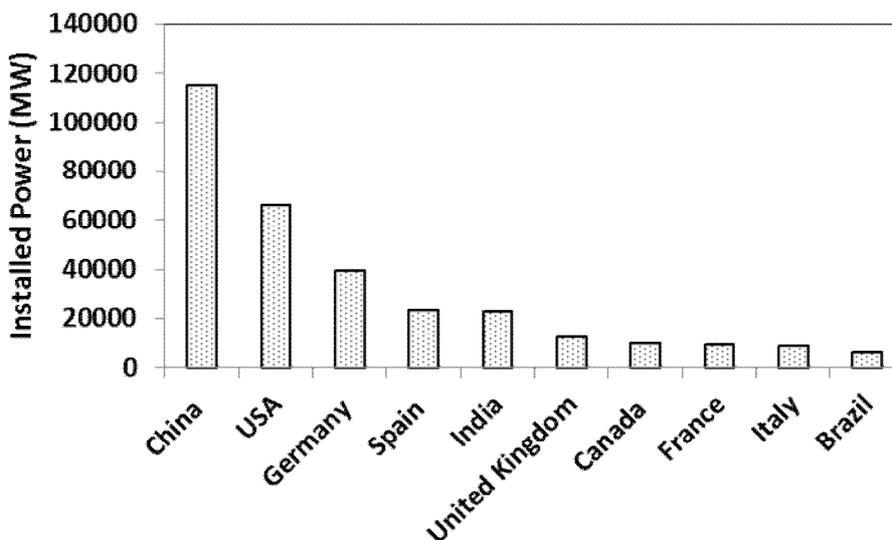


Figure 5: Top 10 cumulative installed wind power capacity (GWEC)

Fig. 6 shows regional distribution of cumulative installed wind power capacity. As seen in Fig. 6, Asia is the continent with the most installed power. In this region, 80.75 % of the installed power belongs to China. Europe comes after Asia as installed wind power capacity. In Europe, 29.23 % of

the installed power belongs to Germany. North America ranks third with 70,000 MW installed power. Installed wind power is quite low in other regions. Fig. 7 shows top 10 new installed wind power capacity in Jan-Dec 2014. As seen in Fig. 7, China continues to lead. Spain and Italy could not enter the top 10. It is observed that Turkey and Sweden enter the top 10. 803.65 MW of wind power was established in 2014 in Turkey. Furthermore, the capacity of the wind power plants under construction is 1210.20 MW in Turkey. Turkey aims 20 GW of installed wind power capacity by 2020.

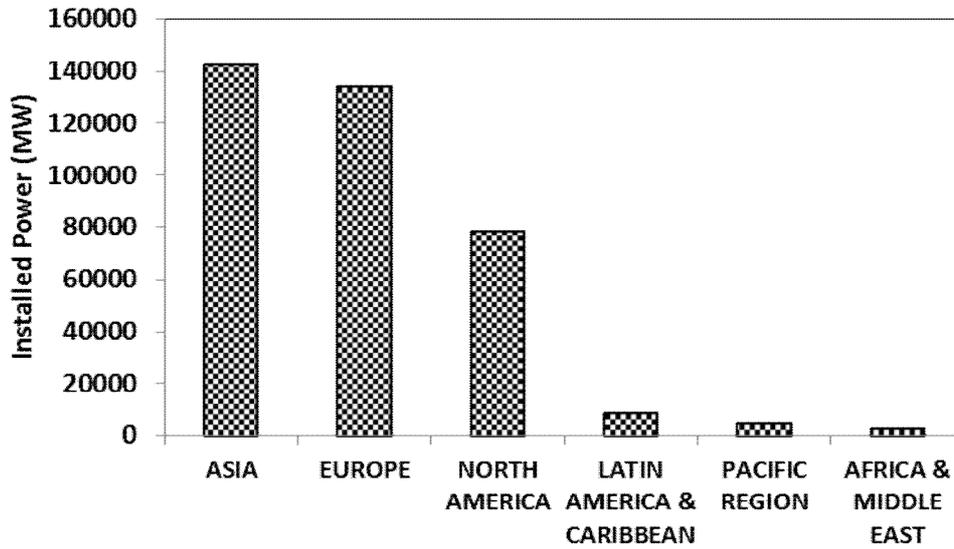


Figure 6: Regional distribution of cumulative installed wind power capacity (GWEC)

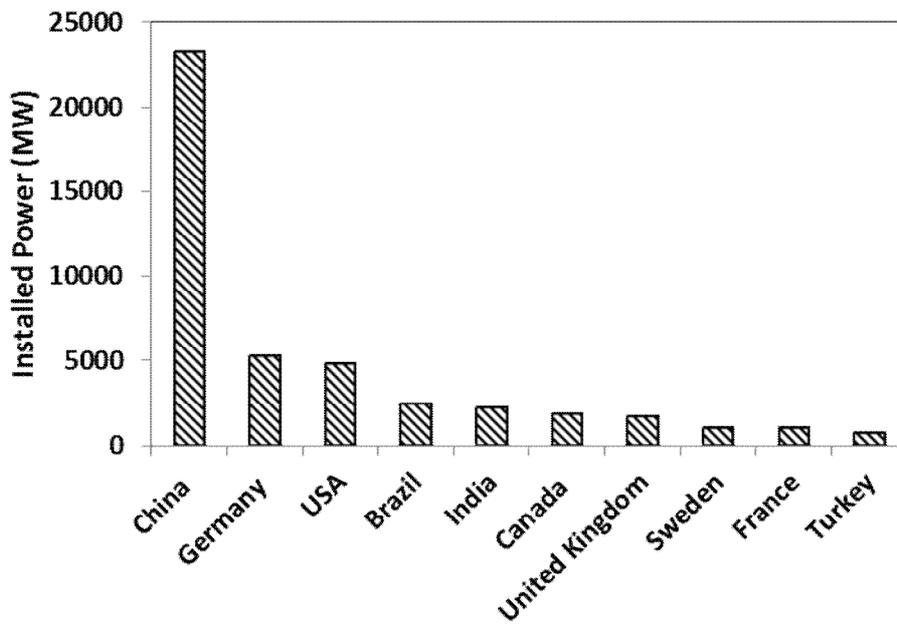


Figure 7: Top 10 new installed wind power capacity, Jan-Dec 2014 (GWEC)

4. Conclusion

Wind energy is one of the popular renewable energy sources. It has been reached a very advanced level in wind energy technology. As a result of technological developments 7.5 MW wind turbine can be installed to offshore and onshore. Today there are many companies operating in the commercial world in general and turnkey wind turbines can be established. Wind turbine installation is rapidly increasing around the world. Recently, installed wind power increasing in Turkey is notable. Installation made with outside technology transfer doesn't provide contribution to reducing the country's foreign trade deficit. The development of the domestic wind turbine technology for each country is therefore great importance. Because approximately 60% of Turkey's annual budget deficit is energy related. It should be given considerable importance to domestic production to reduce the dependence on foreign sources of energy in Turkey.

References

- [1] Hepbasli, A., Ozgener, O. A review on the development of wind energy in Turkey. *Renewable and Sustainable Energy Reviews*, 8, 257–276, 2004.
- [2] Kaplan, Y. A. Overview of wind energy in the world and assessment of current wind energy policies in Turkey. *Renewable and Sustainable Energy Reviews*, 43, 562-568, 2015.
- [3] Kose, R. An evaluation of wind energy potential as a power generation source in Kutahya, Turkey. *Energy Conversion and Management*, 45, 1631–1641, 2004.
- [4] Onat, N., Ersoz, S. Analysis of wind climate and wind energy potential of regions in Turkey. *Energy*, 36, 148-156, 2011.
- [5] Yaniktepe, B., Savrun, M.M., Koroglu, T. Current status of wind energy and wind energy policy in Turkey. *Energy Conversion and Management*, 72, 103–110, 2013.
- [6] Ilkilic, C., Turkbay, I. Determination and utilization of wind energy potential for Turkey. *Renewable and Sustainable Energy Reviews*, 14, 2202–2207, 2010.
- [7] Akpinar, A. Evaluation of wind energy potentiality at coastal locations along the North eastern coasts of Turkey. *Energy*, 50, 395-405, 2013.
- [8] Dursun, B., Gokcol, C. Impacts of the renewable energy law on the developments of wind energy in Turkey. *Renewable and Sustainable Energy Reviews*, 40, 318–325, 2014.
- [9] Yaniktepe, B., Koroglu, T., Savrun, M.M. Investigation of wind characteristics and wind energy potential in Osmaniye, Turkey. *Renewable and Sustainable Energy Reviews*, 21, 703–711, 2013.
- [10] Kucukali, S., Dinçkal, Ç. Wind energy resource assessment of Izmit in the West Black Sea Coastal Region of Turkey. *Renewable and Sustainable Energy Reviews*, 30, 790–795, 2014.
- [11] Eskin, N., Artara, H., Tolun, S. Wind energy potential of Gokceada Island in Turkey. *Renewable and Sustainable Energy Reviews*, 12, 839–851, 2008.
- [12] Bilgili, M., Sahin, B., Kahraman, A. Wind energy potential in Antakya and Iskenderun regions, Turkey. *Renewable Energy*, 29, 1733–1745, 2004.

- [13] Türkiye Rüzgar Enerjisi İstatistik Raporu. TUREB. 2014.
- [14] Çalışkan, M. EİE-Yenilenebilir Enerji genel Müdürlüğü, “Türkiye Rüzgâr Enerjisi Potansiyeli, sunu”. Available at:<[http:// www.mgm.gov.tr/](http://www.mgm.gov.tr/)>. 2015.
- [15] Hau, E. Wind Turbines Fundamentals, Technologies, Application, Economics, ISBN 978-3-642-27150-2, Springer-Verlag Berlin Heidelberg. 2013.