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Technical note

Wind energy potential estimation and micrositting on Izmir Institute of Technology Campus, Turkey

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Abstract

The aim of this study was to predict the wind energy content over the campus area of Izmir Institute of Technology. The wind data were collected at 10 and 30 m mast heights for a period of 16 months. Mean wind speeds were 7.03 and 8.14 m/s at 10 and 30 m mast heights, respectively. The 'WAsP' and 'WindPRO' softwares were used for the wind statistics and energy calculations. Suitable sites were selected according to the created wind power and energy maps. Wind turbines with nominal powers between 600 and 1500 kW were established for annual energy production calculations and best fitted ones were used for the micrositting.

Keywords: Wind energy; Micrositting; Wind site; Annual energy production; Wind farm

1. Introduction

There is a growing awareness for renewable energy resources in Turkey as a result of rapidly increasing population and industrial development. Total electricity installed capacity was 31,846 MW and total electricity production was 129,400 GWh in 2002. According to the eight Five Year Development Plan prepared by the State Planning Organization, estimated electricity installed capacity and total electricity production are 42,783 MW and 193,900 GWh for 2005, respectively. Since electricity consumption estimation is 195,100 GWh, the gap is planned to be imported [1,2].

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Turkey does not possess enough conventional fossil fuel reserves, but possesses rich renewable energy resources such as hydrolic, solar, geothermal and wind. Among all, wind energy seems to be the most suitable renewable energy resource for electricity production. The first and second wind farms in Turkey were installed in Cesme-Izmir in 1998. One with 1.7 MW nominal power capacity, generates 4,500,000 kWh electricity per year and the other with 7.2 MW nominal power capacity, generates 20,000,000 kWh electricity per year. The last wind farm, so far, with 10.2 MW nominal power capacity was installed in Bozcaada-Canakkale in 2000. It generates 30,000,000 kWh electricity per year. It must be noted that, despite her natural capacity, the usage of wind energy is very limited in Turkey.

In order to provide a broad wind resource assessment over Turkey, the wind characteristics must be studied in detail. Wind resource assessments can be divided into two main areas: regional assessment and micrositting. Regional assessment is overall estimation of the mean energy content of the wind over a large area. Micrositting is to position one or more wind turbines on a land in order to maximize the overall yearly energy output of a wind farm.

During the last decade, advanced computational methods have been developed to gain the data to use in estimation of wind energy potential and micrositting [3–7]. A precise prediction of the wind speed at a given site is essential for the determination of regional wind energy resources. Because of aerodynamic reasons, the power output of a wind turbine is proportional to the third power of the wind speed. It is a fact that, especially in complex terrain, wind energy content may vary significantly from one region to another. Therefore, wind data taken over many years are utilised to calculate wind climatology. European Wind Atlas [8] is a good example of this. Some other wind resource maps such as Wind Atlas of Russia [9] and the Irish Wind Atlas [10] also have been prepared.

According to the European Wind Atlas, the western Anatolia appears to have good wind energy potential. Izmir Institute of Technology campus which occupies 3500 ha area is located on a hilly topography right by the Aegean Sea. Several studies have been done to estimate the potential, especially, in western Anatolia [11–15]. However, further studies are necessary. This article aims to provide a wind energy potential estimation and to perform micrositting study on Izmir Institute of Technology campus in order to bridge this gap.

2. Material and method

2.1. Site selection

Wind speed and, consequently, wind energy potential are heavily influenced by the surface roughness of the surrounding area of nearby obstacles such as trees or other buildings, and by the contours of the local terrain. Therefore, in most cases, using meteorological data directly will underestimate the true wind energy potential in an area. Mast should be located in the site area where characteristic wind parameters of the location can be measured as a representative of the whole site.

The campus area which is located in Urla, Izmir, occupies 3500 ha area. It includes several hills covered with typically Mediterranean bush. Topography of the region is hilly,