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A comparative analysis of wind power density prediction methods for Çanakkale, Intepe region, Turkey

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ABSTRACT

Wind is an environmentally natural and a renewable source of energy. In most parts of the world, wind energy has been utilized as an energy source. In some developed countries, particularly in Europe, the global climate change issue has been the main cause of the wind energy developments. In parallel to these developments, the importance dedicated to the renewable energies has risen in recent years in Turkey; and the number of renewable energy operated power plants has gradually increased as a result. Determination of the potential has the priority for the energy generation from wind power studies. The present study attempts to review and discuss the status and potential of Çanakkale—Intepe region in Turkey with a focus on wind energy. Wind energy resource assessment was carried out by using WAsP software. The average wind speed data and the potential wind energy generation are determined using dominant wind directions, speeds, and the frequency distribution in between 2009 and 2010 for Çanakkale—Intepe region. The results show that the total average of wind speed for the year is 4.26 m/s and average power density is 115.5 W/m^2. Besides wind speed frequencies has been compared with the Weibull, Rayleigh and Normal distribution functions. As a result the Wiebull distribution suits and verifies the actual values. According to the analysis the most frequent wind speed is notably high. The obtained data are classified based on the measurement elevations and the energy potentials were determined using reliable meteorological measurements. Some practical data and considerations given in this study can be used by a company keen to invest in the wind potential in Intepe. A possible wind farm design was performed in the mentioned region.

Contents

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Nomenclature

$f_w(v)$	Weibull distribution function
k	Weibull shape factor
c	Wiebull scale parameter
v	wind speed
$\overline{v}$	mean wind speed
h	hub height
α	wind shear coefficient
G_i	sensitivity coefficients
X_i	measurement errors
Γ	gamma function
σ	standard deviation
$f_R(v)$	density function of the Rayleigh distribution
P_m	wind power density
ρ	standard air density
P_{mv}	average wind power density
A	average wind speed
U	figure parameter
E	energy density
f	frequency

Table 1
Resources used for electrical energy production in Turkey (2012) [10].

Source	Installed power (MW)
Natural gas	16,042.5
Lignite+hard coal	12,395
Coal	2081
Geothermal	162
Liquid gas	1798
Wind	2261
Hydro	19,620
Others (Diesel +LPG+LNG+Naptha)	2712
Total	57,072

1. Introduction

The development of the Turkish industry carried with it the demand for energy. The current energy resources are insufficient to meet this energy demand. Especially the shortage of the fossil fuels and the increase of their cost during the last few years have raised the attention towards the alternative energy resources. As the energy demand increases both for the industry and everyday life, the conventional energy resources become scarce very rapidly. According to the TEIAS's (Turkey Electricity Transmission Company) statistical data, the installed power of Turkey was 5118.7 MW in 1980, and 57,072 MW at the end of 2012. According to TEIAS's projection, installed power levels will be at 78,175 MW in

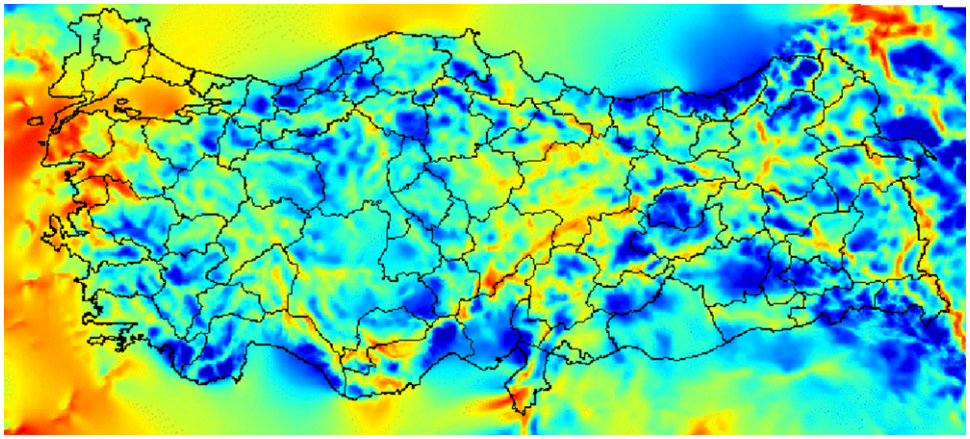

Fig. 1. Average wind speed map of Turkey (30 m) [11].

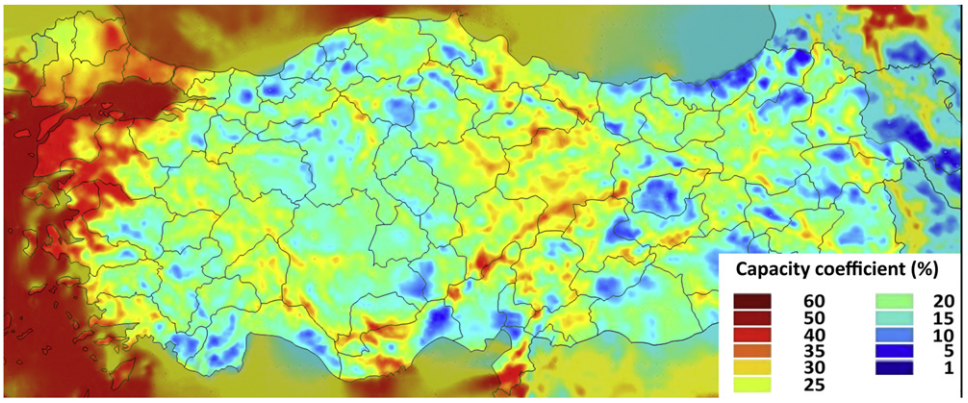

Fig. 2. Average capacity coefficient in Turkey (30 m) [11].