

Review of Turkey's current energy status: A case study for wind energy potential of Çanakkale province

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ABSTRACT

Turkey is a free market economy that is oriented towards Western markets. It also has strong ambitions to join the European Union and this factor has been beneficial but also taxing with respect to its changing economic situation. Turkey imports nearly 70% of its energy requirements. The country spends 40–50% of its total export income to import fuel, mainly crude oil and natural gas. On the other hand, Turkey has significant wind energy potential because of its geographical characteristics, such as its shoreline and mountain-valley structures. The sea fronts of the Aegean, Marmara, Mediterranean, and Black Seas, and some places of the Southeast Anatolian belt have a high wind potential, with an average speed of 4.5–10 m/s. Studies put wind-energy potential in terms of the technical aspects in the region of 80 GW.

Çanakkale province that has more than 10% of the country's total installed wind power has been presently chosen for the case study. In the present study, hourly time-series wind data recorded from the year 2000 to 2005 at a height of 10 m in Çanakkale city centre and Bozcaada, an island in the Aegean Sea belonging to the Çanakkale province, has been statistically analysed. Overall, Bozcaada, with an annual mean density value higher than 350 W/m², offers a much higher wind potential than the former location, indicating sufficient wind potential for large scale electricity generation. The mean power density value in the northeastern direction is highest for the typical year in Bozcaada with a value of 901.6 W/m², while the directional power density distribution shows that over 60% of the wind energy comes from the band between northern and northeastern directions.

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Contents

1. Introduction	2743
2. Wind power and its environmental impact for Turkey	2744
3. Wind energy potential and utilization	2745
4. Case study for Çanakkale region	2745
4.1. Analysis of wind speed and direction	2745
4.2. Analysis of wind power density	2747
4.3. Directional analysis of wind potential	2748
5. Conclusions	2748
References	2748

1. Introduction

Turkey is made up of a European part, Eastern Thrace, and an Asiatic part, the Peninsula of Anatolia, separated by the Dardanelles, the Sea of Marmara and the Bosphorous. Eastern Thrace located in the southeast of the Balkan Peninsula, makes up less than one-thirtieth of the country's total land area. Anatolia is a mountainous

area with many lakes and wetlands. The Ponticas range in the north and the Taurus range in the south form the natural boundaries for the Anatolian Plateau, which extends eastward to form the Armenian plateaus [1]. Turkey is one of the largest economies within the Balkan region achieving an average annual growth rate of 5.6% over the past 25 years and a GDP/capita of 9980 Euro (in 2009). Strong population growth of 1.45% per annum and rapid urbanization has played an important role for development of Turkey.

Turkey is a free market economy that is oriented towards Western markets. It also has strong ambitions to join the European Union and this factor has been beneficial but also taxing with respect to

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Table 1
Energy statistics for Turkey.

	2005	2006	2007	2008
Gross inland consumption of primary energy, 1000 toe	85,355	94,664	101,510	100,318
Final energy consumption, 1000 toe	13,398	14,883	16,947	16,254
Energy dependency on imports, %	71.9	72.5	74.4	–

Table 2
Turkey's population, economy and energy use.

Year	Population, million	GDP/capita, \$	Energy use, kgoe/capita
1990	56.5	4628	942
2000	67.8	9134	1140
2007	70.6	12,890	1370
2008	71.5	13,138	–
2009	72.5	12,339	–

Note: 1 kgoe = 11.63 kWh.

its changing economic situation. Turkey imports nearly 70% of its energy requirements. The country spends 40–50% of its total export income to import fuel, mainly crude oil and natural gas. The following energy and econometric data for the year 2009 will enable an assessment that pertains to the present study: energy consumption of 1370 kg of oil equivalent per capita annually (18,100 kWh/capita annum) and bank interest rates of 6.5%. Tables 1 and 2 provide data respectively on Turkey's external energy dependence and the per capita energy use [2]. Fig. 1 on the other hand presents the sectoral breakdown of final energy consumption of 71.857 (1000 toe) in Turkey as of 2008 [3].

Major price change in gas supply from Russia is now an inducement for investment in solar energy within Turkey with 45% of its electricity delivered by gas. Natural gas production in Europe is declining while demand will grow over the foreseeable future. The International Energy Agency (IEA) has determined that imports will thus grow from 35% of demand in 2009 to 65% of demand by 2030. Within the member states of EU-27 the expected growth in energy demand will reach over 80% by 2030 [4]. With gas being sourced predominantly from Russia with the latter providing 25% of OECD European consumption, countries such as Turkey would be well advised to switch to a more sustainable energy source such as solar PV.

Table 3 provides further information on energy and economy for Turkey and places it in contrast to the relevant data for the EU and the world [5]. Fig. 2 presents information on the fuel-mix for electricity generation. Of particular note is the heavy use of coal and imported gas.

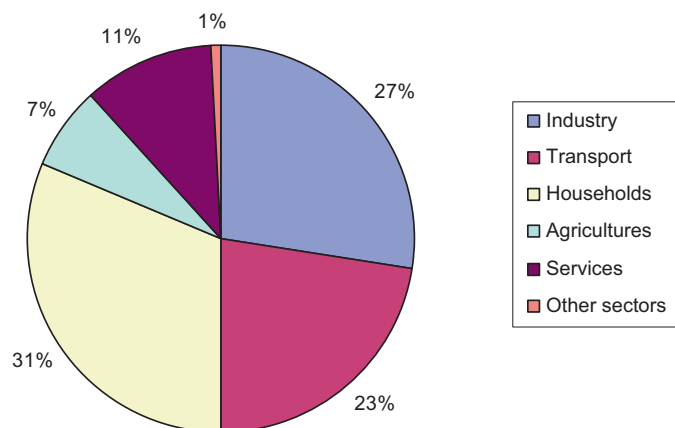


Fig. 1. Sectoral breakdown of final energy consumption in Turkey.

Table 3
Energy data for Turkey.

Turkish per capita energy consumption	15,933 kWh/annum
EU per capita energy consumption	47,440 kWh/annum
World per capita energy consumption	19,460 kWh/annum
Turkish annual increase of energy consumption	8%
Turkish per capita electricity consumption	2732 kWh/annum
EU per capita electricity consumption	5930 kWh/annum
World per capita electricity consumption	2625 kWh/annum
Turkish annual increase of electricity consumption	6%
Energy cost data for Turkey, domestic sector (June 2010 data)	
Petroleum	1.9 Euro/l
Diesel	1.5 Euro/l
Electricity	12.8 Euro cents/kWh

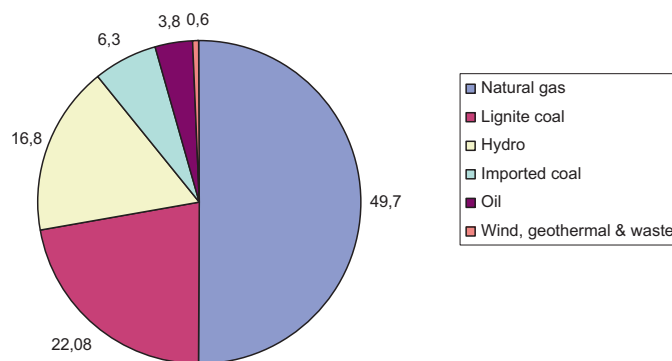


Fig. 2. Turkish electricity generation by fuel type.

2. Wind power and its environmental impact for Turkey

Turkey's income level is rapidly moving towards that of the rest of the OECD area. This catch-up process has been associated with a rapid growth of greenhouse gas (GHG) emissions. The Turkish government is now in the process of developing a strategy to reduce the growth of GHGs. This strategy will be elaborated in the context of Turkey's adhesion to the United Nations Framework Convention on Climate Change. Turkey passed the national legislation to ratify the convention in January 2004. Following adhesion, Turkey has the obligation to implement measures and policies to mitigate GHG emissions [6]. It is acknowledged that the potential of wind energy to curb global emissions is crucial for the long-term sustainability of the power sector [7]. Wind power is an environmentally clean, emission-free power generation technology. Like all renewable sources it is based on capturing the energy from natural forces and

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